بسم الله الرحمن الرحيم

Sudan University of Sciences and Technology

College Graduates Studies

Evaluation of Technetium 99^{m}-DTPA and Excretion Urography in Renal Disorders

تقويم التصوير بالتكنيشيم 99م المشع والصورة الملونة بالاشعة السينيىة لامراض الكلى

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

By

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DEDICATION

Especially To :-

- *My mother Noor El Kalifa Mohammed Elamin*
- *My brothers:Salih,Mohammad,*

  Ahmed,Yasseen,Elhassen.
- *My sister Saffia*
- *patients*
- *The soul of Computer user, Kammal Rahum Talla*

  who was died before the end.

I dedicate this modest thesis

ACKNOWLEDGMENT

I would like to express my most sincere gratitude to my supervisor

Dr Mohammed Elfadil Mohammed

for his patience and guidance through out the study. Appreciation is accorded due to our weekly meeting.

I gratitude to my colloquies , the technologists at the radiographic and nuclear medicine departments in Khartoum State , for their patience and greater help during the practical part of this study, and I record my great thanks to the computer users for their patience and help.

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Abbreviations

E.U.	Excretion Urography
^{99m}Tc-DTPA	It is a chelate, complex of diathylene-triamine - penta acetic acid
Dep. No.	Department Number
Kh. S.	Khartoum State
Pt.	Patient
N.M. Dep.	Nuclear Medicine Department
N.M. Tech.	Nuclear Medicine Technologist
Rad. Tech.	Radiographic Technologist
N.M. Ph.	Nuclear Medicine Physician
Tech. No.	Technologist Number
Son. No.	Sonographer Number
P.M.P.S.	Personal monitoring Protective System
Q.C.P.	Quality Control Program

Abstract

Despite the advances in radiologic techniques, no criterion standard exists for the noninvasive imaging evaluation of the urinary collecting system, with each modality having its own set of pitfalls that preclude optimal visualization of the entirety of the urinary system. Excretory urography has been used in general to assess the integrity of the urinary tract status. Also renal scintigraphy has been used for a long time to measure the relative renal function; where different radiopharmaceuticals such as Tc-99m DTPA were used. In this essence the main objective of this study was to evaluate the renal function using excretion urography (EU) and renal scintigraphy. This study consisted of 100 patients suffering from renal disorders; all patients underwent excretion uorography and renal scintigraphy ^{99m}Tc-DTPA. The result of this study revealed that Tc-99m DTPA showed the same sensitivity as EU which is = 100% but Tc-99m DTPA has been accomplished in a shorter time (20 mints) in respect to EU (24 hours) for nonfunctioning kidney as well as patient will receive a substantial amount of radiation dose in EU. In conclusion in EU the amount of radiation to the patient increase in respect to the patient age; where exposure factor Kv and mAs increase linearly with the patient age in addition to the delayed film (nonfunctioning kidney) which results in more exposure, where entrance-surface air kerma also increases directly by 0.3 unit per each one Kvp and mAs.

***Their for ,

- The ^{99m}Tc-DTPA renal study had definitive results for the most of the urinary tract disorder. The ^{99m}Tc-DTPA renal study was more safe form radiation protective point of view for the N.M. technologist, & had the same effect of irradiation to the patient as the excretion urography had, which was at some of radiological department not protective. Excretion urography was more available over all the radiological departments at

Khartoum State. The cost price for a patient to pay for ^{99m}Tc-DTPA imaging was cheaper than that for excretion urography. The mechanism of ^{99m}Tc-DTPA imaging procedure was easiest and comfortable for both the patient & technology than that for excretion urography.

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المستخلص

التطور التقنى فى مجال الفحوصات التشخيصية بالتصوير الطبى و وتكاثر عدد المرضى بمراكز الفحوصات ولانتشار أمراض الكلى هذه الأيام بالسودان عملت هده الدراسة لاقسام الطب النووى والأشعة السينسه المختلفة

بولاية الخرطوم . هذه الدراسة هي مقارنة بين الفحص لمرضى الكلى بالأشعة السينية الملونة للكلى Excertion Uorography والنظائر المشعة 99mTc-DTPA

- وقد اجريت فى ستة عشر قسم أشعة سينية تقليدية وأربعة مراكز طب نووى بولاية الخرطوم لمائة مريض ، كما أجريت مقابلات مع ستين تقني خمسة وأربعين منهم أشعة تشخيصية, وخمسة عشرة منهم تقنيي طب نووي. كما أجريت أيضا مقابلات شخصية مع المرضى و كبار التقنيين(17 اشعة تشخيصية و3 طب نووى) , وأخصائيين بمختلف التخصصات, ثلاثة منهم أخصائى طب نووي, وسبعة عشر أخصائي أشعة تشخيصية وموجات فوق صوتية, وخمسة أخصائي باطنية(كلى), وخمسة أخصائي جراحة كلى ومسالك بولية.
- أجريت ايضا دراسة قياسية لكل من أقسام الاشعة و مراكز الطب النووى, لمعرفة مدى جودة المبانى, والاجهزة لتوفير الوقاية والسلامة من خطر الاشعة الثانوية(secondary radiation) للعاملين والمرضى والبيئة حول الاقسام .

- عمل إستبيان لتقنيى الاشعة التشخيصية و الطب النووى, الذين شملتهم الدراسة. و خلصت نتائج هذه الدراسة على الاتى:-

= مركز الطب النووى مستوفى كل شروط الوقاية من حيث المبنى والأجهزة لكل من التقنى, والمريض, وبقية العاملين, وعملت فحص ال(99mTc-DTPA) والواقى للتقنى, للمقارنة بما وجد في بعض أقسام الاشعة التشخيصية حيث ظهر أنها غير واقية للتقنى. أما بالنسبة للمريض تأثير أشعة قاما(Gamma Ray) وال (X-Ray) فى أثناء عمل فحص ال (Excretion Urography) متساوى تقريبا, وتزيد قليلا ال (E.U.) بزيادة التعرض للاشعة الثانوية, بزيادة تعرض المريض الأشعة الثانوية واحتمالات إعادة الفحص مرة أخرى,

= نتائج فحص ال 99 mTc-DTPA نهائية وقاطعة ولا تتأثر بأي مؤثرات خارجية. كما يحدث بالنسبة لفحص ال E U. الذي قد تتأثر نتائجه بعوامل التعرض للإشعاع لعمل الصورة وعملية التحميض وخلافه.

= نسبة لوجود مراكز أشعة تشخيصية كثيرة بولاية الخرطوم, ومركز واحد للطب النووي قومى , الثلاثة اقسام الاخرى قطاع خاص, فإن عمل فحص ال . EU متوفر, مقارنة بتكاثر عدد المرضى من مختلف أنحاء القطر, فاما فحص ال 99 mTc-DTPA عدم توفره يؤدي إلى عمل جدولة المواعيد قد تطول لمريض يسكن خارج ولاية الخرطوم.

= قيمة عمل صورة ال 9 mTc-DTPA أقل من قيمة عمل صورة ال E.U فهذه تزيد من سعر أدوية التحضير وقد يعاد عمل الصورة مرة أخرى.

= كيفية عمل صورة ال (99 mTc-DTPA مريحة للمريض والتقني مقارنة بكيفية عمل صورة ال E .U فهى غىر مرىحة من حيث حركة التقني المتواصلة من وإلى الكنترول وتحميض كل صورة على حده فى بعض الاقسام وهكذا.. وأيضًا عير مريحة للمريض بالتحضير والصيام, واحتمال إعادة الصورة.

Chapter One

Introduction

Chapter One

Introduction

An unknown rays called x-rays was discovered by a physicist named Wilhalm Konrad Roentagen in 1895. This rays pass through matter and thus they used for radiological investigation. Shortly after the discovery of the x-ray, Henry Becqueral was discovered radioactivity in 1896. Marie Curie proved that these rays were different from those of Roentgen, and she identified three emissions, radium and its daughters.

The medical use of radioactivity did not occur until 1936 when radioactive phosphorus (^{32}P) was used to treat rats with leukemia and lymphomas. Treatment of humans gave similar result. In 1951, Benedict Cassen developed the first nuclear (rectilinear) scanner; this device moved lack and forth across the organ generating a picture of the organ based on the amount of radioactivity in it.

In 1958, Hal Anger took imaging one step farther with his development of the scintillation camera. This discovery, timed with the discovery of technetium-99m [^{99m}Tc], allowed nuclear medicine to more into a special medical position in the early 1970s.

The study of the urinary tract divided into demonstration of the anatomy and the study of its function. The imaging investigation includes: conventional radiography (e.g. excretion urography), ultrasonography, radionuclide imaging (e.g. DTPA studies), computed tomography and magnetic resonance imaging. The anatomy of the kidneys, ureters and bladder is best displayed using diagnostic ultrasound and excretion urography, it is better termed excretion urogrphy, rather than intravenous pyelography (I.V.P) because with modern methods the whole urinary tract, and not just the pelvi-cylyceal systems, is demonstrated. Excretion urography (E.U.) depends upon the ability of the kidneys to concentrate and excrete circulating contrast medium. Radionuclide renography is one of the older nuclear medicine techniques, which with some modifications, has survived the test of time. It played on important role in the investigation of the urinary tract providing information on individual renal function and urine excretion. Clear knowledge of radionuclide renography (DTPA studies), should be possessed by all in the medical community and in particular by those interested in renal diseases, it should be as familiar to the urologist and nephrologists. It is relatively simple to perform, well accept by patient (adult & children) and provides valuable clinical information not available with any other investigative modality.

1-1 Problem of the study

Nowadays in Sudan the urinary tract diseases are commonly affecting the population, (e.g. nephritis and renal failure), several method has been used to investigate these diseases which includes excretion urography and DTPA renal studies depending on the physician experience the therefore evaluation of these two modalities in investigation the renal problems can provide a valuable investigation trend with a limited cost and effort to the Sudanese patients.

1-2 Objectives

The general objective of this study was to evaluate the application of ^{99m}Tc-DTPA and Excretion Urography in renal studies to emphasize the priority of each as the first line of choice.

Specific Objectives

- To determine the accuracy, sensitivity and specificity of DTPA renal study and excretion urography.
- To evaluate the radiation protection status for patient and technologist.

- To evaluate the cost, suitability and efficiency , for borh methods DTPA & E.U.

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1-3 Significant of the study

This study was provide a basis for comparison between the usage of ^{99m}TC-DTPA and excretion urography in renal examination and hence was facilitate an easy ground for selection which will save money and time for the patient as well as it will speed up the process of management.

1-4 Overview of the study

This study consisted of five chapters, with chapter one is an introduction which includes; problem of the study, objective and significance of the study. Chapter two was present comprehensive theoretical backgrounds and literature review about ^{99m}TC-DTPA and excretion urography in renal examination, while chapter three is a methodology which includes material used to collect the data and method of data acquisition and analysis. Chapter four includes presentation of the result using tables and figures, finally chapter five included discussion, conclusion and recommendation.

Chapter Tow

Literature Review

&

Previous study

Chapter Tow

2.1 Anatomy & Physiology of Urinary System :-

Human anatomy is the science concerned with the structure of the human body. The term anatomy is derived from a Greekword meaning “to cut up” The science of physiology is concerned with the function of the body.

The term physiology is derived from another Greek word—this one meaning “the study of nature.” The “nature” of an organism is its function. Anatomy and physiology are both subdivisions of the science of biology, the study of living organisms.

The urinary system consists of two kidneys, two ureters**,** the urinary bladder, and the urethra (fig. 2.1). The reddish brown kidneys are positioned against the posterior wall of the abdominal cavity between the levels of the twelfth thoracic and the third lumbar vertebrae The right kidney is usually 1.5 to 2.0 cm lower than the left because of the large area occupied by the liver on the right side. The ureters, like the kidneys, are retroperitoneal. These tubular organs, each about 25 cm (10 in.) long, begin at the renal pelvis and course inferiorly to enter the urinary bladder at the posterolateral angles of its base. The thickest portion of a ureter, near where it enters the urinary bladder, is approximately 1.0 cm (0.4 in.) in diameter. The urinary bladder is a saccular organ for storage of urine. It is located just posterior to the symphysis pubis, anterior to the rectum In females, the urinary bladder is in contact with the uterus and vagina. In males, the prostate is positioned below the urinary bladder. The shape of the urinary bladder is determined by the volume of urine it contains. An empty urinary bladder is pyramidal; as it fills, it becomes ovoid and bulges upward into the abdominal cavity.

The tubular urethra conveys urine from the urinary bladder to the outside of the body. The urethral wall has an inside lining of mucous membrane surrounded by a relatively thick layer of smooth muscle, the fibers of which are directed lsongitudinally. The urethra of the female is a straight tubular organ, about 4 cm (1.5 in.) long, that empties urine through the urethral orifice into the vestibule between the labia minora. The urethra of the male serves both the urinary and reproductive systems. It is about 20 cm (8 in.) long . Three portions can be identified in the male urethra: the prostatic part, the membranous part, and the spongy part .

The urinary system maintains the composition and properties of the body fluid that establishes the internal environment of the body cells. Tubules in the kidneys are intertwined with vascular networks of the circulatory system to enable the production of urine. After the urine is formed, it is moved through the ureters to the urinary bladder for storage, and is voided from the body during maturation, which occurs through the urethra.

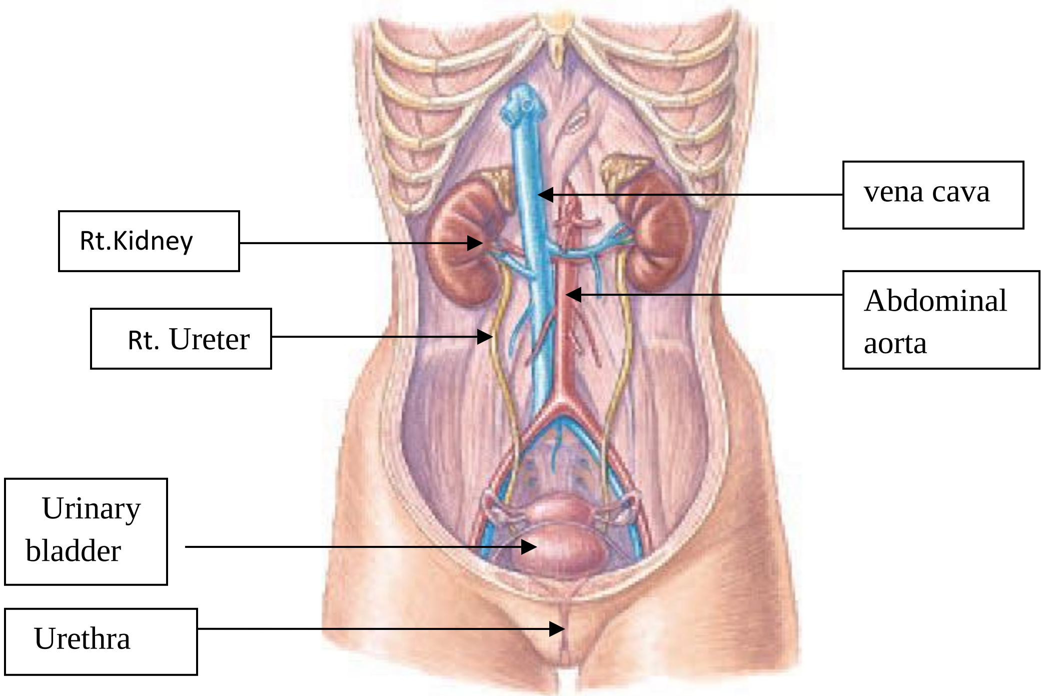

Fig. 2.1 The organs of the urinary system are the two kidneys, two ureters, urinary bladder, and urethra

2.2 Pathology of Urinary System:-

The diseases of the kidney may be classified according to its four main structural components, namely glomerular, tubular, vascular and interstitial diseases, the diseases in each case may be primary, that is, kidney is the seat of disease or may be secondary when the same renal diseases is produced by a systemic disease. On other hand the diseases of the kidney may be congenital abnormalities, aumatic conditions, infective and other inflammatory conditions, neophasms and other types of acquired disease.

Among the clinical signs and symptoms of renal diseases, the various clinico-pathologic presentation and manifestations are being defined as follow :

- *Oliguria*, is a reduction in the volume of urine over 24 hours. (out put less than 500 ml).
- *Anuria***,** is theoretically ‘nourine’ out put, ingeneral anything less than 100 ml per 24 hours is considered as anuria.
- *Polyuria*, denates excessive out put of urine.
- *Proteinuria,* normally with the use of sensitive techniques 0.05 gm of protein can be detected in the urine over 24 hours.

Protein uria is usually the first and the most reliable indication of glomerular damage.

- *Hematuria*, is passage of blood into the urine.
- *Hemoglobinuria***,** is the leakage of soluble hemoglobulin into the urine and indicates an intravascular hemolysis.
- *Azotemia* or nitrogen retention, denotes failure of excretion of end products of protein metabolsim.

- *Acute renal failure (ARF)***,** is a clinical state of oliguria / anuria in a patient with no cronic renal disease. There is a rapid increase in urea levels and other electrolyte disturbance. It may due to renal disease, or renal conditions in which there is failure of renal blood perfusion.

= *Chronic renal failure (CRF),* develops over a period of time in patients with renal diseases.

= *End Stage renal disease (ESRD)* in the irreversible state of chronic renal failure with glomerular filtration rate falling below 5 percent of normal.

=*Metabolic acidosis :*

A state of decreased sodium bicarbonate.

=*Renal colic* is one of the most painful spasmodic condition caused by spasm of ureter, due to passage of blood clot or stone down the ureter.

congenital abnormalities of kidneys and ureters :

The congenital abnormalities of kidneys, many are of a minor nature and the more are not very common. They include :

- *Congenital absence of one kidney***.**
- *Ectopic kidney* – the term ectopic means "abnormally placed" or "displaced". Usually lies in pelvic cavity or lower abdomen.
- *Congenital hypoplastic kidney* – a kidney which fails to develop normally both as regards size and in the development of its internal structure.
- *Horseshoe kidney* – a condition of which there is a partial tusion of two kidneys. The fusion is usually between the lower poles, which are joined by a band of renal tissue.

- *Duplex kidney [duplication of the renal belvis*] - in this apnormaly, which may be present on or both sides.
- *Congenital polycystic kidneys* it will be mentioned later
- *Medullary "Sponge kidney*" – it is a condition of which there is wide spread dilatation of renal tubules and associated cyst formation.
- *Ureterocele* – a localised dilatation of the lower end of the ureter. It is sometimes associated with an abnormally placed opening of the ureter.

2.2.1 Diseases of the tubules:-

Tubulointerstitial Nephritis (TIN)

TIN refers to a group of inflammatory diseases of the kidneys that primarily involve the interstitial and tubules. In most case associated with bacterial infection, the renal pelvis is involved, hence the more descriptive term pyelonephritis (Pyelo = pelvis).

Acute Pyelonepharitis :

Is a common supperative inflammation of the kidny and the renal pelvis, it is caused by bacterial infection, it is an important manifestation of urinary tract infection (UTI), which involves the lower urinary tract (cystitis, prostatitis and urethritis) or the upper urinary tract (pyelonephritis), or both.

Chronic Pyelonephritis (CPN) & Reflux Nephropathy :

Chronic Pyelonephritis : Is a morphologic entity in which predominantly interstitical scarring of the renal parenchyma is associated with grossly visible scarring and deformity of the pelvicalyceal system. (Fig. 2-14).

Chronic Obstructive PN :

Is recurrent infections superimposed on diffuse or localized obstructive lesions lead to recurrent bouts of renal inflammation and scarring, which cause (CPN). The disease can be bilateral or unilateral.

Reflux Nephropathy Chronic Reflix – Associated PN :

Results from supeSSrimposition of a urinary tract infection on congenital VUR and intrarenal reflux. Reflux may be unilateral or bilateral, the resultant renal damage either may cause scarring and atrophy of one kidney or may involve both and lead to chronic renal insufficiency.

Renal Necrosis :

Acute Tubular Necrosis (ATN) : It is a clinic pathologic entity characterized morp-hologically by destruction of tubular epithelial cells and clinically by suppression of renal failure (ARF).

Diffuse Cortical Necrosis : This is an infrequent lesion which in about 50% of cases follow the obstetric emergency of premature separation of the placenta (abruptio placenta). 30% of cases occur as a complication of septic shock.

Tuberculosis of Kidney and Urinary Tract : Tuberculosis of the kidney is an important interstitial infection of the kidney in developing / underdeveloped countries the tubercle bacilli reach kidney through blood stream, though secondarily the urinary tract may be infected by acending spread. (e.g. the genital tuberculosis is females). It is of three forms :-

= Miliary Tuberculosis due to hmatogenous spread with multiple tuberches all over.

= Ulcerocaseous tuberculosis : This is similar to a chronic pyelonephritis is which there are widespread areas of caseous necrosis in the kidney together with tuberculosis of renal pelvic lining. The pelvis contains caseous pus. There is atrophy of renal cortex and medulla.

Tuberculoma of kidney is a rare form in which solid caseous nodules form in the renal cortex.

2.2.2 Diseases Involving Blood Vessels:

All diseases of the kidney involve the renal blood vessels secondarily. Systemic vascular disease such as various forms of arthritis also involve renal blood vessels, and their effects on the kidney are clinically important. Hypertension and its effects are renal blood systemic will discuss here to show the relationship between the kidney and blood pressure.

Hypertension :-

Hypertension has been identified as the single most important risk factor in both coronary heart disease and cerebrovascular accidents, it may also lead directly to congestive heart disease and renal failure. There are two types of hypertension :-

- Benign hypertension, is the show on set prolonged cause disease, the glomeruli are shrunken and sclerosed.
- Malignant hypertension is the short on set high BP disorder, also known as accelerated hypertension and causes fibrinoid necrosis of arterioles and medial muscular hyperplasia of arteries. The glomeruli show corresponding lesions.

2.2.3. Obstructions in Urinary Tract (Obstructive Uropathy) :

The conditions that lead to urinary tract obstruction, are divided according to the anatomic location, from below upwards, as follow :-

- The obstruction in urethra includes congenital stricture of valves in children, and urethritis in later life.
- Uretero-pelvic junction obstruction.
- Obstruction at bladder neck may be due to enlarged prostate.
- Obsruction in urinary bladder includes stones, cystitis and tumors.
- Obstruction to ureters is generally due to impaction of stones, blood clots, or to pressure from tumors in the surrounding areas, or a tumor in the ureteric wall and mucosa.
- Obstruction of renal pelvis by stones and tumors.

Hydronephrosis :-

Hydronephrosis refers to the dilatation 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 common causes for hydronephrosis are :-

- *Congenital:- Atresia* of the urethra, valve formations in either ureter or urethera, aberrant renal artery compressing the ureter, renal ptosis with torsion, or kinking of reter.

- *Acquired* :- *Foreign bodies* : Calculi, necrotic pupillae.

- *Tumors* : Benign prostatic hypertrophy (BPH).

- *Inflammation* : Prostatitis, ureteritis,…etc.
- *Neurogenic* : Spinal cord damage with paralysis of the bladder.
- *Normal pregnancy* : Mild and reversible.

2.2.4. Tumors of Kidney and Urinary Tract :

Many types of benign and malignant tumors occur in the urinary tract, below are some examples :

-*Adenoma (Benign)* : Tumor of tubular of less the 3 cm size.

-*Carcinoma (Malignant)* : Tumor of tubula beyond 5 cm . Renal carcinoma presents in adult and midle age subject with three cardinal features; lump in abdomen, pain and hematuria, sometimes unexplained fever is also associated.

-*Wilm's Tumor* : Embryoma of kidney or nephrobastoma, arises from primitive embryonal renal blastoma, commoner tumor of childhood between 2 to 4 year of age.

-*Transitional Carcinoma of Renal Pelvis* : It produces hematuria, ureteropelric obstruction, the size can not grow very large because it attracts attention guite early.

-*Metastatic Tumors of Kidney* : Are not significant clinically because generally such a patient will have other more serious metastatic lesion, e.g. metastaic of lung cancer.

The Lower Urinary Tract Diseases :-

The lower urinary tract diseases are the bladder stones, cystitis, tumours…ect.

Ureteric Disease :-

- *Ureteritis* is usually a part of cystitis or chronic pyelonephritis

- *Stones* in the ureter, that are passed down from the renal pelvis.*Tumors* of ureter may be primary.

2.2.5 Urinary Bladder Diseases :

Acute and Chronic Cystitis **:** Commonly in females and children caused by suppurative organisms, fungi, parasites like schistosomiasis.

Malakaplakia : It is a form of chronic necrotizinginflammation.

*Urinary Bladder Tumor :*Cells tumours are known in the bladder association with chemical carcinogens, bladder stones and the parasite, schistosomiasis.

2. 3Urinary Tract Imaging

The urinary tract imaging are comprises various types, conventional radiography, ultrasonogrphy (U/S), radionuclide imaging, computed tomography (CT) and magnetic resonance imaging (MRI).

2.3.1 Ultrasonography (U/S) :

Ultrasonography is a diagnostic procedure employing high frequency sound waves. It is a choice examination for urinary tract and be employed as a complement to other diagnostic procedures. The frequency of the sound waves used in medical diagnosis may be between 1-15 MHz, being useful and practical frequencies. During scanning, the transducer is usually in contact with the patient's skin. To achieve satisfactory ultrasonic coupling, a thin layer of aqueous gel is first spread over the skin to as a coupling medium.

Clinical Applications **:-**

U/S used to demonstrate renal cysts, renal tumors , renal calculi , hydronephrosis , non-function kidney, bladder tumors, site for renal cyst puncture and biopsy , prostatic disease, scrotal disorders , and functioning of transplanted kidneys.

2.3.2 Computed Tomography (CT Scanning):-

This technique produces cross – sectional images and requires highly sophisticated equipment. Sensitive x-ray detectors are used to measure x-ray attenuation through the patient in a large number of different directions, and a fast digital computer then uses these measurements to compute the image.

Clinical Applications:- Computed tomography is able to enhance radiology in general. It is useful in locating, defining and staging primarytumors in most parts of the body, and helpful in following up the results of treated tumors. It is being increasingly used in the investigation of non-malignant diseases. It supplements most of the investigations performed in a radiology epartment, (e.g. renal studies).

2.3.3 Magnetic Resonance Imaging (MRI) :-

MRI is a diagnostic technique based on the fact that certain atomic nuclide, placed in a magnetic field and acted upon by a suitable ratio frequency pulse; undergo changes in their energy states which result in a measurable radio signal. This signal, after manipulation by a computer, is used to produce sectional tomography images. There is no ionizing radiation involved and so the procedure is without the known risks of X – or gamma - radiation. Magnetic resonance imaging is non-invasive and can be performed as an out patient procedure.

Clinical Application :-

MRI is performed in selected cases only and in conjunction with other imaging modalities. It is now well established for the investigation of the central nervous system, neural axis and spinal cord, pelvis (to demonstrate tumors of rectum, bladder, prostate, ovaries), heart, chest and breast.

2.3.4 Excretion Urography :-

The radiographic examination of the renal drainage or collecting system are performed by various procedures classified under the general term urography. This term routinely employed methods filling the urinary tract with a contrast medium. The first and most frequently employed is the physiologic method, in which the contrast agent is routinely administered intravenously. This method is called excretory or intravenous urography (E.U. or I.V.U) (Fig.2.2) . The second is the instrumental method called retrograde pyelography. These investigations are obtained by means of radiographic instrument, x-ray unit which will be illustrated later.

2.3.4.1. Contrast Media:

The outline of the kidney is visible on a plain film because it is surrounded perinephric fat, but pelvi-calyceal pattern is not visible artificial methods of delineating such organs are required and so a suitable contrast medium is employed. The contrast medium may have either a high atomic number and density and provide positive contrast or a low atomic number and density and provide positive(rev.) contrast, example of positive contrast media is organic iodine compounds.

The iodine contrast media is current use are solutions of the sodium and/or meglamine salts of triodinated substituted benzoic acids e.g. omnipaque.(rev.) There is a good correlation between the dose of contrast medium and plasma concentration. This is independent of the renal function. The minimum concentration of contrast agent in the glomerular filtrate necessary to produce an appreciable nephrogram is probably in the range of 70 mg. Iodine percent. This can apparently be attained with 40cc. in 1 to 2 second. Side Reactions to Iodinated Media :- The modern iodinated organic preparations (e.g.omnpaque) used for urologic examinations are of low side reactions. The clinical history of each patient must be carefully checked and all patients kept under careful observation for any sign of systemic reaction. Emergency equipment and medication to treat any untoward reaction must be available even they have low side reaction.

2.3.4.2 Instrumentation

- The imaging procedure is obtained by using conventiona x- ray unites, general and fluoroscopic ones.

- The processing of the hidden image so as to be visible, by means of manual processing system. Application of using this system may affect the quality of the image.

- Automatic processing unit. (Used in most of the diagnostic department involved in this study).

- Computed radiographic processing system is that instead of taking the image on film, you will use an imaging plate, which is processed through a computer scanner to create a digital image which can be. Once the image is digital, CR soft ware allows you to enhance and reconstruction it.

- Digital radiographic unit. Digital images are numeric images of objects. A digital computer is used to convert the information of an image which is in analogue form into digital one .This computer named the analog-to-digital computer(ADC), which is the main of the components of this unit ,examples of imaging unites which are applied this system are: CT, FLoro, MRI and Gamma Camera.

2.5. ^{99m}Tc-DTPA Renal Studies :-

Renography is the method of monitoring uptake and elimination of a radiopharmaceutical by the kidneys to give an assessment of individual renal function.

2.5.1 Radiopharmaceuticals :-

There are several radiopharmaceuticals which be used to study the kidneys and urinary tract. The choice of a particular one depends on the specific aspect of renal function being studies. Radiopharmaceuticals should have a constant composition and be radionuclidally pure and non toxic. The radionuclide to label the selected compound :

- Should have a physical half-life which is long enough to permit completion of the test and short enough to avoid unnecessary radiation to the patient.
- Should emit only gamma rays in the range of 100 – 200 Rev.
- Must not emit alpha particles or beta particles. Particulate radiation does not contribute to the image as it is not detected by a gamma camera or scanner, alpha emitters must never be used because they cause severe radiation damage.
- Must be non-toxic and capable of labeling a pharmaceutical compound which has a suitable metabolic pathway.

Radiochemical purity is defined as the proportion of the stated radionuclide that is present in the stated chemical form. The biologic distribution, and thus the quality of the image, and the radiation absorbed dose are directly related to radiochemicopurity.

Technetium – 99m (Tc – 99m), is a radionuclide of wide spread use, and of choice for a variety of nuclear medicine imaging, such as renal studies. Procedures has been based mainly on its physical properties, half live of 6 hours, energy of 140 Kev. (which provides good tissue penetration and imaging capabilities for use with gamma cameras), and it is available as a generator – produced radionuclide. It is obtained from a generator (^{99}Mo - ^{99m}Tc), which in 0.9% Nacl (saline) as a pertechnetate ion ($^{99m}TcO_4$). .There are several renal imaging agents, the radiopharmaceuticals, for demonstrating renal function :^{99m}Tc – Pentetate (DTPA, dicthylenetriamine – penta acetic acid), ^{99m}Tc-glucoheptonate (CHP), and others.

^{99m}Tc-DTPA :- It is a chelate, complex of diathylene-triamine - penta acetic acid (DTPA) and reduced ^{99m}Tc when it injected intravenously is distributed through out the extra cellular space, excreted rapidly from the body by the glomerulofiltration, and isn't reabsorbed or secreted by the tubules. Total or differential glomerulofiltration rate, (GFR), can be estimated by the method recommended by Gates using ^{99m}Tc-DTPA. This method is simple and requires only a short imaging procedure by which GFR is directly determined from the net uptake of ^{99m}Tc-DTPA by the kidneys. ^{99m}Tc-DTPA is not an ideal agent for demonstrating lesions with the kidney, because for its rapid clearance, it is, however an excellent radionuclide for demonstrating obstruction of collecting system, by use a diuretic drug such as furosemide (lasix) to be injected during imaging sequence, it can help differentiate a mechanical obstruction from stasis of the radioactive urine in the dilated pelvis and calyces. The maximum activity per test recommended by ARSAC (Administration of Radioactive Substances Advisory Committee) for the renal imaging is 300 MBq, but adequate Reno grams may be obtained with 75 MBq.

The other renal agents for example ^{99m}Tc –Glucoheptonate (GH), ^{99m}Tc-DMSA & ^{99}

2.5.2 Instrumentations :-

There are two types of instrument for radionuclide imaging; gamma camera and rectoleanear scanner. Each type consists of three main part :-

- The detecting device containing : The scintillation detector, Collimator and Phomultiplier tubes.

- The amplifier and other electronic components.

- The recording device.

The Gamma Camera : Camma radiation is detected by a large scintillation crystal of sodium iodide, which has a thickness of 12.3 mm (0.5 inch). A lead collimator prevents scattered radiation from being visualized, which would reduce resolution. Light flash from the crystal are converted into current pulses in the photomultiplier tubes and then amplified. The recording device converts these impulses into a visible record, in a form of dots providing an image of the activity distribution with the patient.

The gamma camera is the most common used imaging instrument in nuclear medicine. There are many types of it, the most commonly used is the scintillation camera, first developed by Anger in 1956, the original Anger camera used a crystal 10 cm in diameter. The developed large field of view (LFOV) cameras are over 50 cm in diameter. Now a days there a multiple crystal camera for advance imaging in nuclear imaging.

In current multiple crystal camera, a single blocked of sodium iodide is divided into 400 detector elements in a 20 x 20 matrix by partially cutting through the block. Photomultiplier tube are directly coupled to the block, and arranged in such away that each scintillation event is seen by two tubes. The difference in signal from the two tubes is electronically coded to directly yield the specific crystal location of the scintillation, display, and processing of data.

Emission Computed Tomography :

= Single Phton Emission Computed Tomography (aspect):

Emission computed tomography, in its most general use, refers to the process of producing a picture of the distribution of radiactivity in a slice through the patient. To day only transaxial approaches are in widespread use; these include single photon emission computed tomography (SPECT) and is refer to transaxial tomography with standard radiopharmaceuticals, those which emit single photon on decay as opposed to positron emitter. it widly used in skeletal, lung, liver and kidneys .

= Postron Emission Tomography (PET) **:-** PET is the exciting tomographic techniques scanning. Postron emitting radionuclides are used with this technique. A postron is an antimatter electron, and consider a postron – emitting radiopharmaceutical distributed in a patient.

PET radiopharmaceutical are now available to measure in vivo such important physiologic and biochemical processes as blood flow, oxygen, glucose, and free fatty acid metabolism, amino acid transport, PH, and neuroreceptor densities.

2. 6 Examples of Images Findings:

2.6.1. Excretion Urography Shows :-

- Pelvicaliceal system, ureters and bladder.
- Renal substance in nephrogram phase.
- Renal outline.

- Renal substance thickness.
- Urethra an micturating cystogram.

Radiographic Signs of Contrast Back Flow :-

See page of contrast medium into renal substance, outside pelvicaliceal system or into lymphatics.

a\ Pyelotubular Back Flow :-

- Stasis of contrast in tubules in pyramid.
- Fan-shaped linear opasification of mdullary pyramids imping on minor calices (Fig 2-3).

b\ Pyelosinus Back Flow :-

- True contrast back flow between renal tissue and pelvicaliceal junction may flow on to retroperitoneal tissue.
- Fig. (2-4) shows :-
  - Pyelosinus back flow (a).
  - Contrast leak on to psoas shadow (b).
- Markedly obscures detail at minor calices.
- Occurs especially from over injection in retrograde pyelography.
- Also occurs in acute obstructive uropathy, e.g. stone in ureter.

***c*\ Pyelolymphatic Back Flow :-**

- May outline renal lymph node (Fig. 2-5).

d\ Pyelovenous Back Flow :-

- Curving, perivenular contrast leak (Fig. 2-6).

Radiographic Signs :

Normal Variations :

- Medium – sized pelvis and calices (Fig. 2-7a).
- Small pelvis, long major calices (Fig. 2-7 b).
- Large pelvis, small major calices (Fig. 2-7 c).
- Minor Calices :-
    - Upper – pole calix is frequently a compound minor calix but angles are sharp (Fig. 2-8).
    - Renal substance thickness :- distance of intercaliceal line to renal margin in normal not less than 20 mm (Fig. 2-9).
- Vascular impression (Fig. 2-10).
    - Underfilled grooves or lines of lesser density in pelviceal systems due to impressions by renal arteries.

Changes in Minor Calices, Major Calices and Pelvis :-

a\ Rounding of the Angles, (Fig. 2-11).

- Earliest sign of hydronephrosis :-
    - May by transient, as after pregnancy often brought on by compression.
- If not visible on precompression film or after release of compression.
- If present with out compression, indicates early clupping.
- If in single or scattered minor calices, or in only on angle of minor calix, suspect :-

tuberculosis or pyelonephritis.

- Acute obstruction can occur without pelvicaliceal dilatation.

- Upper tract dilatation due to :
    - obstruction, refux, .. ect.

b\ Clubbing **:-**

- Later phase of rounding of angles (Fig. 2-12).
- General :
    - i.e including of all calices in the kidney (hydronephersis), may be due to : obstruction or reflux.

Pylonephritis with Renal Scaring :-

- Patchy renal disease – more often has polar distribution.
- Lesions :-
    - Scars from calix through medulla to cortex calix becomes clubbed and adjacent renal surface indented (Fig. 2-13).
    - Scars develop in growing kidneys caused by : intravenal reflux – also after ureteric diversion associated with reflux.
- Compensatory hypertrophy of non-involved part of kidney.

Tuberculosis :-

- Cubbing with excavation of renal parenchyma but little or no irregularity of renal margin (Fig. 2-14).

Congenital Lobulations :-

- Normal calices with margin dipping between (Fig. 2-15), leaving normal substance thickness.

Localized Markd Hydronephrosis :-

- Caused by : Stricture of major calix or infiltrating tumour. Stricture usually due to tuberculosis. Obstructing stone.

- Can mimic caliceal diverticulum.
- Exclude ureteric obstruction of upper moiety of duplex kidney.

Irregular Caliceal Margins :-

- Destruction of caliceal margins due to : tuberculosis, tumour and papillary necrosis.

Displacement of Calices and Pelvis :-

- Indicates a space – occupying lesion (Fig. 2-16).
- May be associated with bulge on renal margin (Fig. 2-17).
- Lesion in region of renal pelvis :-
    - Causes outward displacement of all minor calices. Narrowing of renal substance thickness stretched major calices radiating like the spokes of wheel. (Fig. 2-18)
    - Can be caused by : cyst, abscess, tumour and pseudotumour in renal hilum by sinus fibrolipomatosis (Fig. 2-19).

- Pseudotumour, Hypertrophy of Column of Bertin :-

- ‘Cloison’ or ‘cortical lump’. Commonly occurs at site of ‘incomplete’ duplex kidney.
    - Can be internal, cortical or medullary. Medullary pseudotumour : Stretching of adjacent major calices.Short stem calices – ‘teat and udder’ sign (Fig 2-28)

Distortion of Pelvicaliceal Pattern :-Displacement with rotation of multiple calices and /or pelvis with elongation of major calices (Fig. 2-20).

2.6.2 ^{99m}Tc-DTPA Shows:

- Left duplex kidney Fig. (2.21)

- Right hypoplastic kidney Fig. (2.22)

- Malrotation of the right kidney Fig. (2.23)

-Horseshoe kidney Fig. (2.24)

- Ptosis of the right kidney a) Erect b) lying supine Fig. (2.25)

- Bilateral moderate pelvi-ureteric junction stenosis Fig. (2.26)

Radiation Safety

The uses of ionizing radiation are potentially harmful, but if proper protective measures are taken the risk is small compared with the benefits. Internationally accepted unit for quantity of ionizing radiation is roentgeon . An exposure of IR will produce 2.08 x 10 ionizations in a cubic centimeter of air at standard temperature and pressure. If an object such a patient is present at the point of exposure; energy will be deposited by ionization in the patient. This deposition of energy by radiation exposure is called radiation absorbed dose, and measured in rads. One rad is equivalent to depositing 100 ergs of energy in each gram of the irradiated object. The SI unit of absorbed dose is the gray (Gy), and 1 Gy = 100 rads = 1 joule/kg. Erg and joule are units of energy. The dose equivalent is measured in rems, 1 rem = 100 ergs/g SI unit of dose equivalent is the seivert (SV), and 1 SV = 1 joule note that the rad and rem (gray and seivert) / kg. Are expressed in similar units. The basic difference between the rem and other radiation units is that the rem is used only for radiation protection purposes. In diagnositc radiology, IR can be considered to be equal to 1 rad and to rem.

Basis for Radiation Protection Standard :- The basis for radiation protection guidance was first enunciated in 1931, when the National Council for Radiation Protection and Measurements (NCRP) recommended a whole body maximum permissible dose (MPD) of 50,000 m rem/yr (500 m SV/yr) MPD is the level than which the exposed persons have been observed is not exceeded. The MPD for the population at large is one tenth of that for occupationally exposed persons, (500 m rem/yr). The phrase MPD used in preference to earlier statements of dose limitations. Radiation protection program must be consistent with ALARA concept, as previously defined.

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Absorbed Dose: Absorbed dose (D) is the quantity that specifies the energy imported to a material by any type of ionizing radiation per unit mass at the point of interest. It is defined as:

$$D = E/M$$

- E is the energy absorbed by material of mass M.
- S1 unit of absorbed dose is the gray (Gy) which is defined as the energy deposition of joule/kg of material.
  - The traditional unit is the rad : 1 Gy = 100 rad

Dose Equivalent (H) : The dose equivalent is computed quantity that expresses a measure of the biologic harm imparted tissue. It defined, at a point of interest in tissue, by the equation.

$$H = D\,Q\,N$$

D : absorb dose Q : Modifying quantity called a quality factor. N : The product of all other appropriate modifying factors that apply to a given situation.

Federal Regulations : Federal regulations concerning the radiation dose limits for radiation workers due to their occupational exposure to ionizing radiation. These limits are :-

* 50 mSv [5 rem] EDE to whole body.

* 150 mSv [15 rem] EDE to the eye

* 500 mSv [5o rem] EDE to any individual organ.

Calculation of Dosage to patients :-

The radiation dose from exposure in excretion urography is determined in the table below:-

Table(2-1) Illustrated Patient dose during Excreition Urography

Excretion Urography	**KVP**	**Mas**	**F.F.D (in)**	**Skin dose (M rad)**	**Gonand dose (m rad)**	
					Male	Female
* AP addomen	120	30	40	675/film	60.2/film	132/film
* Bladder AP	120	30	40	659/film	181/film	105/film

Consideration in Excretion Urography Imaging:-

The points at which particular x-ray attention must be paid may be summarized as follows :-

- Correct positioning, kilo-voltage, exposure factor must be used so as to prevent the necessity for repeat films.
- The primary beam must be accurately limited by means of light beam diaphragms, cones, so that only the exact area to be investigate is irradiated.
- Gonand dose should be minimized by placing lead rubber over the gonands.
- Used high Kilo voltage technique in examination of a thicker parts of body, so as to minimize the skin dose.
- Radiography of a pregnant patient should never be undertaken, and when it is carried out case must be taken to avoid, irradiation of the fetus.
- Techniques involving the use of short focus skin distances must be avoided because of the high skin doses involved.
- The grid should be used, as too high a grid ratio may lead to an increase in the dose received by the patient. Use air gab technique instead of a grid for such examination. (e.g. obese patient at the pelvis area).

Consideration in ^{99m}T-DTPA Imaging:-

Dose Limits :-

Dose rates for staff and patients can be measured directly with a survey instruments, e.g. scintillation detectors (Na1), typical figures 30 cm and m from a patient who just been injected with 500 MBq of Tc being 6.5 mGy^{-1} and 2 m Gyh^{-1}. Notice that the dose rate does not decrease in accordance with the inverses square low (ISL) because the patient is an extended source.

All technical and nursing staff will be issued with personel monitoring badges, e.g. film badges or thermolumin escent dosimetry (TLD).

Dose equivalents should not exceed 0.2 – 0.4 mSv per month. Calculations of dose to the patient from internally deposite radionuclide is much more difficult because the activity will be distributed to and cleared from. The organ contain the actvity iscalled the source organ (S), and the organ for which the dose is being calculated the target organ (T).

Table 2.2

99mTc- DTPA administration Effects Dose administrated is 200-750 MBq

Organ	**Distributed Activity**
- Kidney S	- 0.8 – 30 mGy (8 – 30 m rad)
- Bladder S	- 7.0 – 30 mGy (700 – 3000 m rad)
- Gonads T	- 0.5 – 2.0 mGy (45 – 200 m rad)
- Ovaries T	- 0.8 – 3.0 mGy (8 – 38 mrad)
- Whole body T	- 0.4 – 1.6 mGy (8 – 300 m rad)

Effective dse equivalent 2.0 – 7>5m Sv [200 – 750m rem]

Staff Safety :-

Radiografic and nuclear medicine departments must be well designed and well equipped so as to be well protective to both the staff and the patients.The procedure for justifying radiation exposure involves balancing the harm against the gain from the Practice involving radiation. The working staff should have no difficulty in complying with the internationally agreed dose limits, there fore the ALARA principle is to the overriding one. The staff must be advised of basic physical Principles which can reduce their radiation dose. The advice on protection should be formulated in the local departmental rules procedures. Copies of relevant rules and regulations should also be on display in the department.

The physical factors in radiation protection for ^{99m}T-DTPA imaging as follows :-

- **Time** ***:*** Must be kept to a minimum.
- Patients to whom radioactive materials have been administered are radioactive sources. Therefore all patient examinations, markings, interview, documentation, should be carried out before injecting the radio-pharmaceutical.
- Radioactive waste and contaminated items must be quickly removed to a safe place.
- **Distance :-** Gamma radiation obeys the inverse square low (ISL) :
  - Doubling the distance from a point source reduces the does rate by a factor of four, therefore put as much distance as possible between yourself and radioactive sources. Using carrying boxes, handling tools and forceps.Use a larger size syringe.
  - Increase the distance between the source and the finger whether a syringe shield is used or not.

- Use methods which ensure an adequate distance between radioactive patients and others.

Shielding :-

- Use shielding e.g- syringe shields.
  - Put radionuclide generators behind lead walls.
  - Put radionuclide generators behind lead walls.
  - Shield the bench surface.
  - Work with lead or a lead glass screen between you and radioactive material.
  - Keep stock solutions in lead pots.

Contamination :-

To protect against external radiation and also against the possibility of contamination:-

- Wear gloves when dealing with radioactive materials or containers that may have been contaminated.
- Wash and monitor your hands frequently.
- To avoid the possibility of in advent ingestion of radioactive material, observe the restrictions on eating, drinking and smoking.
- Clothes should be protected by wearing a laboratory – type coat.
- Since gloves are likely to become contaminated while working with radioactive materials, use a paper handkerchief to touch instrument switches.

Decontamination of Persons :-

- Remove contaminated clothing as soon as possible, taking care not to spread the contamination.

- When high – level contamination of any part of the body is suspected, do not take a bath until the affected areas have been cleaned locally. Wash contaminated hands repeatedly with large quantities of soap and running water. Do not break the skin.

Patients Safety :

If the staff are well and trained, then it is possible to ensure the safety of the patients, since every aspect of nuclear medicine work has a bearing on patient safety. Good quality radiopharmaceuticals are needed, and their activity must be assayed accurately.

The test must be fitted into the sequence if investigations known as "diagnostic strategy" in such a way as to obtain the maximum benefit from the information it can provide.

Patient preparation should be with correct instructions so as to avoid repetition.

Lactating Mothers:-

- Close contact with an infant should be avoided for a period of 24 hr.
- Variable amounts of radioactivity appear in breast milk, and estimates show that in the worst case one – tenth of the ALI could be exceeded in a single feed if it were taken shortly after the mother had received 1 GBq of ^{99m}Tc, therefore a delay of 24 hr prior to recommencement of feeding is strongly recommended.

Disposal of Waste:-

The clinical use of radioactive materials will invitated result in radioactive waste. The waste are liquid and solid.

Storage of Waste :-

- Waste a waiting disposable should be stored in closed containers.

- Storage period should not exceed two weeks.
- Longer live materials, may require longer storage before disposable.
- Each hospital should have at least one storage area for radioactive waste.
- The area must be lockable and clearly marked with a radiation worming symbol, and it must be adequately shielded.

Transport of Waste : For transportation of rad-wastes, it should be proper packaging, labeling and documentation.

Waste Records :- The waste record should indicate :-

- The radionuclide and its activity.
- The disposal rout.
- The date on which the disposal was made based on different principles for the complete evaluation of the renal scan.

Previous study

The previous studies founds are almost fourteen , illustrated as follow:-

1\ Oscar et al study the application of Renal scintig raphy in initial evaluation of renal colic in order to determine the role of renal scintigraphy (RS) in patients with suspected acute urinary tract obstruction, a prospective study was performed comparing RS with emergency intravenous excretory urography (IVU) in 36 examinations. Their results showed that sensitivity was = 93 %. The results of their study support the use of RS combined with a plain film of the abdomen in the initial evaluation of renal colic.

2\ Peter and Leonard in renal transplant stated that renal ischemia, whether caused by mechanical obstruction of the blood vessels or ureter or immunological rejection can be detected by qualitative and quantitative perfusion studies using 99mTc-complexes such as pertechnetate, glucoheptonate and DTPA.

3\ The Radiologist and the Radiographer at McKinley Health Center radiology unit were evaluated structure and function of the kidneys ureters and bladder for a renal patient by excretory urography and illustrate the risk of allergic reactions to iodine dye and preparation of the patient .The test values, reveal fine details of the structure & function of the urinary tract. Normal values, no abnormalities seen. Abnormal values, their abnormalities e.g. renal stone, tumors.

4\ klaipetch et al. were studied whether nonopacified kidney on excretory urography and DTPA indicate nonsalvageability .They reviewed 45 adult patients with chronic unilateral urinary tract obstruction, in whom IVU revealed nonopacified kidney on one side but normal excretion on the contralateral side Their results showed that most nonopacified kidneys on IVU were nonsalvageable, a quarter of them were found to be salvageable on renal scintigraphy.

5\ Milena et al. their experimental studies were made in thirteen patients with one side renal stone using radionuclide & excretion uorography ,and with various animal models showed histological changes of renal tissue after ESWL treatment., Radionuclide studies were made in 3 patients within one week before and after ESWL treatment . Ex-cretory parameter indicated urine flow improved in 4 patients and a delay in 3 patients. Pre-ESWL studies by 99mTc-DTPA detected decreased renal function in 4 patients, while Post-ESWL study with99mTc-DTPA demonstrated the increase of glomerular function in one patient and the decrease in 2 patients. This finding points the need to evaluate renal function before as well as after ESWL treatment in order to assess treatment success or complication occurrence.

6\ American College of Radiology (ACR) guidelines published in 2010, delineated the accepted indications for Excretion Urography, so as to evaluate uriteral obstruction , assess urinary tract status post trauma, congenital abnormalities, different types of lesions such as, hematuria , infection & masses. On other hand they discusses the risk factors pertaining to use of iodinated contrast , such as, allergy , asthma , cardiac status , renal insufficiency & miscellaneous. And also discusses the contraindications conditions for using compressing band, illustrated as follow: obstruction on the 5-minute image, abdominal masses, severe abdominal pain, abdominal surgery, trauma, urinary diversion, renal transplant.

7\ Peter L. Choyke, & Am Fam Physician, (2008) were discussed radiologic evaluation of hematuria. Most adults with hematuria require urinary tract imaging. Intravenous pyelogram urography represents the standard leading techniques. Illustrative e.g. cases,(1) a 69-year-old man a long history of smoking presented with gross hematuria, by excretory urogram demonstrated a radiolucent filling defect in the distal left ureter. (2) At the time of cystoscopy, bilateral retrograde pyelography is often employed toevaluate the upper tracts for pathology, and plain radiographs are obtained.

8\ EK Fishman et al. Initially evaluated patients with cervical cancer by excretory urography. One hundred patients with carcinoma of the cervix were studied to determine the excretory urography is needed for routine evaluation . Excretory urography gave more information in 10 patients. Twenty one hydroureters were identified by it. Excretory urography is currently sufficient in evaluation of stage I or IIA lesions.

9\ Rephael Drachman et al. evaluated children patients with a first episode of urinary tract infection by excretory urography and cyctourethrography. Their study were made in One hundred and ninety-one children underwent intravenous pyelography. Only three children (1.5%) had positive findings in the IVP that were of prognostic significance and were confined to that particular investigation alone.

10\ Michael R. Littner et al. Their sudy were evaluated Bronchospasm during Excretory Urography made on 57 patients, whom mean pulmonary function was decreased during excretory urography. Patients with a history of allergy had significantly greater mean decreases in flow rates than those without. sMost patients undergoing excretory urography have bronchospasm that is greater in magnitude in those with a history of allergy.

11\ Hulya Yalcm et. al. their study involved 144 patients who had both dynamic and static renal imaging , and aimed on determining can Tc 99m DTPA be used in adult patients in evaluation of relative renal function measurement as the reference Tc 99m DMSA method . the patients complained of differ diseases, thirty four patients had hydronephrosis, 28 pyelonephritis, 53 renal calculi, 3 chronic renal failure, 2 acute renal failure, 1 benign renal neoplasia, 15 renal atrophy and 8 ureteropelvic junction stenosis. The result was Tc 99m DTPA is also a good method for the relative renal function evaluation when compared to Tc 99m DMSA scan. Although Tc 99m DMSA is the most reliable method for the calculation of relative renal function, Tc 99m DTPA can be another choice for the calculation of relative renal function without a complementary DMSA scan particularly in patients who require renogram curve and GFR calculations.

12\ Katerina M Antoniou et. al. they were studied prospectively 18 patients (14 male, 4 female) of median age 67yr (range 55–81) with histologically proven Idiopathic Pulmonary Fibrosis (IPF). HRCT scoring included the mean values of extent of disease. . Mean values of these percentages represented the Total Interstitial Disease Score (TID).The aim of their study to assess the clearance of technetium-99m-DTPA and HRCT findings in the evaluation of patients with Idiopathic Pulmonary Fibrosis (IPF). The result was 99mTc-DTPA lung scan is not well associated with HRCT abnormalities, PFTs, and BALF cellularity in patients with IPF. Further studies in large scale of patients are needed to define the role of this technique in pulmonary fibrosis.

13\ K.Senthamizh selvan et. Al. were studied the glomerular filtration rate estimation by cockcroft-gault, mdrd and ckd-epi formula in comparison with dtpa renal scan – a comparative study among live related kidney donors in south india. They aimed to estimate GFR by prediction equations namely COCKCROFT-GAULT, MDRD and CKD-EPI, among live related kidney donors and to analyze how closely the GFR calculated by these equations correlate with that of DTPA renal scan., for undergoing 50 donors evaluation at the Department of Internal

Medicine and the Department of Nephrology, Government Stanley Medical College and Hospital, Chennai, India. The result was that DTPA scan cannot be substituted by the GFR psrediction equations in special situations like renal transplantation. Further studies are required to find newer ways of estimating GFR which can be applied in all clinical setting.

14\ W.R. Cattell et. Al. evaluated excretion urography in acute renal failure High-dose excretion urography has been carried out in 32 patients presenting with non-obstructive acute oliguric or non-oliguric renal failure An early, dense, persisting nephrogram has been observed in all patients with acute uncomplicated tubular necrosis and in patients with acute oliguric pyelonephritis. The study demonstrates that careful analysis of the evolution of the nephrogram in patients with acute renal failure provides valuable information as to the nature of the parenchymal disease.

Conc. :-

11 studies of 14, their results showed a same sensitivity (100%),which support the use of EU. combined with ^{99m}Tc-DTPA in renal disorders investigations. 4 studies showed sensitivity (75%) of the study.

Chapter Three

Methodology

Methodology

This study has been conducted in the period of 2012 to 2014 in 16 x-ray department Khartoum Teaching Hospital, Khartoum North Teaching Hospital, Soba Teaching Hospital, Ibn Cinaa Teaching Hospital, Friendship Chinese Hospital, Advance Diagnostic Centre Khartoum, Advance Diagnostic Centre Khartoum North, Assiaa Hospital, Fedail International Hospital, International Hospital Khartoum North, Royal Care International Hospital, Albraaha Hospital, Antallia Medical Centre, Modern Medical Centre, Alneelain Medical Centre and Academic Teaching Hospital) where data about excretion uorography were collected. The ^{99m} Tc – DTPA were collected from 4 departments which includes: Nuclear medicine department, Khartoum Centre, Fedail International Hospital, Royal Care International Hospital and Alneelain Medical Centre.

3-1 Material

- The x-ray machine (specification of x-ray machine) .
- The gamma camera (specification of gamma camera) .

3-2 Design of the study

This is a descriptive, cross-sectional study

3-3 Population of the study

This study consisted of patient with renal disorders and investigated using excretion uorography and ^{99m}Tc-DTPA.

3-4 Sample size and type

This study consisted of a convenient sample type of 100 patients underwent excretion uorography and ^{99m}Tc-DTPA

3-5 Method of data collection

3.5.1 Excretion Urography Technique :

Excretion urography depends upon the ability of the kindneys to concentrate and excrete circulating contrast medium. It is better termed excretion urography rather than intravenous pyelography (IVP) because with modern methods the whole urinary tract, not just the pelvi-cylyceed systems is demonstrated.

Preparation of the Patient:-

- He should be told also that he will be given a simple, when making the appointment the patient should be warned that the examination is likely to occupy an hour to an hour and a half.
- Injection of 'dye'.
- Physical preparation of the patient after consists of the form of general abdominal preparation current in the department, the patient should take a suitable diet on each of the two preceding nights, The patient should take laxative and gas absorption tablets, so as to have intestinal tract free from gas and fecal masses, and should be fasting 6hours before the examination. The reason for this is to obtain concentration of the contrast medium in the renal pelvis and there for visualization of radiographic detail.

Preparation of the Trolley:

Sterile (upper shelf)

- One 5 ml and one 50 ml disposables syringe.

- One small dressing boul or covered dish for gauze or wool swabs and a towel.

- One kidney dish or closed contain in which to place the syringe and needles.

Non – Sterile (lower shelf)

- Ampoules of the contrast agent e.g omnpaque 40 ml.

- A file for opening the ampoules it is necessary & spirit.

Radiographic Procedure:-

Preliminary Films (K.U.B)

Control films of the renal tract are taken, to insure that the renal area are free from bowel gas and fecal masses.

- The patient is placed on the examination table in the supine position, midsagittal plane of the body is centered at the table centre.
- A support should be placed under the patient knees to reduce the lord tic curvature of the lumbar spine.
- The cassette or sensitive plate size(17 x 14 in) in case of using CR processing system is placed in the Bucky tray.
- The cassette or plate size (10 x 8 in) is used for bladder.
- Centre point at the level of the third lumbar, or at the centre of the cassette or sensitive plate.

- Illustrate the preliminary film (KUB).

Contrast Films (IVU) : Contrast Medium e.g. Omnpaque 40 ml)

- After check KUB film or plain film the technologist should prepare the contrast medium for injection using aseptic technique.
- The cassette or plate sizes (17 x 14 in) used for antero-posterior abdomen, centre at level of the third lumbar vertebra.
- The cassette or plate size (10 x 8) used for antero-posterior bladder, 15 degree angulations towards the feet, centre at the mid way between the superior iliac spines.
- Identification, side, and time – internal markers are positioned.
- Any change in centering or exposure technique is made as indicated by the scout radiography.
- 20 to 40 ml of the contrast medium is administered to adult patients of average size.
- The dosage administered to infants and children is regulated according to age and weight.
- A compression band is applied to the lower abdomen to compress the ureters and delay the passage of the medium down the ureters from the renal pelvis.
- Radiographs are made at specified internal from the time of the completion of the injection of contrast medium.

- Immediately after each film is exposed, it is processed and reviewed to determine according to the kidney function of the individual patient, the time intervals at which the most intense shadows will be obtained, a typical sequence would be : 5 min after injection (in expiration technique), 10 min after injection (in inspiration technique) and 20 min after injection (in expiration technique).

- Depending on whether the patient is partially dehydrated and on the speed of the injection, the contrast agent normally begins to appear in the pelvicalyceal system within 2 to 8 minutes, the greatest concentration usually occurring is 15 to 20 minutes.
- The compression is then released and a film may be takens of the whole urinary tract in an attempt to demonstrate the ureters and bladder.
- Alternatively, a film of the bladder only may be taken, followed by a further film after micturition when required, mainly for adult males to demonstrate the prostate.
- In cases of suspected ureteric obstruction, where no function is shown is one kidney up to 30 min, further films may be taken up to 24 hr, when delayed filling may be observed.

*Evaluation***:** Entire renal shadow should be included, bladder and pubic sumphysis should be included, and there should not be any motion.

Exposure Factors: usually for adult and stander size patient; KV = 70, mA = 200, time = 0.25 s with focus film distance of 40 inches.

X-ray Radiation Measurement:-

The measurement had been obtained during the E.U. imaging at 16 departments at Khartoum state as follows

- The first test point, at three meter away from the focus point of the x-ray beam.
- The second test point, at the cubic control area, which was vary in situation from radiographic department to other.
- These tests had been repeated for hundred patients.

3.5.2 ^{99m}TC-DTPA Protocols :-(Techniques)

When ^{99m}T-DTPA is injected intravenously and the count-rate over each kidney recorded, the resulting time – activity curve is known as a renogram, it is usual include curves for kidneys, the bladder and a background.

A normal renogram comprises of three phases:

- Vascular or perfusion phase, the initial sharp rice.
- Secretary or functional phase.
- Drainage or excretory phase.

In the renogram the kidney curves are usually symmetrical and not identical. The peak of the Reno gram lies in the range of 3-5 min post injection it will take 10-15 min for the activity to drop to the half its peak value, the clearance half time. Since the renogram was obtained from data stored on a computer, the opportunity exists for further data processing; there are two categories for this tends :-

Background subtraction.

- The renal function or perfusion by using deconvolution techniques.

Renal Clearance Studies:-

The mechanism of renal clearance depends on the pharmacentical used. ^{99m}T-DTPA is cleared by glomerular filtration while (^{123}I) OIH is cleared mainly by tubular secretion. A renogram carried with ^{99m}T-DTPA therefore assesses glomerular filtration rate (GFR). Similarly, when (^{123}I) OIH is used, the renogram is assessing effective renal plasma flow (EFPF).

^{99m}T-DTPA Imaging Protocols:-

The sequence of the particular procedure as follow:-

- Preparation of ^{99m}T-DTPA.
- Activity administrated (the close) 200-750 MBq, (5-20) mCi.
- Set the gamma camera for the gamma ray energy of the radionuclide (technetium-99m) and select the collimator (usually low-energy general purpose).
- Set up the computer system for an acquisition of 20s frames for a period of 40 min.
- Make sure that the patient is properly hydrated – 200 ml fluid given about 30 min before injection with in patient.
- Send the patient to empty his bladder immediately prior to injection.
- The patient by in supine position on the examination table and the gamma camera put under the tube facing upward, so as to obtain a posterior view. Anterior preferable for horseshoe kidneys and pelvic one.
- By means of the persistence oscilloscope to position the patient to include the whole region of interest (kidneys and bladder).
- Inject the ^{99m}T-DTPA intravenously as quick as possible.
- At the time of injection start the acquisition process.
- If diuresis is not indicated, the procedure may be terminated at 20 or 30 min.
- If a duretic dose is necessary, prepare a syringe with 0.5 mg/kg body weight. of frusemide and inject it intravenously at approximately 20 min. the acquisition should continue for 10-15 min after the frusemide injection.
- In certain cases it may be necessary to send the patient to empty his bladder and then continue with the acquisition process.

- When the study is completed, send the patient to empty his bladder before leaving the department.
- Proceed to analyses the data in the computer and produce the renogram image display for report.

Renogram Analysis:-

It is recommended that counts in the derived renogram be represented as a percentage of injected doses. The analysis performed as follow:-

- Display the images, checking for patient movement and validity of the data.
- Sum the first 12 frames and the last 12 frames in order that the kidneys and bladder can be seen clearly.
- Draw regions of interest (ROJ), for each kidney, bladder and a background region.
- If indicated delineate ROI within the kidney area.
- Generate the curves for each region and correct the curves for background.
- Convert the counts to percentage dose and determine the relative function for each kidney by means of the computer program used for this purpose.
- Produce the copy of results.

Deconolution Analysis:-

- Repeat steps 1 and 2 as above.
- Create a ROI for each kidney and a blood region in a vascular area above the left kidney over the lower border of the heart.
- Display the region of interest over the kidney in a frame where the renal pelvis is clearly visualized.

- Generate the curves corresponding to the regions.
- Run the computer program which carries out deconvolution analysis.
- Produce a copy of the results, count rate curves and in put retention functions and tabulate the mean transit times.

Frusemide – 15 Reno gram: Frusemide may be given 15 min before the administration of ^{99m}T-DTPA and standard renography is then performed, the actual renographic procedure lasts 15 – 20 min.

Gamma camera Radiation Measurement:-

For gamma camera these departments had been assessed for radiation protection.

The test had been done for by means of radiation monitor, PW 4514 "Philips " so as to detect if there was scattered radiation of both gamma and x-rays in the departments, at two specific test points as follows:

- The first test point, at one meter away from the radioactivity administered patient, viz he was an extended source. Thus the test was repeated at 30 cm from the patient.
- The second test point, at the computer systematic control area, which was at two meter from the exanimation table.
- The tests obtained just after the injection of ^{99m}Tc-DTPA during the imaging procedure. These tests had been repeated for hundred patients.

Chapter Four

The Results

The Results

The leftover data collected for this study had been collected by means of :-

- Ques data tionnaire for radiographic & nuclear medicine technologists .

  The Technologists whom had been selected for this study are 60 (sixty tech.s) , 45 (for five) radiographic technologists & 15(fifteen) nuclear medicine technologists.

* Focused interview: with 100 patients underwent excretion uorography and renal scintigraphy ^{99m}Tc-DTPA , 17 radiologists ,3 nuclear medicine physicians ,16 senior radiographic technologists , 4 senior nuclear medicine Tech.,10 physicians and surgeons (urologists & nephologists)

. Table(4. 1): Frequency distribution of renal dysfunctions

FINDINGS	Frequency
None function kidney	26
Poor function kidney	9
Delayed function kidney	15
Obstructive nephropathy	16
Renal failure	9
PUJ obstructed + Hydronephrosis	14
Uriteric obstruction + Hydrouriter	11
Total	100 %

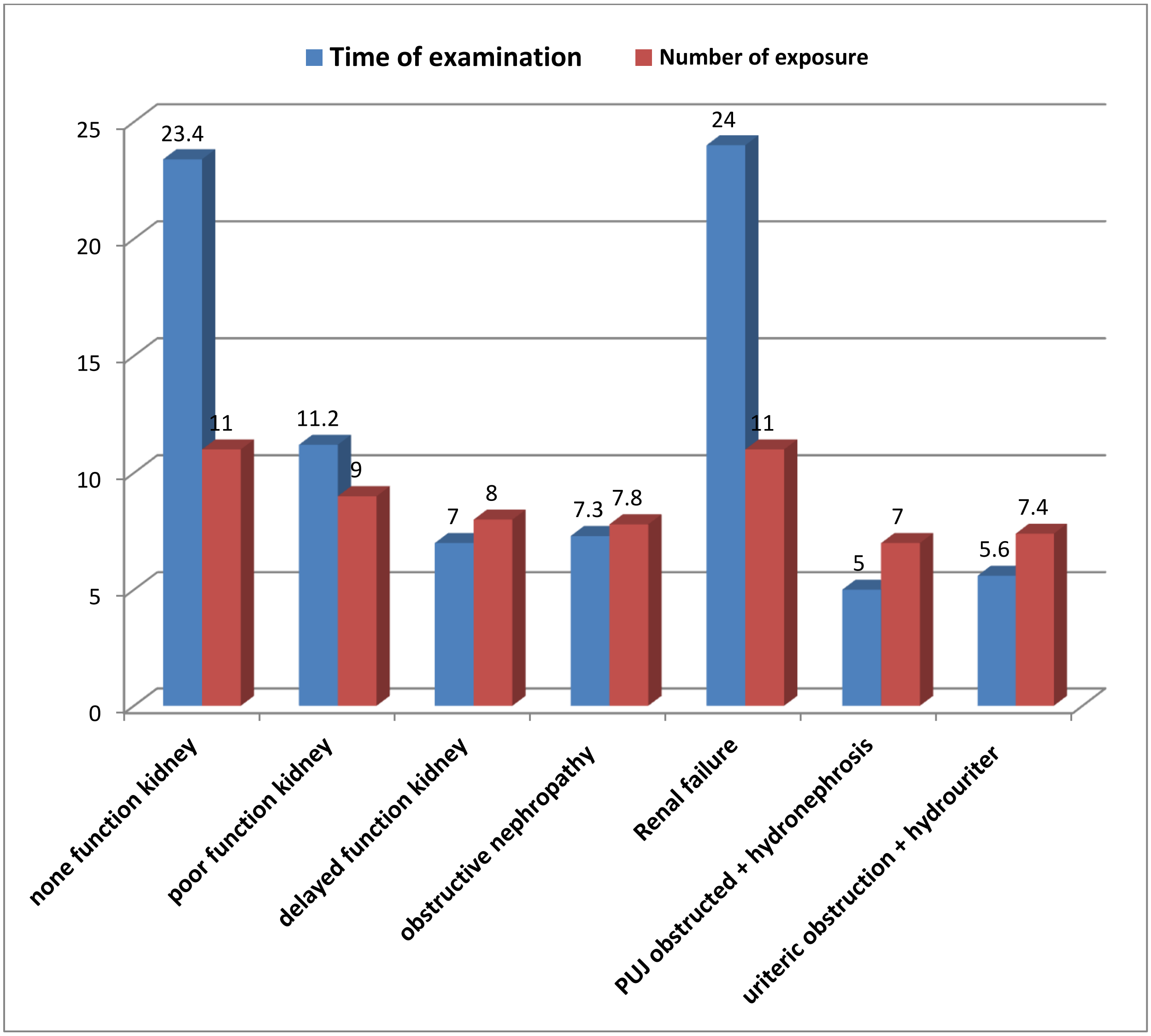


Fig.(4. 1). a bar graph of average time of examination and number of exposure versus renal disorders

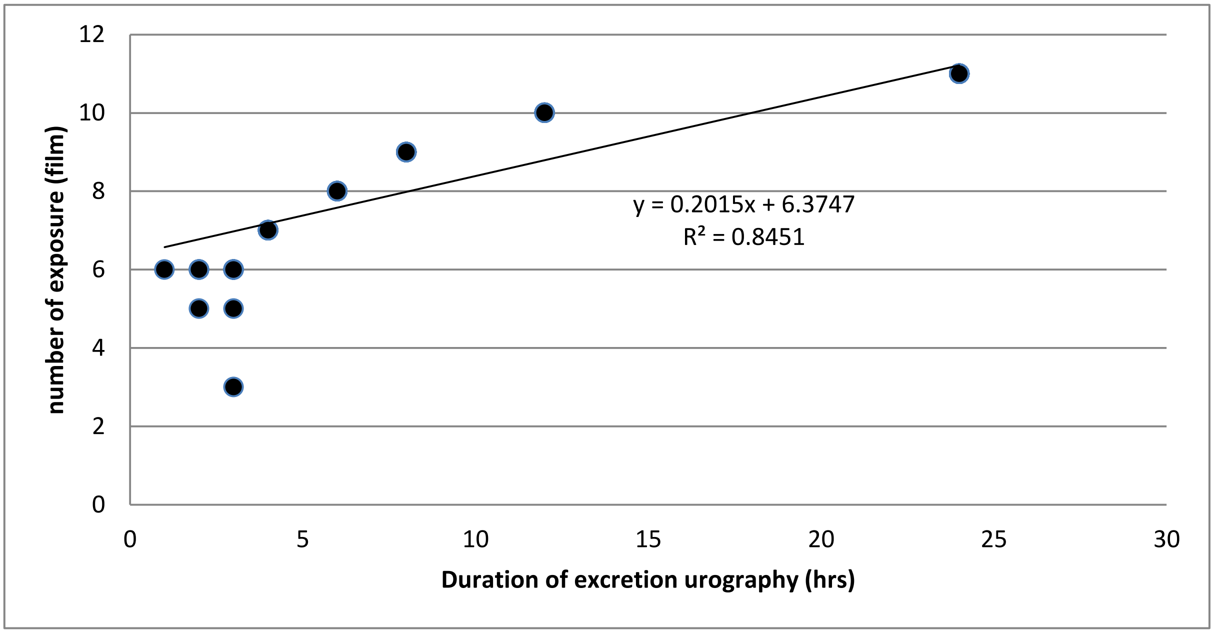


Fig 4. 2 Scatter plot show a direct linear relationship between the number of exposure and duration of excretion urography

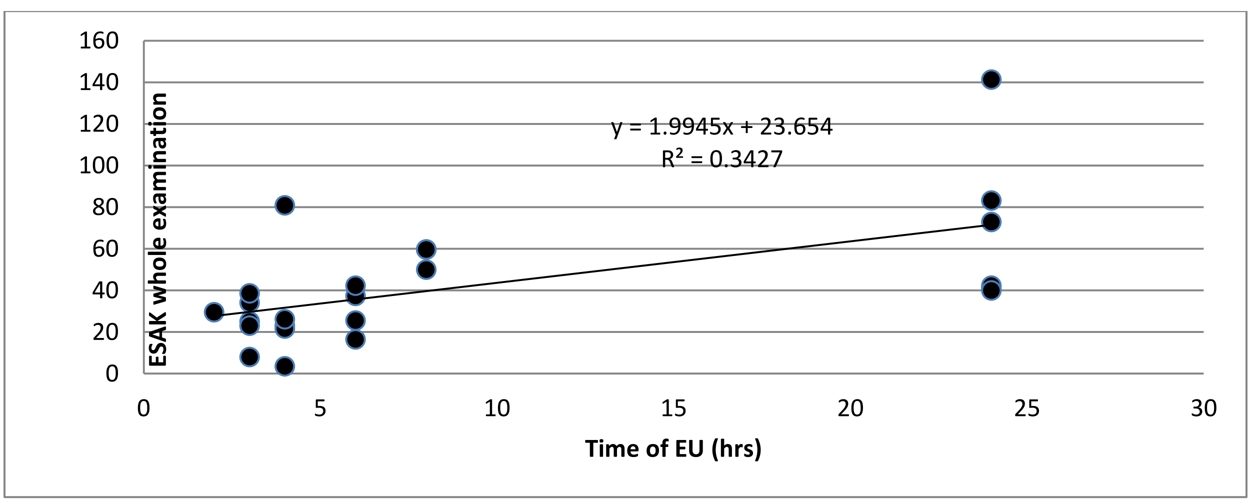


Fig. (4 3). Scatter plot show a direct linear relationship between the Entrance-surface air kerma and duration of excretion urography

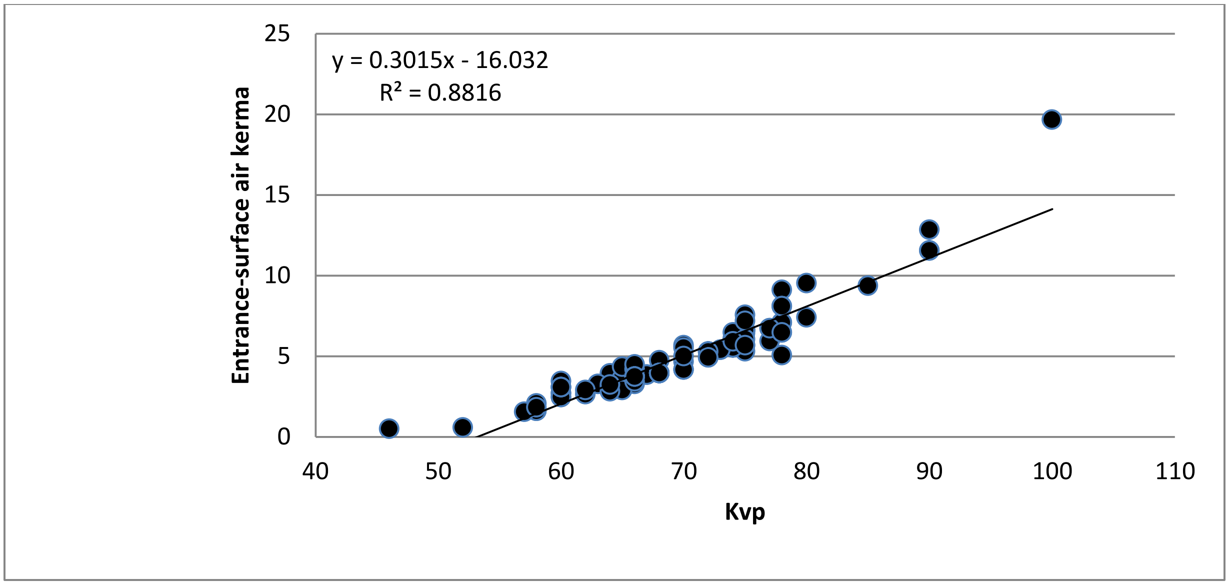


Fig.(4. 4) catter plot show a direct linear relationship between the Entrance-surface air kerma and Kvp

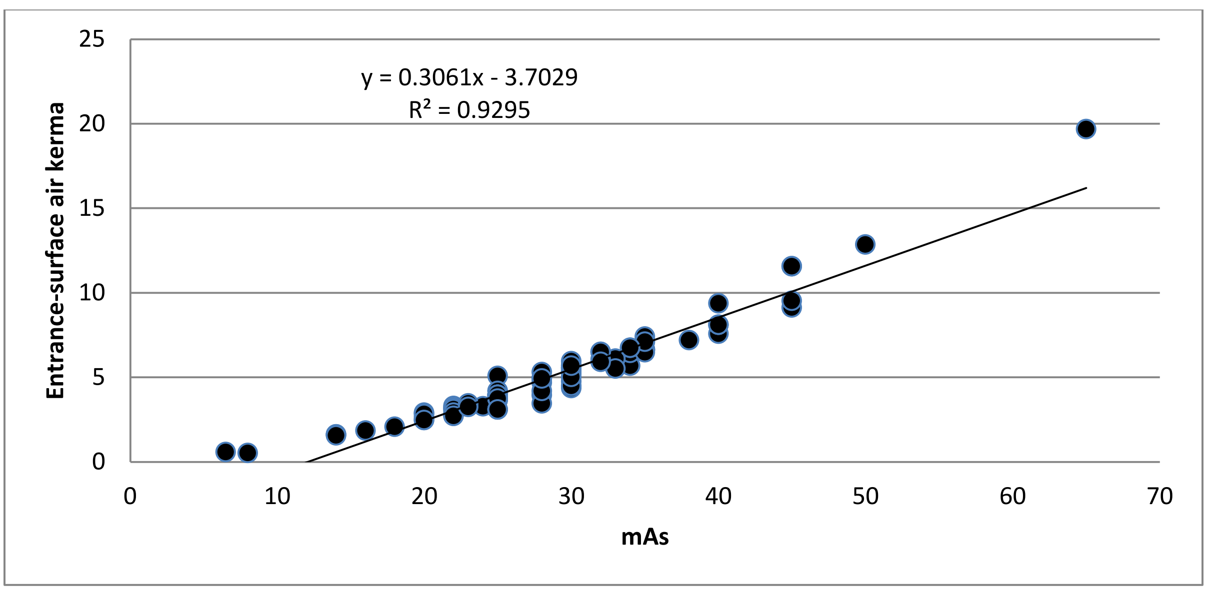
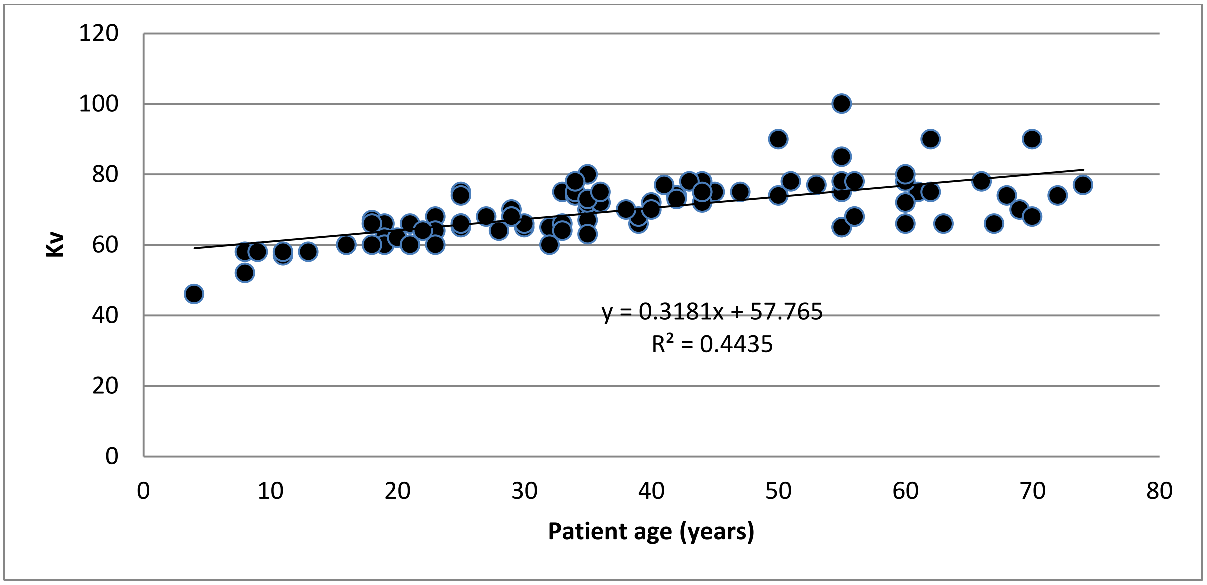


Fig (4.5). Scatter plot show a direct linear relationship between the Entrance-surface air kerma and mAs.



Fig(4.6.a). Scatter plot depict a linear relationship between the Kvp and patient age

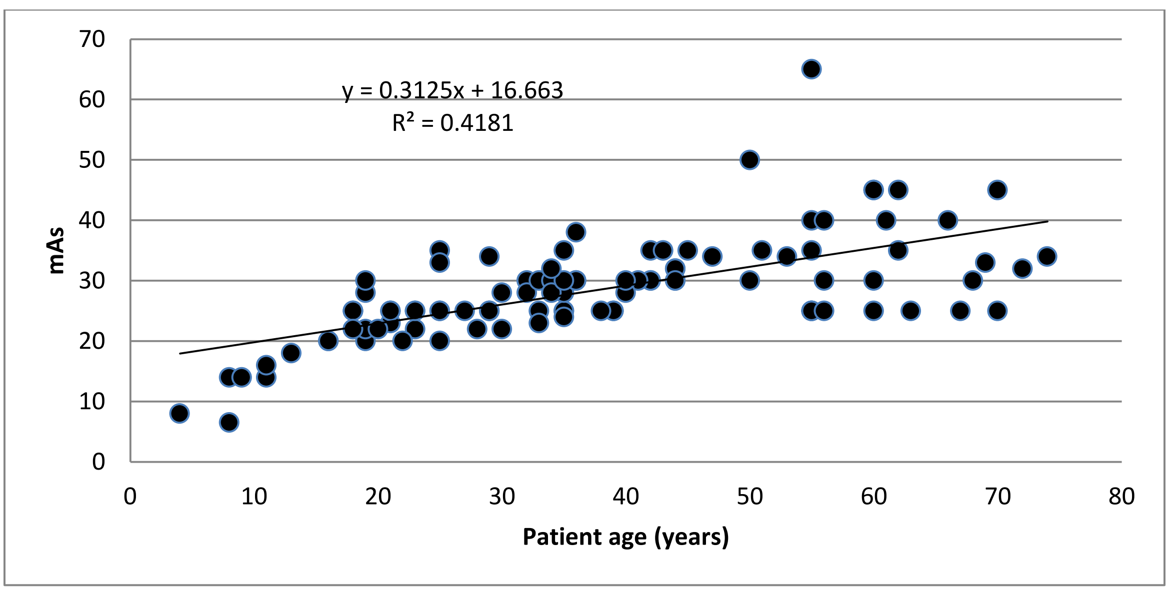


Fig (4.6.b) Scatter plot depict a linear relationship between the mAs and patient age

Table (4.2.a): Parients by age group

Age Group	**Frequency**	**Percentage**
Less than 10 years	4	4%
10 – 19 years	12	12%
20 – 29 years	19	19%
30 – 39 years	22	22%
40 – 49 years	14	14%
50 – 59 years	13	13%
60 – 69 years	12	12%
70 years and above	4	4%
Total	**100**	**100%**

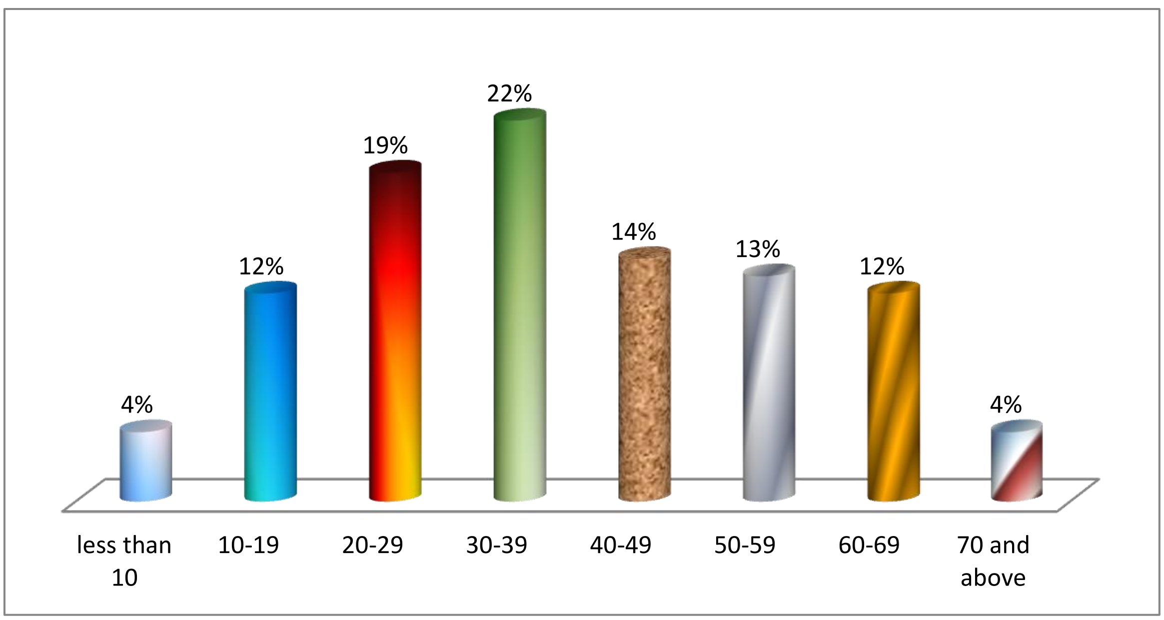


Fig.(4.7.a) Patient by Age Group

Referred to table (4.2.a) & Fig. (4.7.a)

41% of hundred patients are at age of fit persons who affect the economic Progress for population

Table (4.2.b): Patients by home

Home	**Frequency**	**Percentage**
In Khartoum State	55	55%
Outside Khartoum	45	45%
Total	**100**	**100%**

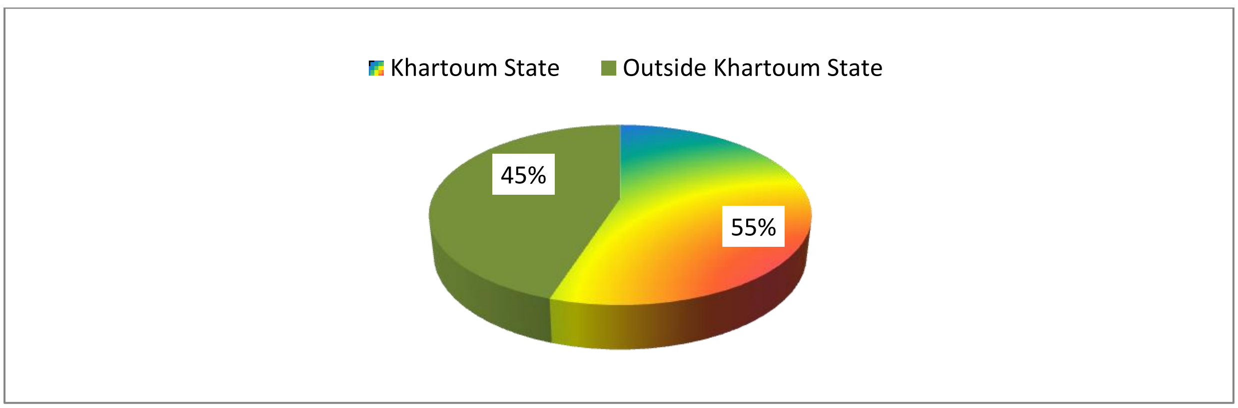


Fig.(4.7.b) Patient by Home

Referred to table (4.2.b) & Fig. (4.7.b)

55% of hundred patients are leave at the Khartoum province and the rest (45%) are leave at the other provinces of the Sudan.

Table (4.2.e): Patients by previous E.U. and DTPA

	Previous E.U.		**Previous DTPA**	
	Yes	No	Yes	No
Freq.	14	86	0	100
Percent	14%	86%	0%	100%

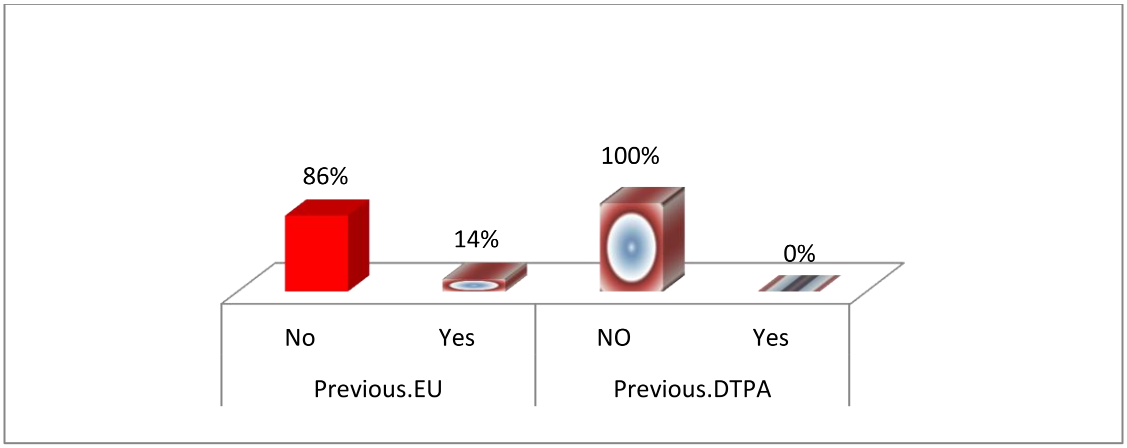


Fig .(4.7.c) Patient by previous EU & DTPA

Referred to table* (4.2.e) *& Fig. (4.7.c)

14% of E.U. patients examined more than once which affect the protection point of view for them. But there wasn't any previous DTPA which protect the patient from unnecessary radioactivity.

Table (4.3.a): E.U. Info, protection to Patient

Protection Tech.	**Frequency**	**Percentage**
Yes	36	90%
No	4	10%
Total	**40**	**100%**

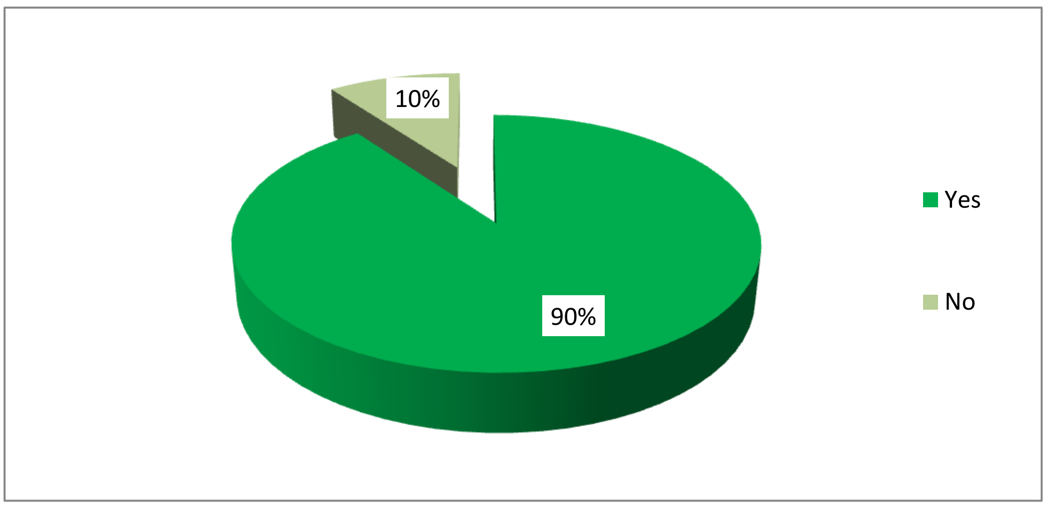


Fig. (4.8.a) EU Info, protection to Tech

Referred to table (4.3,a) & Fig. (4.8.a) :

90% of Rad. tech. said that their department was well designed for the requirements for the protection purpose, there for most of departments was protective for both the technologist, but fewer wasn't .

Table (4.3.b): E.U. info, effect. Rad. Units

Effect. Rad. Unit	Frequency	Percentage
Yes	32	80%
No	8	20%
Total	**40**	**100%**

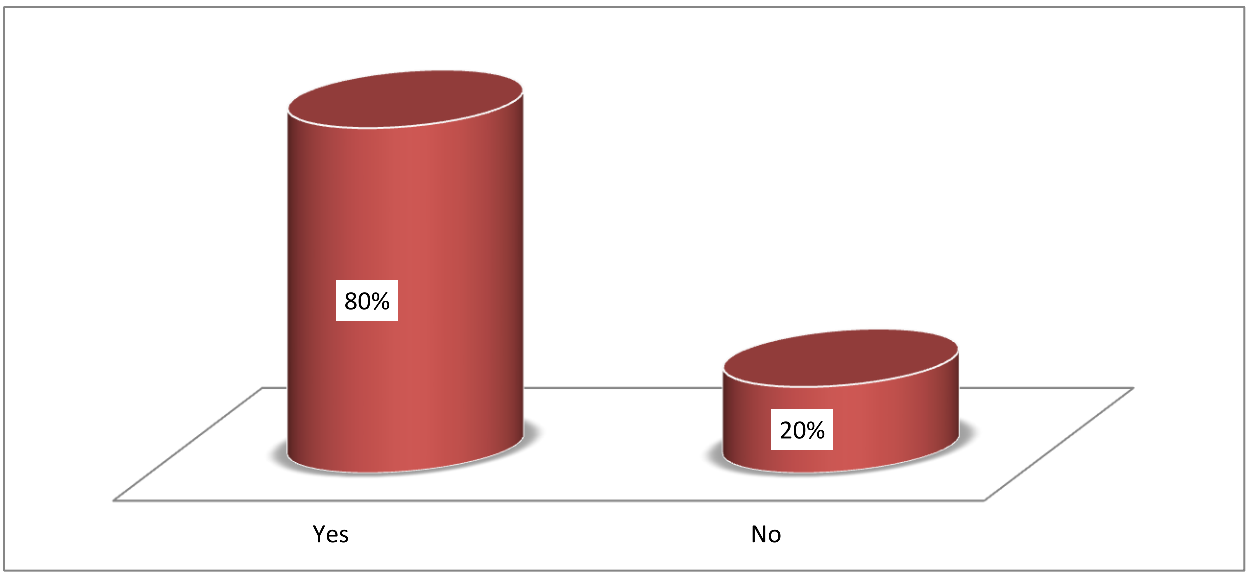


Fig.(4.8.b) EU Info, Effec.Rsd.Units

Referred to table (4.8.b) & Fig. (4.8.b) :-

80% of rad. techs. said that most of the x-ray units which involved in this study, were in good condition with high efficiency. Fewer wasn't.

Table (4.3.c): E.U. info, patients/Month

Patients/Month	**Frequency**	**Percentage**
1 – 15 patients	21	52.5%
16 – 30 patients	14	35%
31 – 45 patients	5	12.5%
Total	**40**	**100%**

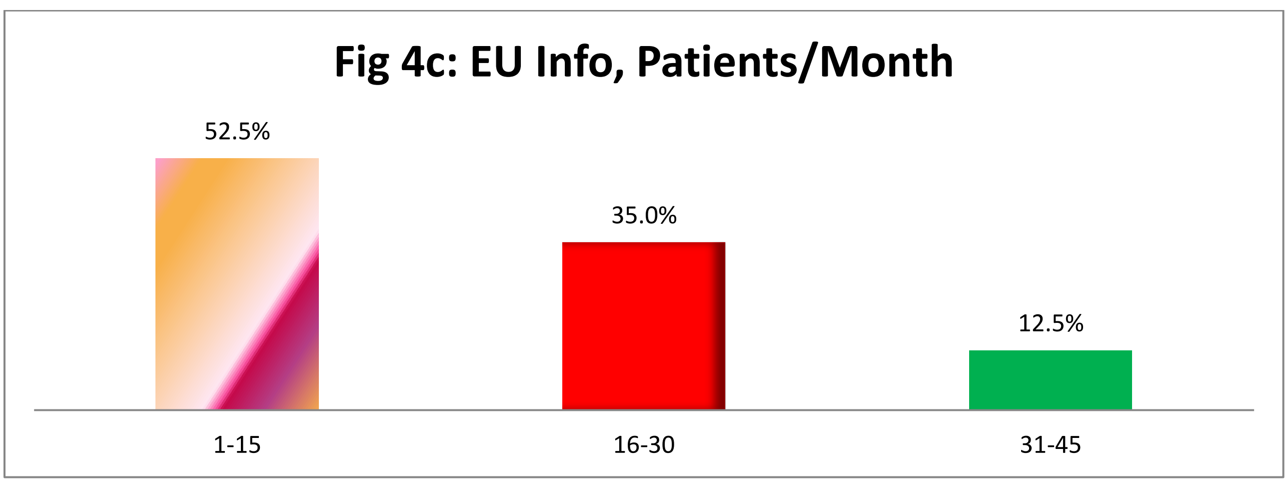


Fig.(4.8.c) EU Info, Patients/Month

Referred to table (4.3.c) & Fig. (4.8.c) :-

The average of the E.U. Patients was 53 pt/month at all radiographic departments.

Table (4.3.d): E.U. info, comf. Ima. Pro. For pt.

Comf. Ima. Pro. For pt.	Frequency	Percentage
Yes	16	40%
No	24	60%
Total	**40**	**100%**

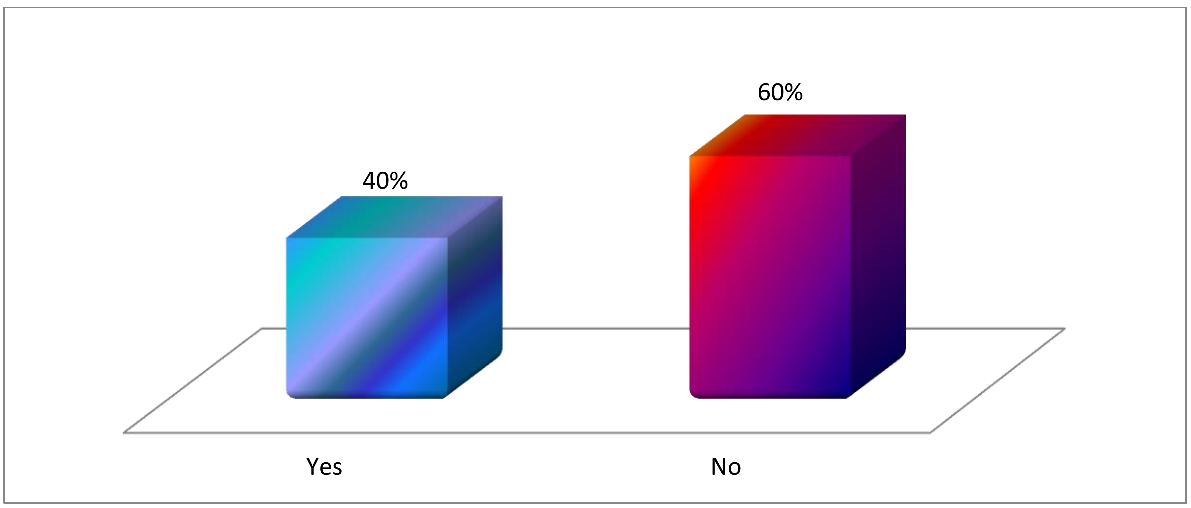


Fig..(4.8.d) EU. Info.,com ima.pro. for pt.

Referred to table (4.3..d) & Fig. (4.8..d) :-

40% of the Rad. tech. said that the E.U. imaging steps were comfortable for the patient, and 60% of the Rad. tech. said that the E.U. imaging steps were not comfortable for the patient.

Table (4.3.e): E.U. info, comf. Ima. Pro. For tech.

Comf. Ima. Pro. Tech.	**Frequency**	**Percentage**
Yes	11	28%
No	29	72%
Total	**40**	**100%**

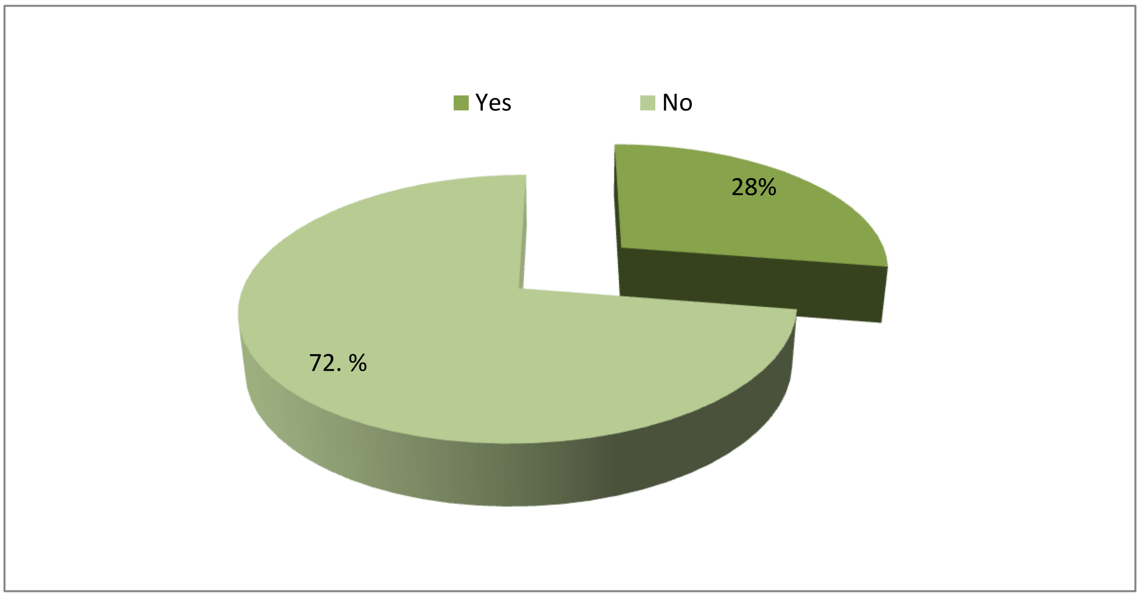


Fig.(48.e) EU. Info, comf.ima.pro. for Tech.

Referred to table (4.e) & Fig. (4.e)

28% of the Rad. tech. said that the E.U. imaging steps were comfortable for the technologist, and 72% of the Rad. tech. said that the E.U. imaging steps were not comfortable for the patient.

Table (4.g): E.U. info, cost of image in SG

Cost of image in SG	Frequency	Percentage
150 – 249 SG	20	50%
250 – 349 SG	18	45%
350 and above	2	5%
Total	**40**	**100%**

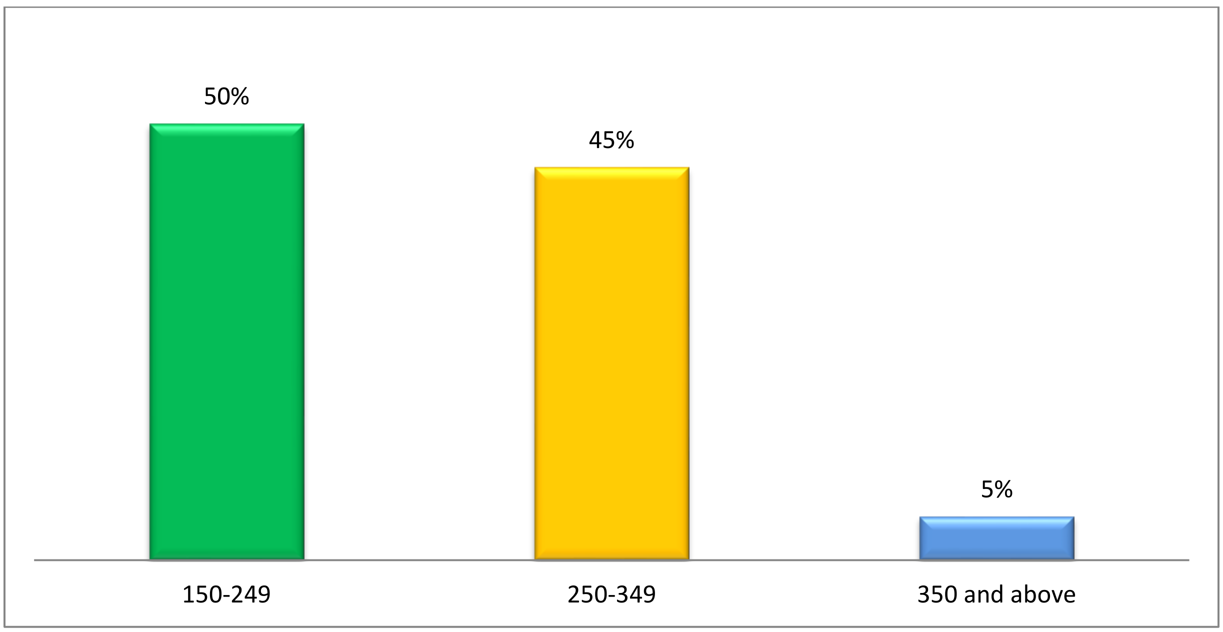


Fig.(4.8.g) E.U. Info, Cost of Image in SG

Referred to table (4.3.g) & Fig. (4.8.g)

E.U. cost price about 150 SD in side the hospital in average and doubling of it in private clinics . 45% of requested E.U. were done at private hospitals.

Table (4.3.h): E.U. rep image

Rep image	**Frequency**	**Percentage**
Yes	6	15%
Rare	8	20%
No	26	65%
Total	**40**	**100%**

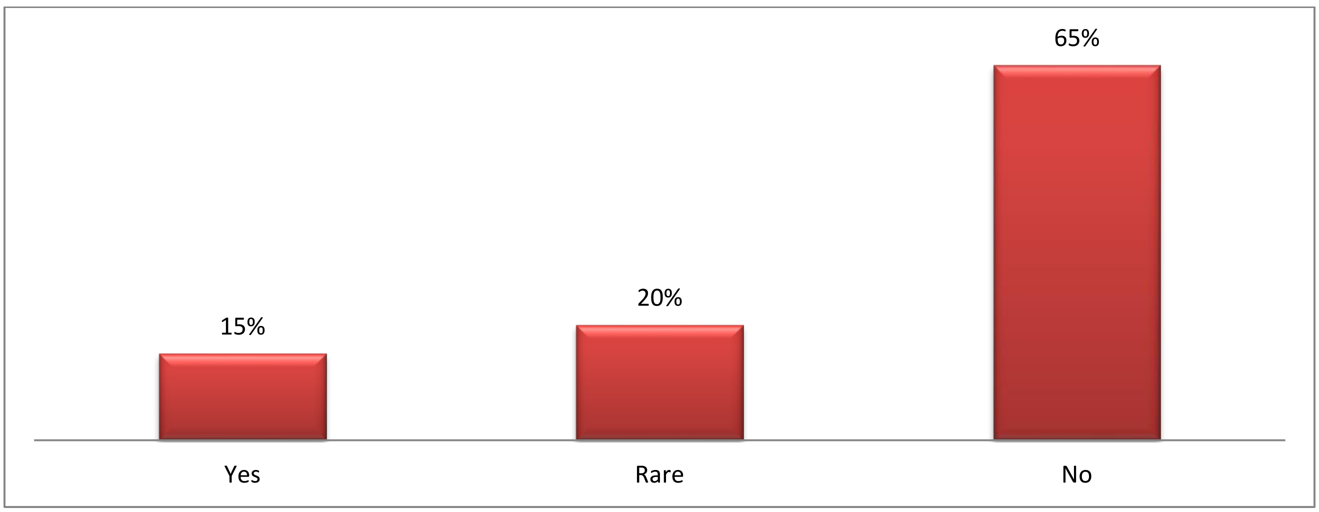


Fig.(4.8. h) E.U. Info, Rep Image

Referred to table (4.h) & Fig. (4.h)

15% of the rad. tech.s said that the E.U. image was sometimes had bad quality, or for other reasons, must be repeated, which affect the protective required.

Table (4.3..i): E.U. Info C.P.A.

InfoQ C.P.	**Frequency**	**Percentage**
Yes	12	30%
No	28	70%
Total	**40**	**100%**

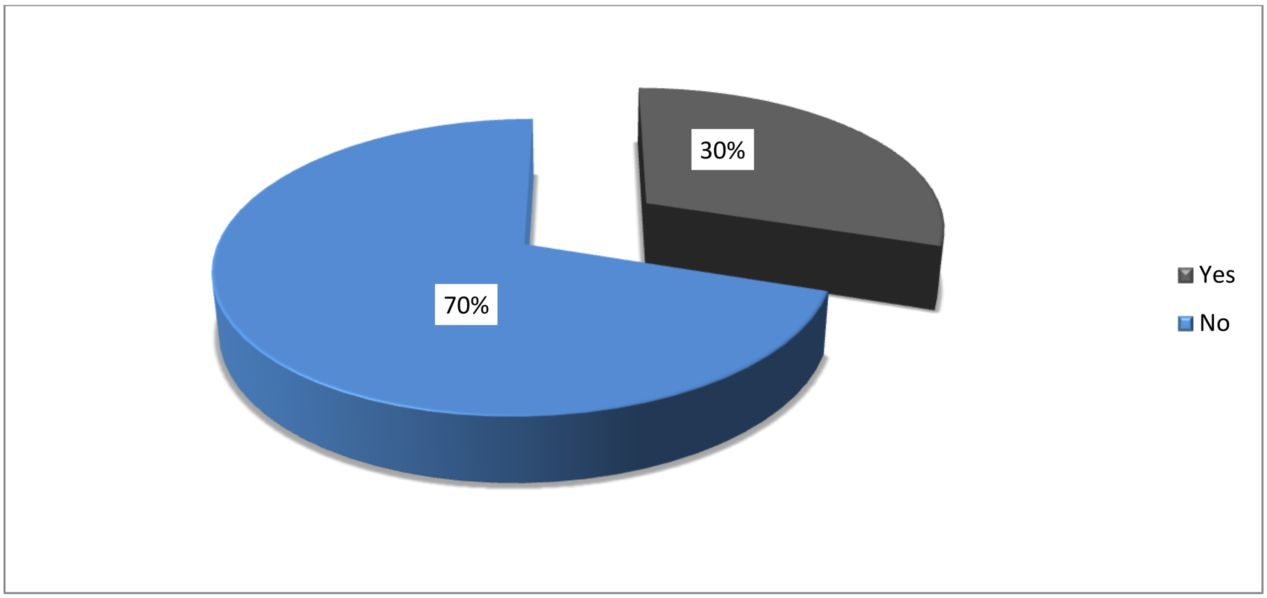


Fig .(4.8..i) E.U. Info,Q.C.P.A.

Refered to table (4.i) & Fig. (4.i)

Only 30 % of 16 Rad. Departments. had been applied the. QC.P.& personal monitoring not available,(e.g. using of T.L.D.)

Table (4.4.a): Senior Rad. Tech. No. of Units

No. of Units	**Frequency**	**Percentage**
1 Unit	10	60%
2 Unit	6	40%
Total	**16**	**100%**

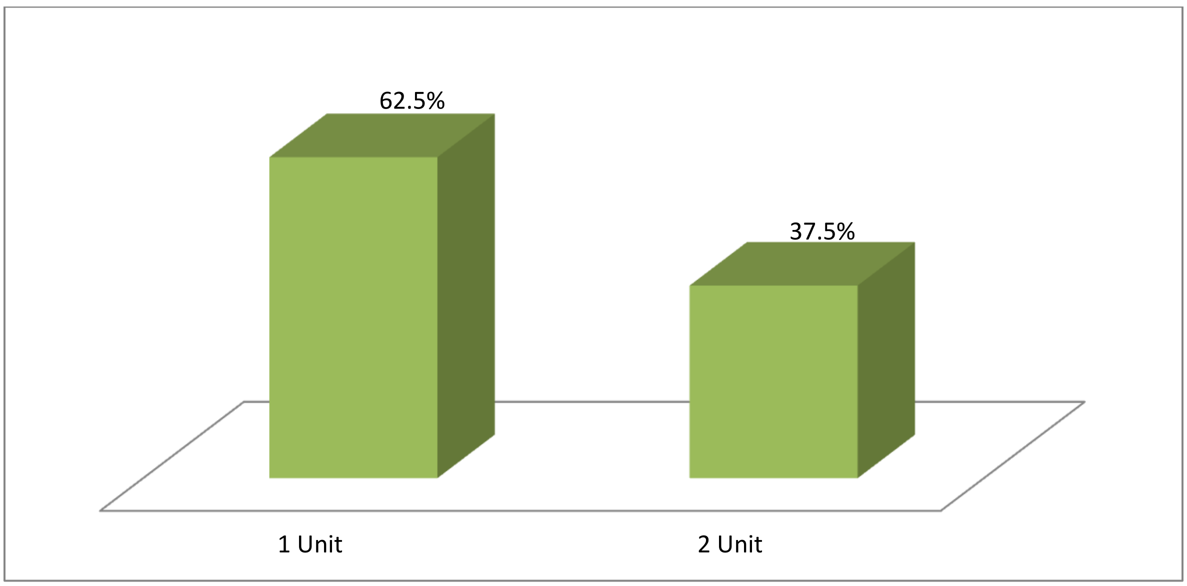


Fig. (4.5.a) Senior Rad. Tech. No. of Units

Referred to table (4.4.a) & Fig. (4.5.a)

40% of 16 rad. Departments had 2 X-Ray unites at each one which affect the number of E.U. cases had being done .

Table (4.4.c): Senior Rad. Tech. Staff meeting org.

Staff meeting org	**Frequency**	**Percentage**
Yes	2	13%
No	14	87%
Total	**16**	**100%**

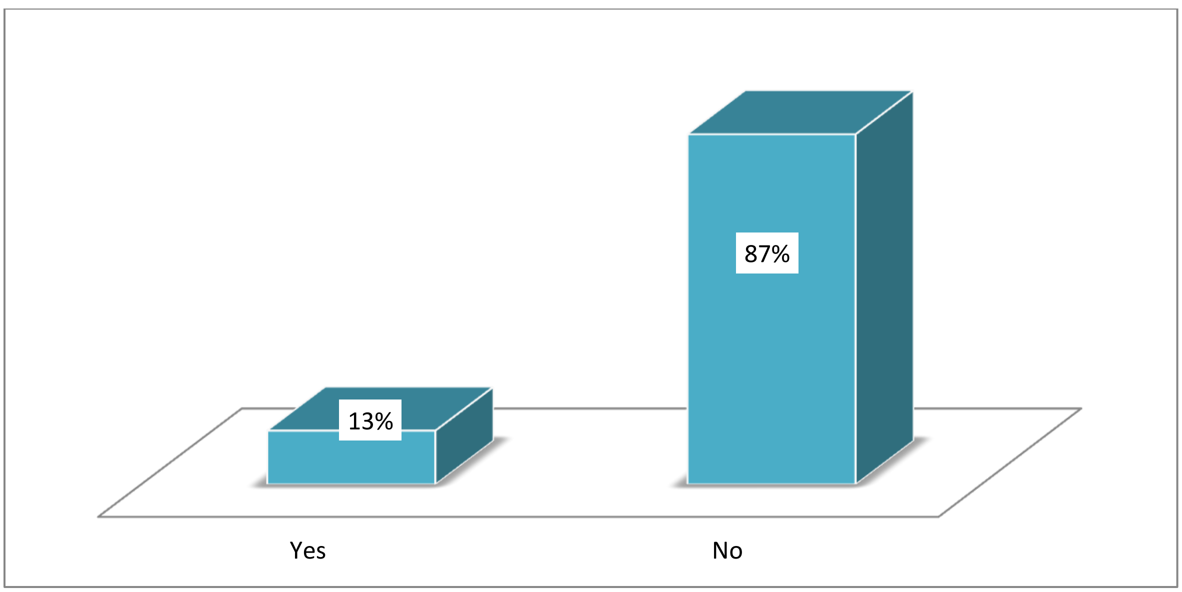


Fig.(4.5.a) Senior Rad. Tech. No. of Units

Referred to table (4.5.b) & Fig. (4.5.a)

87% of rad. dep.s didn’t organized staff meeting so as to assess the imaging procedure and solve the problems were it being e.g. reject images .

Table (4.5..a): DTPA info. Patient/ month

Patient/month	**Frequency**	**Percentage**
10 – 29 Patients	9	60%
30 – 49 patients	0	0
50 – 69 patients	0	0
70 and above	6	40%
Total	**15**	**100%**

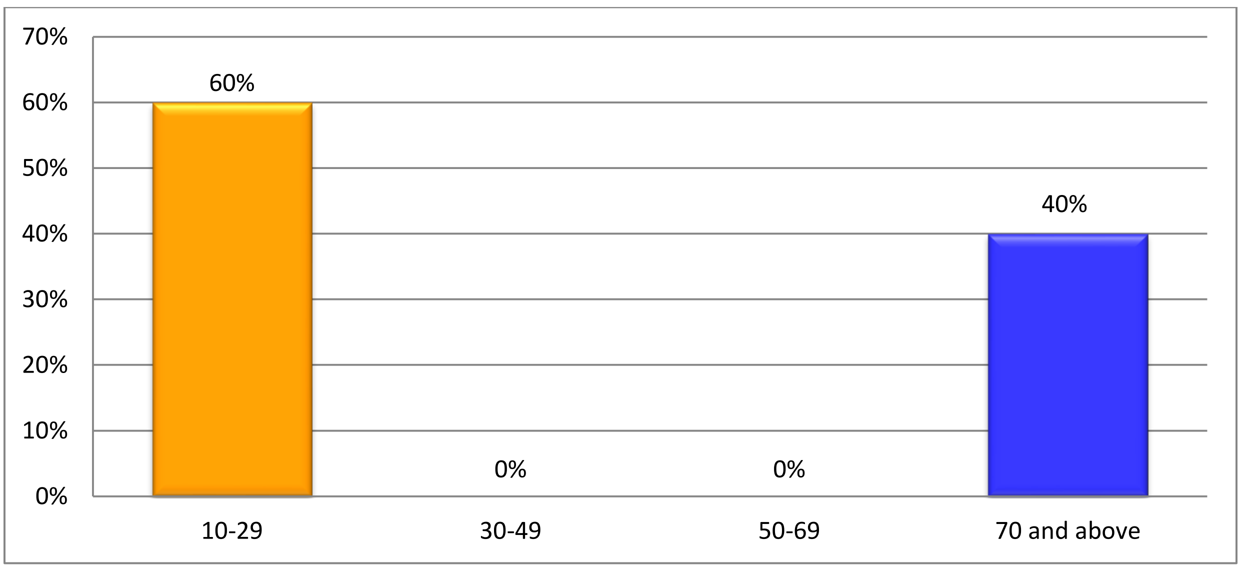


Fig.(4.6.a) DTPA Info, Patient / Month

Referred to table (4.5.a) & Fig. (4.6.a)

The average of the total number of the patients send for ^{99m}Tc-DTPA was 60 pt/month.

Table (4.5.b): DTPA info. Cost of Image

Cost of Image	Frequency	Percentage
75 SDG	6	40%
500 SDG	9	60%
Total	**15**	**100%**

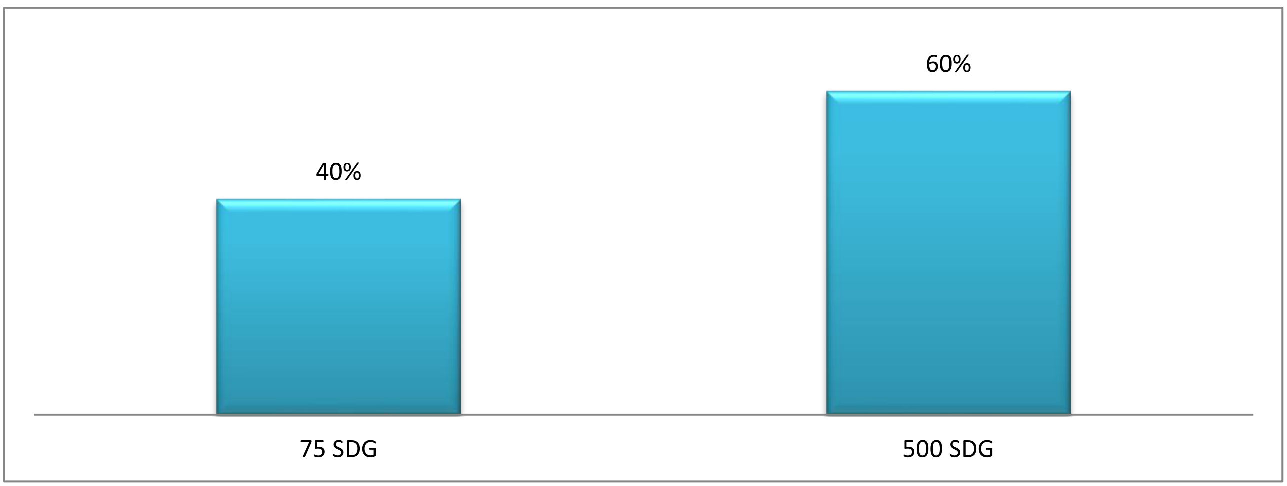


Fig.(4.6.b) DTPA Info. Cost of Image

Referred to table (4.5.b) & Fig. (4.6.b)

40% of N.M. Dep. The price of ^{99m}Tc-DTPA image about 75 SG, but at private dep.s. was 500 SG.

Table (4.6.a): Senior N.M. Tech. No. of Units

No, of unit	Frequency	Percentage
1 Unit	3	75%
2 Units	1	25%
Total	**15**	**100%**

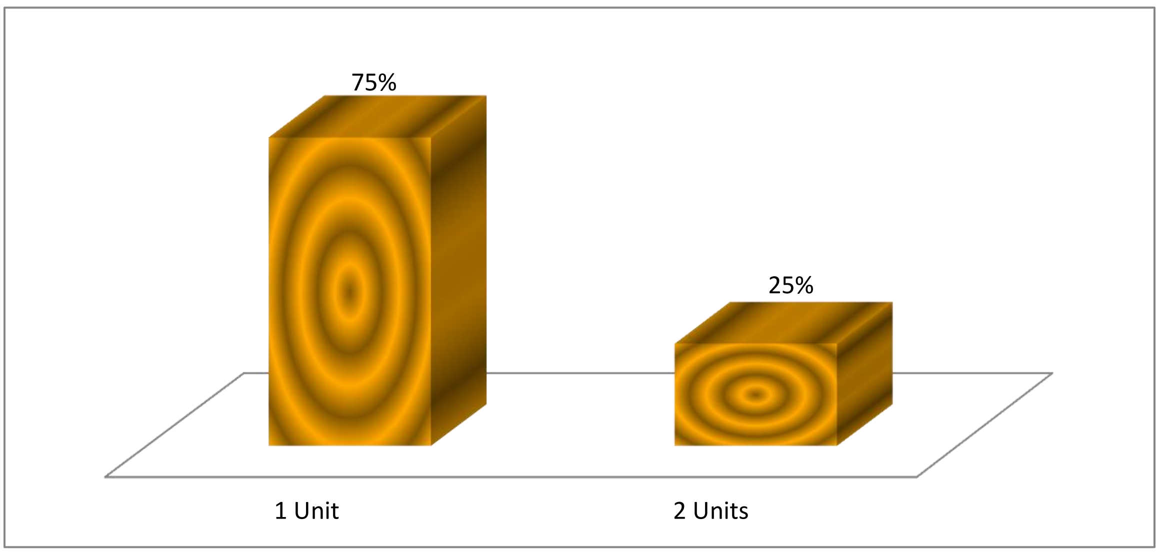


Fig.(4.7.a) Senior NM.Tech. No. of Units

Referred to table (4.6.a) & Fig. (4.7.a)

Each of three N.M. departments had only one gamma camera unite. Only one department had two unites.

Table (4.7): NM Physician

NM Physician	Yes	No	Total
Diag. DTPA %	3 100%	0 0%	3 100%
Image qua. %	3 100%	0 0%	3 100%
Rereq. Image %	0 0%	3 100%	3 100%
Staff M. %	0 0%	3 100%	3 100%

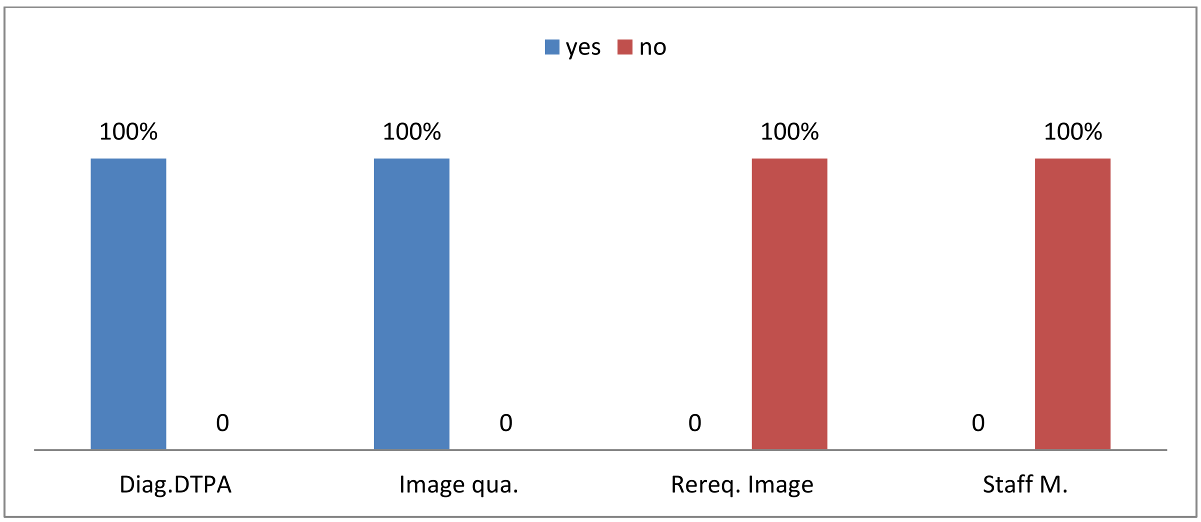


Fig.(4.8) NM Physician

Referred to table (4.7) & Fig. (4.8)

All N.M. Physician said that ^{99m}Tc-DTPA scintigraphs are acceptable with good quality, and no reject scintigraph. They said also there wasn't arrangement of staff meeting to solve any problem produce.

Table (4.8.a): Radiologist, Dig. Image EU/m

Cost of Image	Frequency	Percentage
1 – 10	4	25%
11 – 20	6	37.5%
21 – 30	2	12.5%
31 – 40	2	12.5%
41 – 50	0	00%
More than 50	2	12.5%
Total	**16**	**100%**

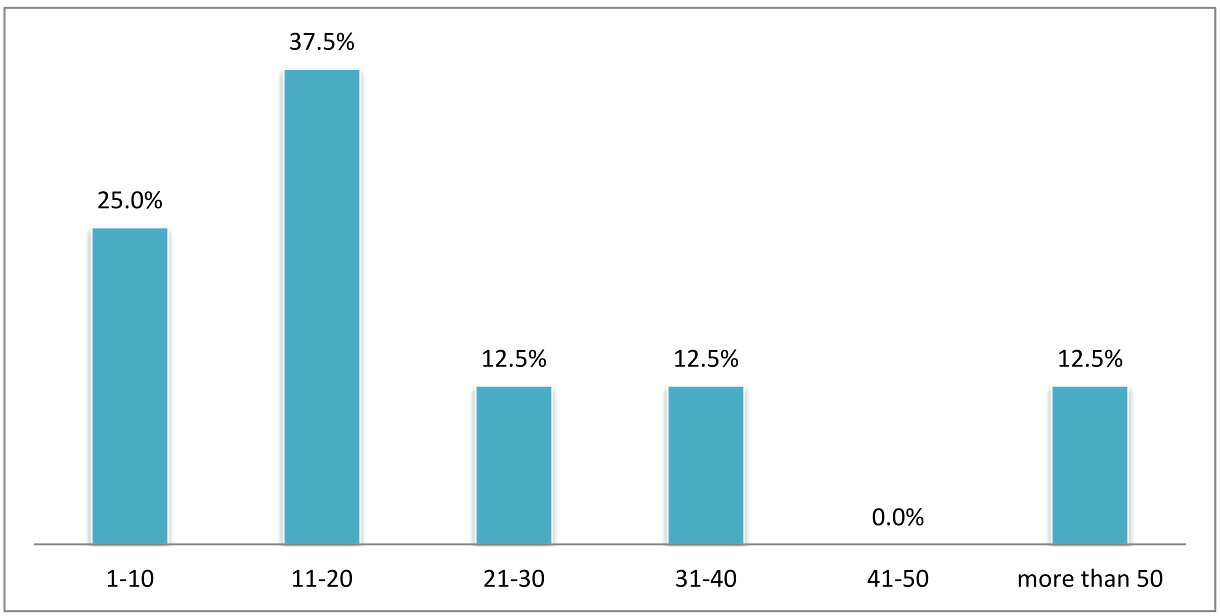


Fig.(4.9.a) Radiologist , Dig. Image EU / m

Referred to table (4.8.a) & Fig. (4.9.a)

Most of radiologists said that the E.U. images for diagnosis per month in average about 20 images.

Table (4.8.b): Radiologist, Diagnostic Image

Diagnostic Image	Frequency	Percentage
n.a.s. time	2	13%
accp.	14	87%
Total	**16**	**100%**

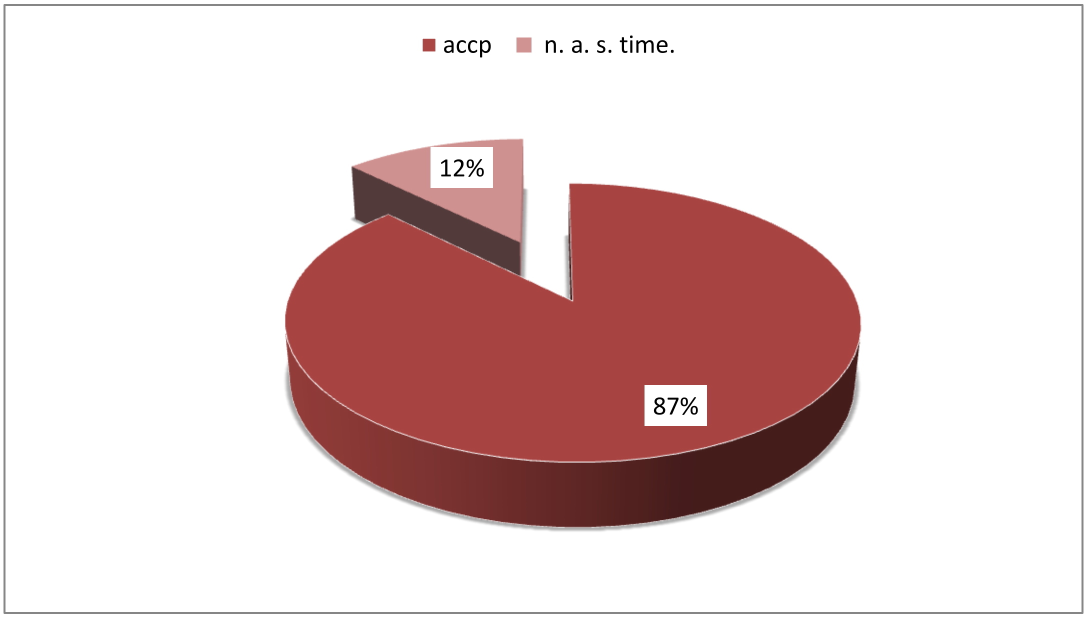


Fig.(4.9.b) Radiologist. Diagnostic Image

Referred to table (4.8.b) & Fig. (4.9.b)

87% of radiologists said that image quality was acceptable, but the rest said it was not.

Table (4.8.c): Radiologist, Staff M.

Staff M.	Frequency	Percentage
Yes	3	19%
No	13	81%
Total	**16**	**100%**

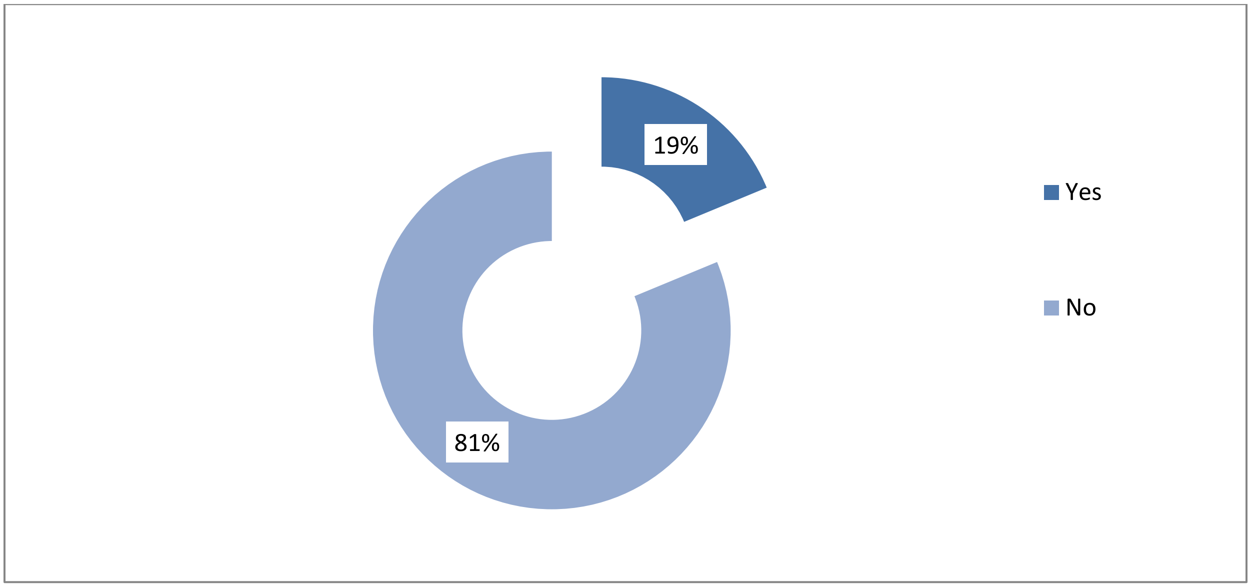


Fig.(4.9.c) Radiologist, Staff M

Referred to table (4.8..c) & Fig. (4.9.c)

81% of Radiologist said that there isn't arrangement of staff meeting so as to discuss the causes of the problem affect the E.U. imaging.

Table (4.8.a): Surgeons (Urolo & Nephro), First option Req.I.

Staff M.	Frequency	Percentage
E.U.	4	40%
CTU	5	50%
CTPA	1	10%
Total	**10**	**100%**

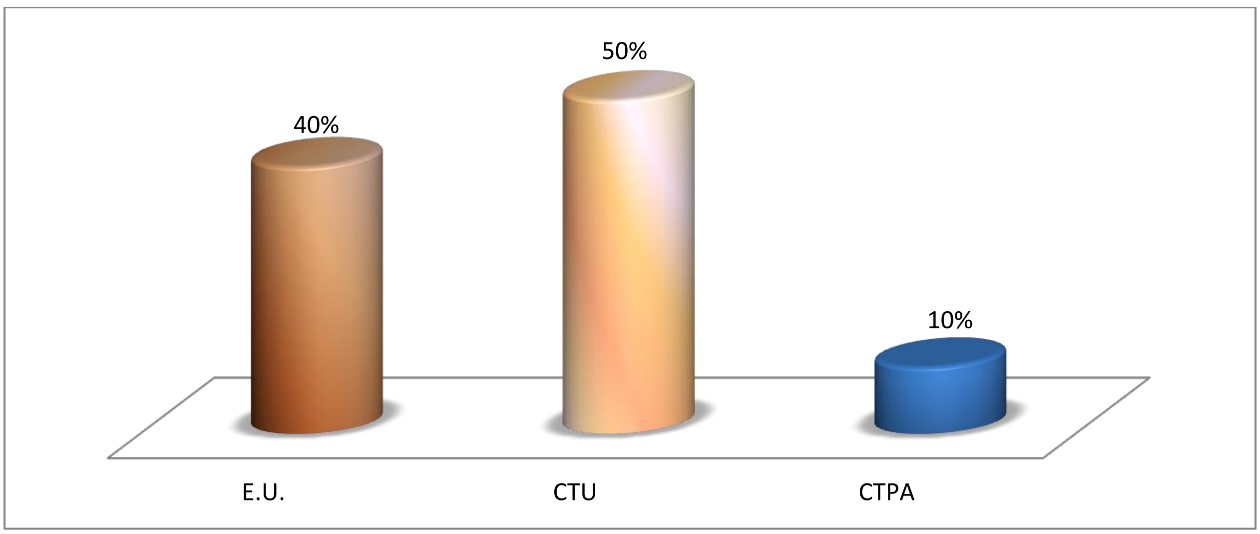


Fig.(4.10.a) Surgeons (Urolo. & Nephro.) First option

Referred to table (4.8..a) & Fig. (4.10.a)

50% of urologist & nephrologists said that the first option to requesting diagnostic image for a patient with renal disorder is CTU , and the second one is E.U. and the last is ^{99m}Tc-DTPA.

Table (4.8..b): Surgeons (Urolo & Nephro), No of E.U. pts.

No of E.U. pts.	Frequency	Percentage
1 – 15	3	30%
16 – 30	4	40%
More than 30	3	30%
Total	**10**	**100%**

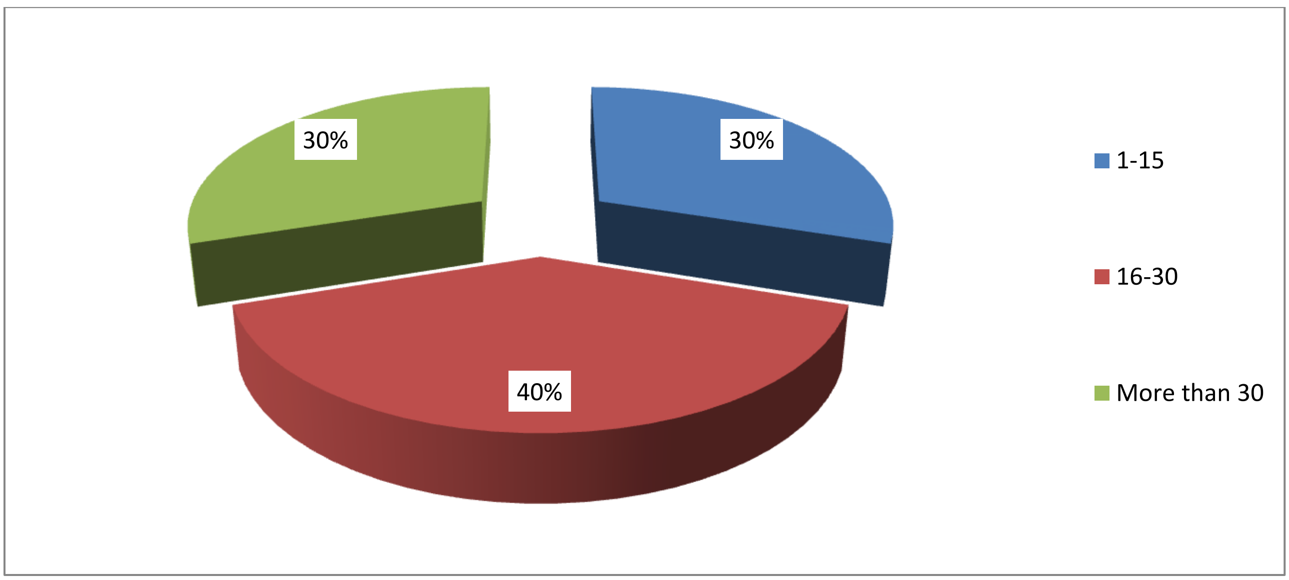


Fig.(4.10.b) Surgeons (Urolo & Nephro), No. of EU. pt.s

Referred to table (4.8.b) & Fig. (4.10.b)

40% of urologist & nephrologists said that 30 patient with renal disorder were send for E.U. imaging which is the first option and the rest said that the first option other examination ,e.g. U/S & CTU….ect.

Table (4.8.c): Surgeons (Urolo & Nephro), No of E.U. pts.

No of E.U. pts.	**Frequency**	**Percentage**
1 – 15	3	30%
16 – 30	4	40%
More than 30	3	30%
Total	**10**	**100%**

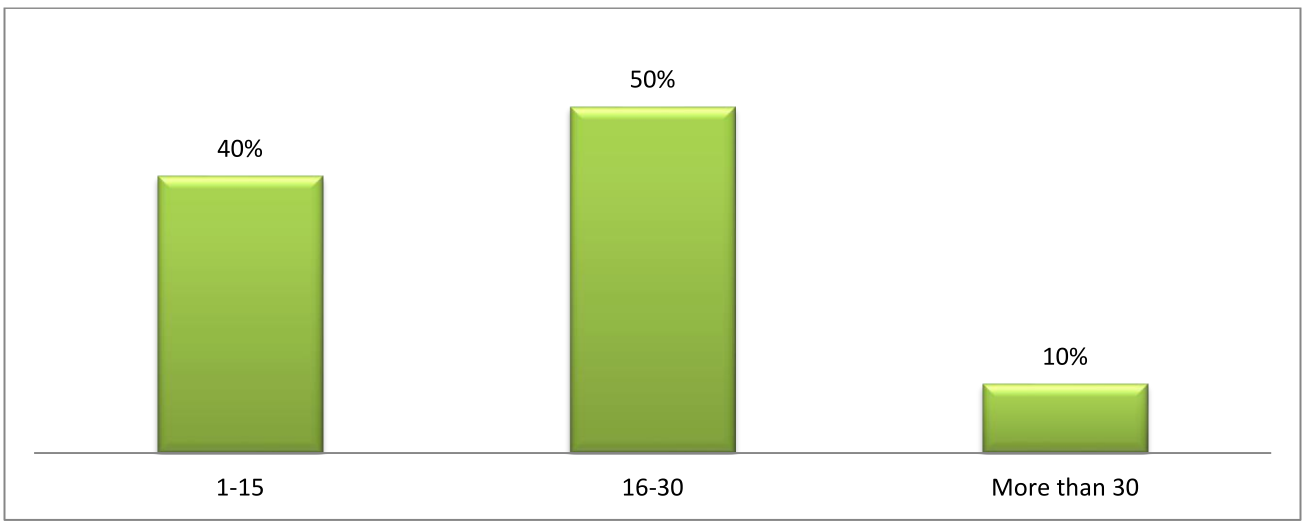


Fig. (4.10.c) Sutgeons (Urolo. & Nephro.) No. of DTPA pt.s

Referred to table (4.8.c) & Fig. (4.10.c)

Most of Surgeons said that they send approximately 20 DTPA pts./mon.

Table (4.8.c): Surgeons (Urolo & Nephro), Accep. Image(E.U.)

Accep. Image	Frequency	Percentage
Yes	8	80%
No	2	20%
Total	**10**	**100%**

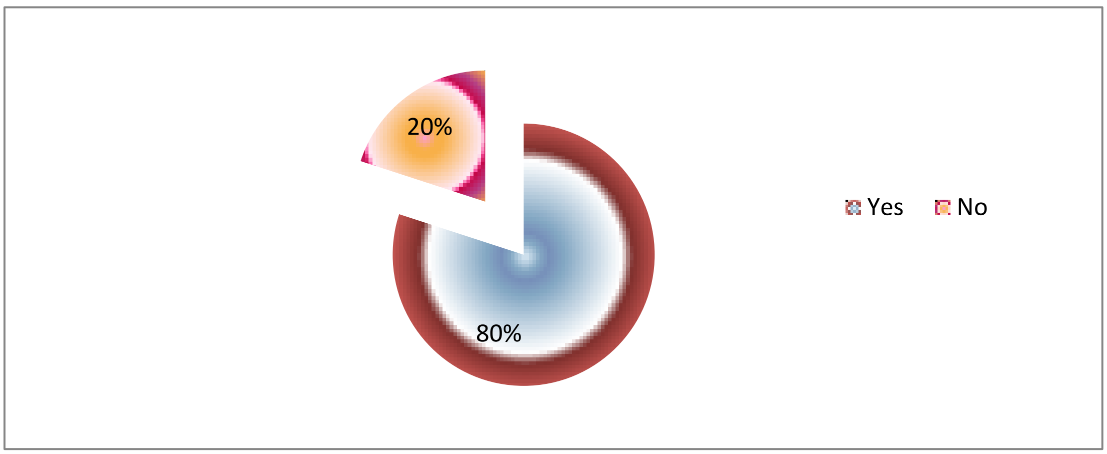


Fig.(4.10.c) Surgeons (Urolo.& Nephrol.),Accep. Image

Referred to table (4.8.c) & Fig. (10.d)

80% of Surgeons said that the E.U. images are acceptable, but 20% of them said it wasn't.

Table (4.8..e): Surgeons (Urolo & Nephro), Rereq. E.U.

Rereq. E.U	**Frequency**	**Percentage**
Yes	1	10%
No	9	90%
Total	**10**	**100%**

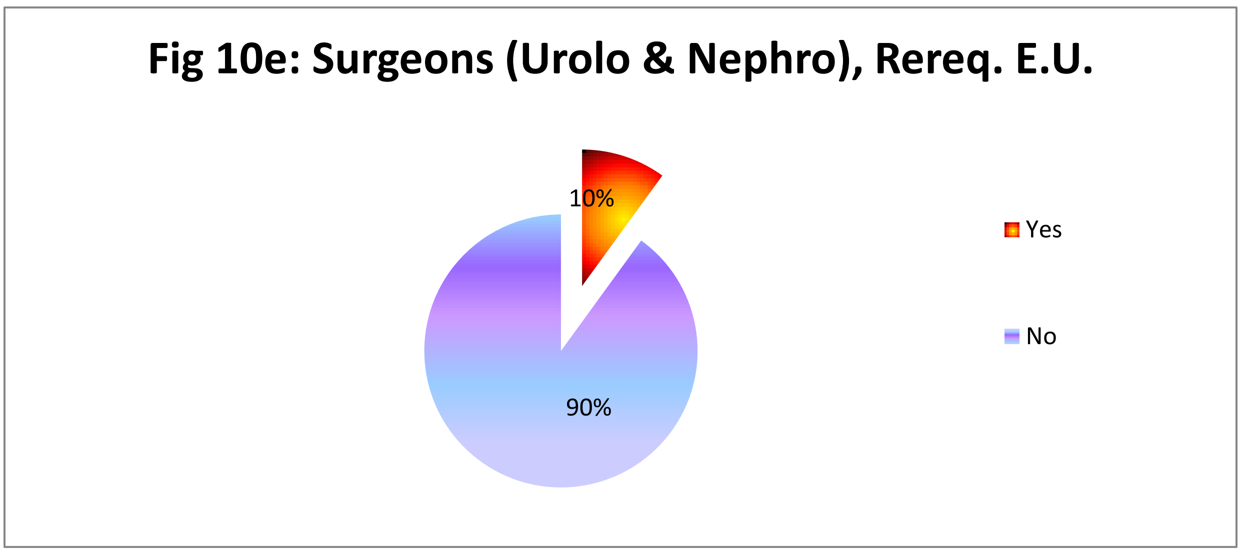


Fig. (4.10.e) Surgeons (Urolo. & Nephro.), Rereq. E.U.

Referred to table (4.8.e) & Fig. (4.10.e)

90% of Surgeons said they weren't re-request the un- acceptable E.U. image , but request other renal imaging procedure.

Chapter Five

a. **Discussion**

b. **Conclusion**

c. **Recommendations**

d. **References**

5-1 Discussion

- The result of this study showed that the examination of renal system using renogram (^{99}Tc-DTPA) takes 20 minutes for all patients. The result reveals that there were 7 physiological disorders as shown in Table 1. Similar results were obtained by excretion urography method, but with a variables acquisition time and a number of exposure depending on the renal disorder as shown in Figure 1.
- This situation leads to keeping the patient for longer time in the department as well as he will receive a substantial amount of radiation in respect to the number of exposure which is range from 4-11, duration of time from 4-24 hours and average Entrance-surface air kerma of 45±24. The number of exposure will increases by 0.2/hrs of examination period with a threshold of 6.4 exposures for each patient (Figure 2). Arbitrary Entrance-surface air kerma will increase by 2/hrs starting at 23.6 in respect to the number of exposure which attributed to the whole duration of examination period (Figure 3).
- The increases of entrance-surface air kerma depend mainly on the exposure factors (Kvp and mAs) where the entrance-surface air kerma increases by 0.3/Kvp and mAs as shown in Figure 4 and 5.
- The increases of Kvp and mAs depend on the body characteristics of the patient and mainly the age of the patient where the Kvp and mAs increases by 0.3/years, starting at 58Kvp and 17mAs respectively as shown in Figure 5 and 6 respectively.

- The ^{99m}Tc-DTPA procedure mechanism was comfortable for both the patient and the technologist, in comparative with that was for the E.U. procedure mechanism which was uncomfortable for the patient and harmful for technologist.
- The ^{99m}Tc-DTPA imaging procedure was more protective for technologist, in comparative with the E.U. imaging procedure which may affected him by secondary radiation at the improper organized department for radiation protective wise. The patient had effect of irradiation during the both imaging procedures.
- The fees that the patient paid for ^{99m}Tc-DTPA imaging was leaser than was paid for the E.U. imaging, which excess than the first by the cost price of the preparation needs.

5.2 Conclusion

- The ^{99m}Tc-DTPA imaging procedure was more protective for technologist, in comparative with the E.U. imaging procedure which may affected him by secondary radiation at the improper organized department for radiation protective wise. The patient had effect of irradiation during the both imaging procedures.
- The ^{99m}Tc-DTPA scinitigraphs had definitive findings for a patient in comparative with the findings of the E.U. radiographs for the same one, which their findings sometimes wares affected by the sequence of the imaging procedure steps. e.g. (exposure factors & processing).The E.U. imaging was available at radiological departments overall the Kh. State, and the needs for doing it were round by easiest manner (e.g. contrast media). The availability of ^{99m}Tc-DTPA imaging in comparative with E.U. imaging was insufficient for the accumulation of the patients were requested for it at Kh. State.
- The fees that the patient paid for ^{99m}Tc-DTPA imaging was leaser than was paid for the E.U. imaging, which excess than the first by the cost price of the preparation needs.
- The ^{99m}Tc-DTPA procedure mechanism was comfortable for both the patient and the technologist, in comparative with that was for the E.U. procedure mechanism which was uncomfortable for the patient and harmful for technologist.
- Their for : **Excretion uorography** and **^{99m}Tc-DTPA** has the same sensitivity; while scintigraphy has the advantage over the excretion uorography by:-

  a) Saving the patient time and resources as well. b) Imaging procedure was more protective for technologist. c) The procedure mechanism was comfortable for both the patient and the technologist . d) The cost of the imageing excess by the cost of the preparation needs.

5.2. Recommendations

1- The x-ray units must be with high efficiency so as to reduce the risk of irradiation for both the patient and the technologist.

2- At the radiological department a periodic maintenance program should be arraigned so as to attained its employment perfectly.

3- G.C.P. should be arraigned and applied probably at the radiological departments.

4- Refreshment courses should be arraigned for the rad. & N.M. techs. So as to updated the scientific knowldegement for their job.

5- A new N.M. deps. should be establish at Kh. State so as to obtain the scintigraphy employment for the accumulation of the patients at it.

6- N.M. physician and technologists must will arrange a clinicl meeting with the medical staff which their jobs were involved with the N.M. dep. because their knowldegement fewer about it.

7- The cost price of the E.U. must be governmentle supported so us to reduce it for the patient, thus the most of them were poor.

8- All radiological department must have an automatic processing units so as to avoid the problems that occur by the using of the manual processing.

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Appendixes

Appendix (1)

An Interview With The Patient

Six

Age

Home

Social State

Requested image type

Is it the first time for imaging or re-requested?

Appendix (2)

Questionnaire for N.M.

& Rad. Technologists.

Dear Colleagues :-

I would be very grateful if you would kindly fill this questionnaire so as to give useful thought towards the same objectives as mentioned before.

* Put a tick mark [✓] in the box of the correct answer

Technologist Information :

* Technologist :

Nuclear medicine tech. [ ]

Radiographic tech, [ ]

* Qualification :

- Diploma [ ] - B.Sc [ ]

- postgraduate Diploma [ ] -M.Sc [ ]

* Experience:……….years.

^{99m}Tc-DTPA and Excretion Urography Studies Informations :-

Q1\ Is the department ready for doing this study with well protection to the:

a) Technologist Yes [ ] No [ ]

b) Patient Yes [ ] No [ ]

Q2\ Is the equipments, gamma camera or x-ray unit and their accessories, of a good condition to do this study?

Yes [ ] No [ ]

Q3\ How many patients per month for this study?

…………………………………………………………………….

Q4\ Is the image staging for this study comfortable for :

a) Technologist Yes ☐ No ☐

b) Patient Yes ☐ No ☐

Q6\ Is the radiopharmaceutical (99mTc-DTPA) or contrast medium (e.g omnipaque) is available :

In side the hospital Yes ☐ No ☐

Out side the hospital Yes ☐ No ☐

By a difficult manor Yes ☐ No ☐

Q7\ Is the preparation of the patient applied for a days ?

Yes ☐ No ☐

Q8\ How much the study cost ?

…………………………………………………………………..

Q9\ Is there any cases failed or repeated ?

Yes ☐ No ☐

Q10\ If the answer of Q9 is yes, how many cases per month ?

…………………………………………………………………..

Q11\ Is there quality control program applied in the

department ?

Yes ☐ No ☐

Q12\ If the answer of Q11 is yes, is an action take place when there is a problem ?

Yes ☐ No ☐

Appendix (3)

An Interview With Radiographic

& Nuclear medicine techs

How many imaging units in the department?

How many technologist in the department?

Is there a monitory protection tests for each technologist?

Is the waiting time for the patient reasonable?

Is there any type of meeting with the staff to discuss the performance of the department and mainly the rejected images analysis?

Appendix (4)

An Interview With

Nuclear Medicine Physician & Radiologists

1) How many images you are reported by month?
2) Are the images quality acceptable and diagnosable?
3) If the answer of Q2 is (No), are the rejected images re-request ?
4) Is there any type of meeting with the staff to discuss the performance of the department and mainly the rejected images analysis?

Appendix (5)

An Interview With Physicians &Surgeons (Urologists & Nephrogists)

1) For a patient with renal disorder and needs imaging, what is the first request you will do, excretion urography or DTPA ?
2) How many patients whom you are send for imaging per month of:-

   a) ^{99m}Tc-DTPA

   b) Excretion Urography.
3) Are the feed back results for the requested images acceptable ?
4) If the answer of Q3 is No, what do you do, are you repeat the requested image, or do other alternative investigations, and what are they ?
5) Is there any type of meeting with N.M. Physcians and radiologist to solve some problems presented ?

Appendix (6) The Images :

Ten of hundred patients were selected as examples to illustrate the images findings as follow :

Rt **Patient No. 26** Lt

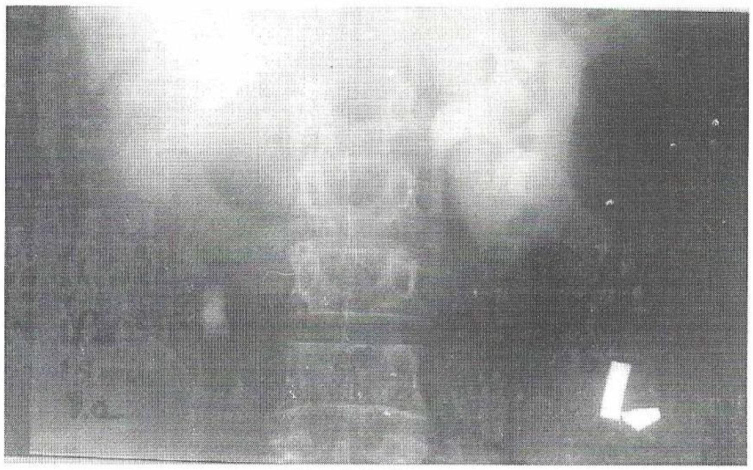


Fig. 3.1.A
AP. Abd. 15 min p.i.

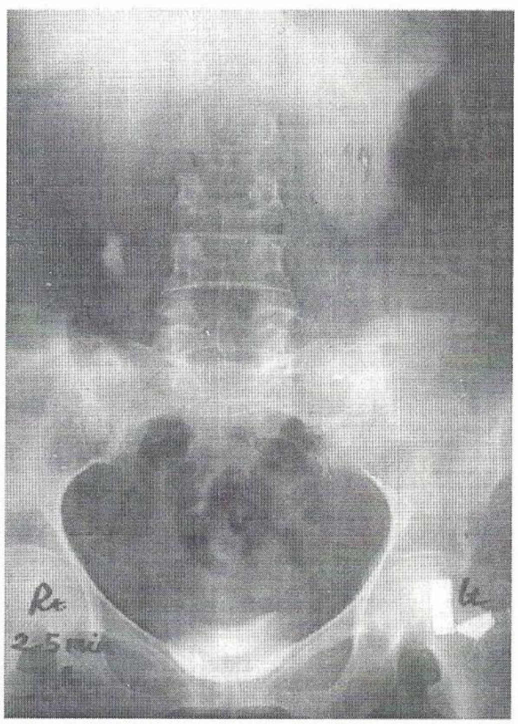


Fig. 3.1.B
AP. Abd. 25 min p.i.

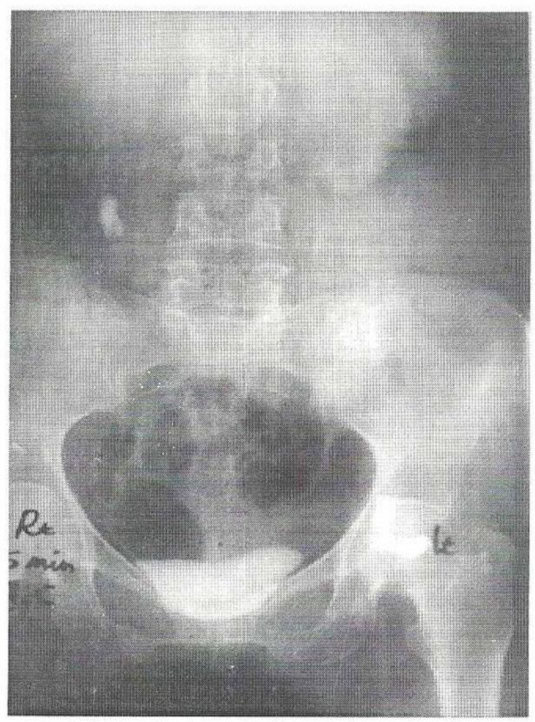
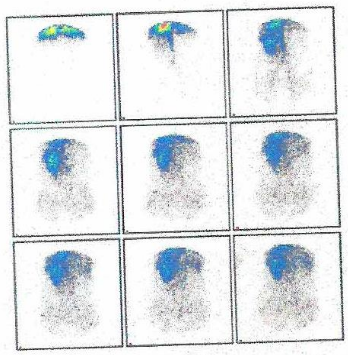
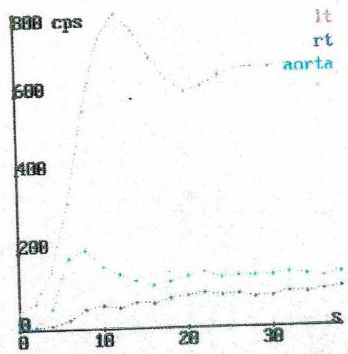


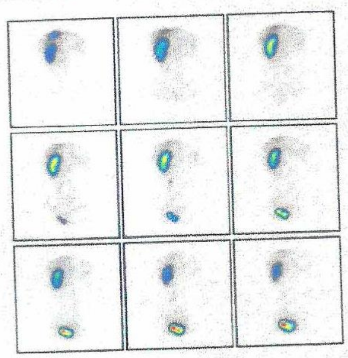
Fig. 3.1.C
AP. Abd. 35 min p.i.

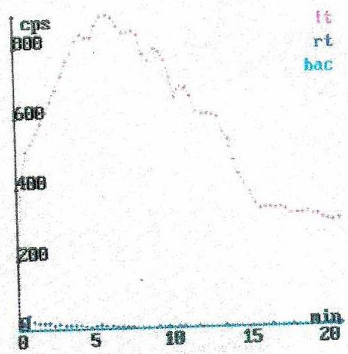
Patient No. 26





Relative perfusion			
Area		Curve	
lt	90.4 %	Maximal value :	861.2
rt	9.6 %	Maximal value :	98.97





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 99.4 %
	Right Kidney	: 0.6 %
Time of Max.	Left Kidney	: 6.000 min
	Right Kidney	: 0.667 min

Fig. 3.1

Presentation Patient No . “26|” - A 60 year old famle ,Home

Conc : Good function left kidney . non function right kidney.

Rt **Patient No. 29** Lt

Fig. 3.2.A
AP. Abd. 10 min. p.i

Fig. 3.2.B
AP. Abd. 30 min. p.i

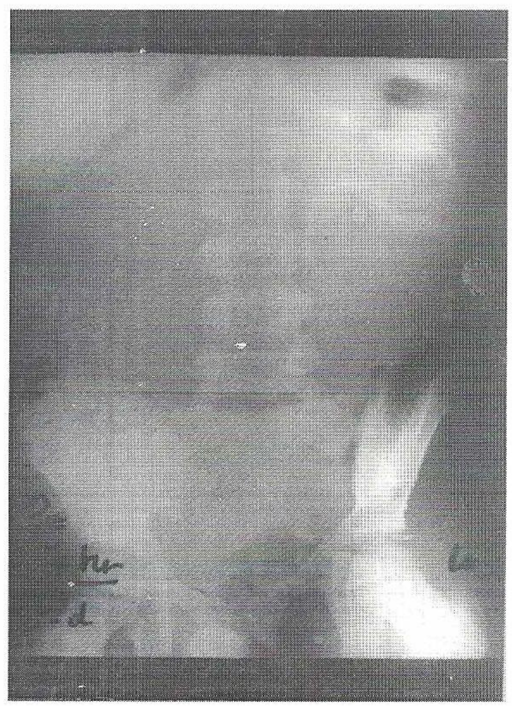
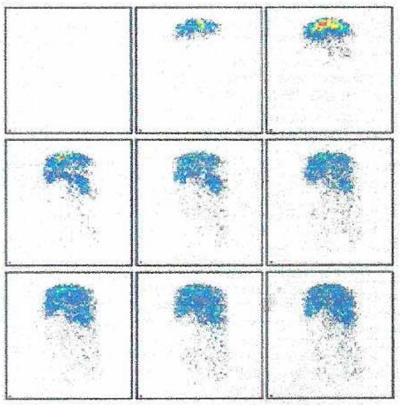
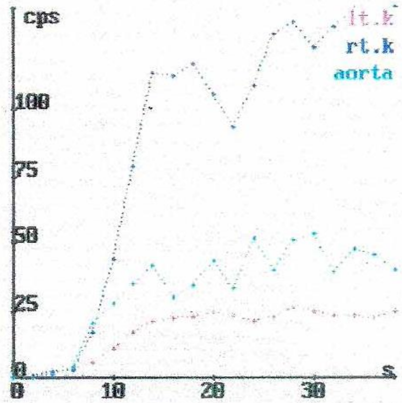


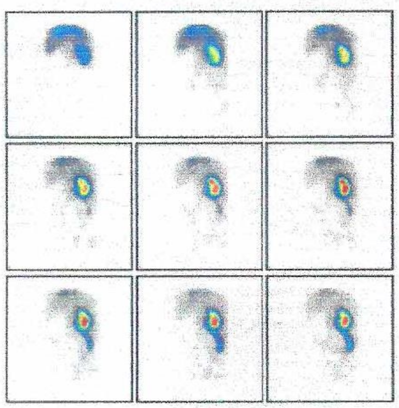
Fig. 3.2.C
AP. Abd. 4 hur. p.i

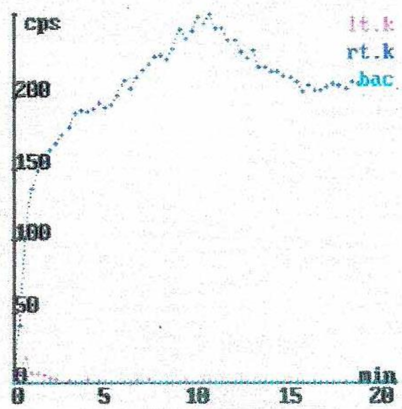
Patient No. 29





Relative perfusion			
Area		Curve	
lt.k	17.4 %	Maximal value :	28.7
rt.k	82.6 %	Maximal value :	138





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 0.0 %
	Right Kidney	: 100.0 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 10.667 min

Fig. 3.2

Presentation : Patient No . “29” An 8 year old male Home

Conc :Non function left kidneyPost renal obstructive nephropathy

Rt **Patient No. 30** Lt

Fig. 3.3.A
AP. Abd. 5 min. p.i

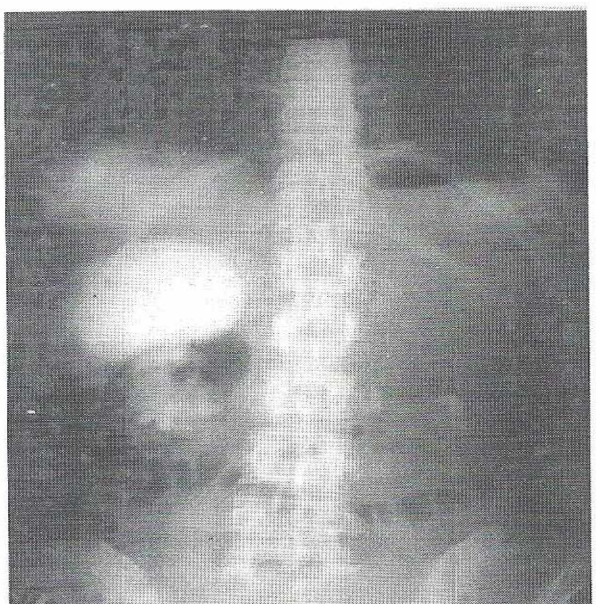


Fig. 3.3.B
AP. Abd. 1 hur. p.i

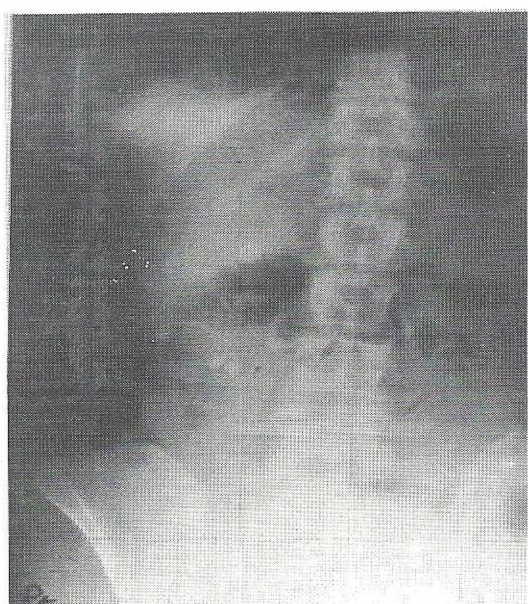
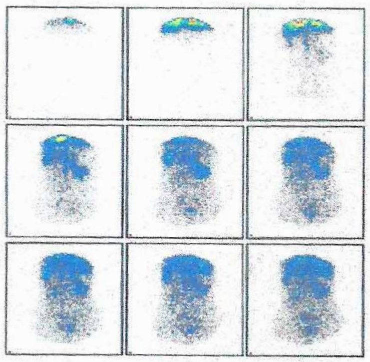
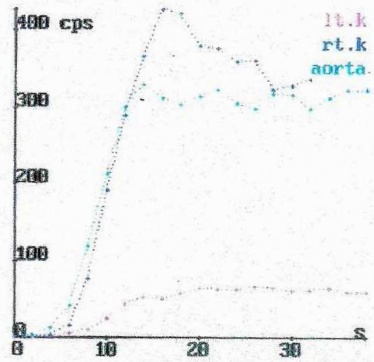


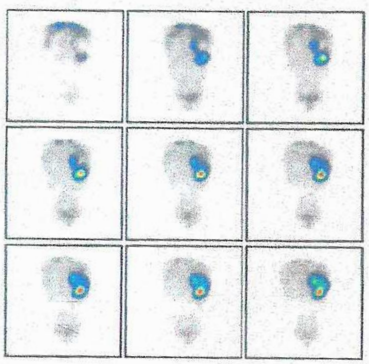
Fig. 3.3.C
AP. Abd. 10 hur. p.i

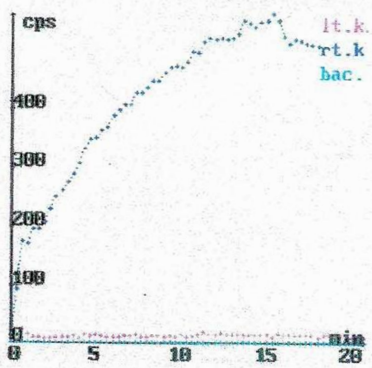
Patient No. 30





Relative perfusion			
Area		Curve	
lt.k	14.0 %	Maximal value :	81.98
rt.k	86.0 %	Maximal value :	426.6





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 5.3 %
	Right Kidney	: 94.7 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 15.333 min

Fig.: 3.3

Presentation Patient No . "30 A 25 year old female

Conc : Non function left kidney ,obstructive nephropathy of the right kidney .

Rt **Patient No. 31** Lt

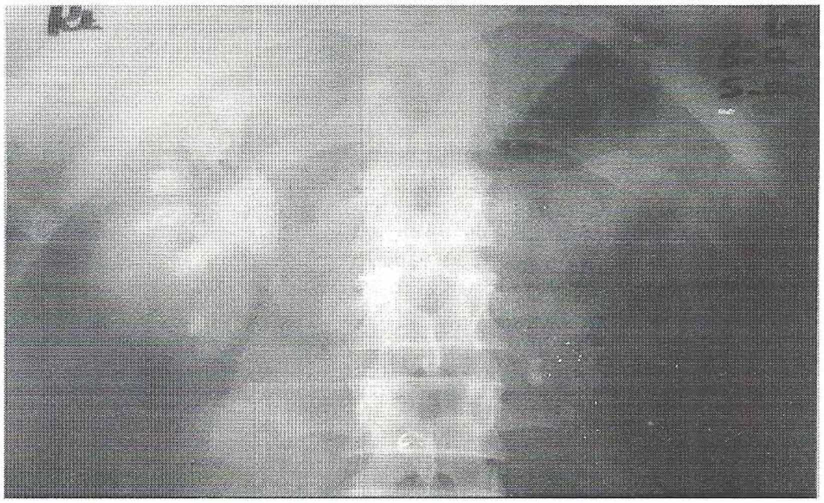


Fig. 3.4.A
AP. Abd. 5 min. p.i

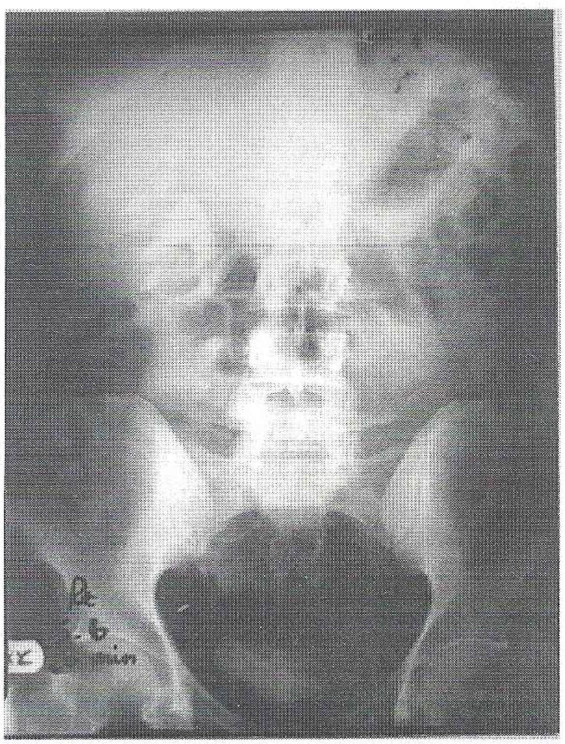


Fig. 3.4.B
AP. Abd. 30 min. p.i

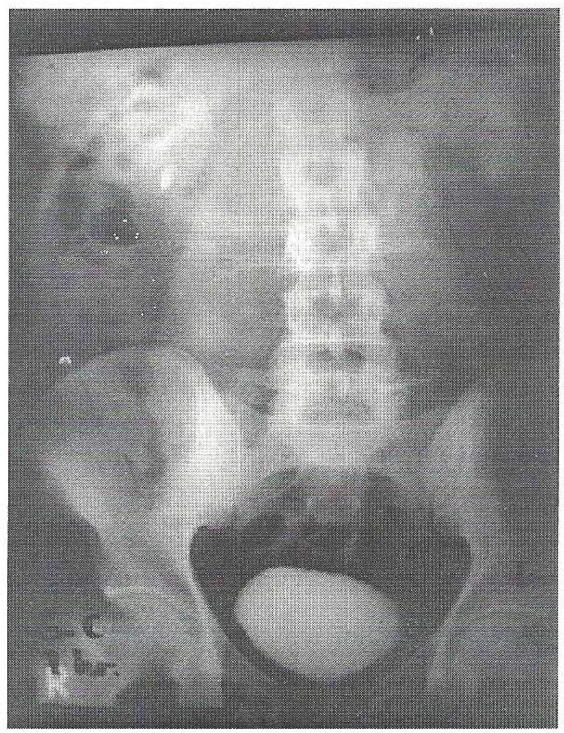
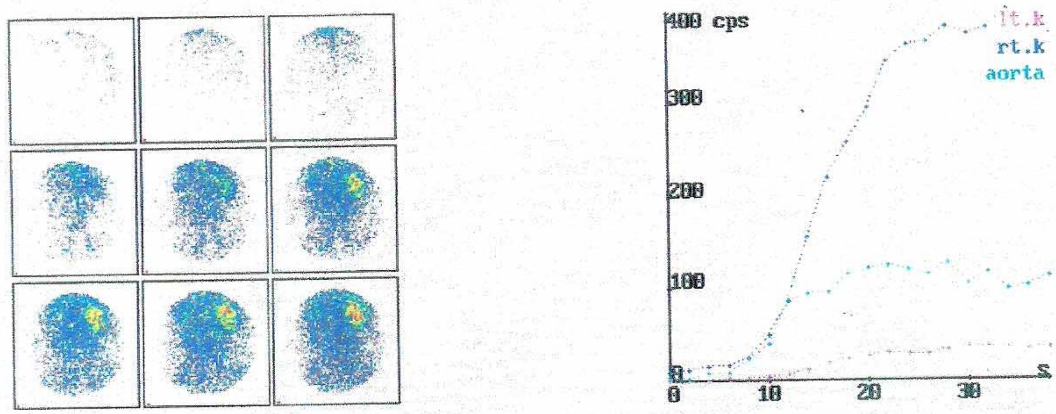
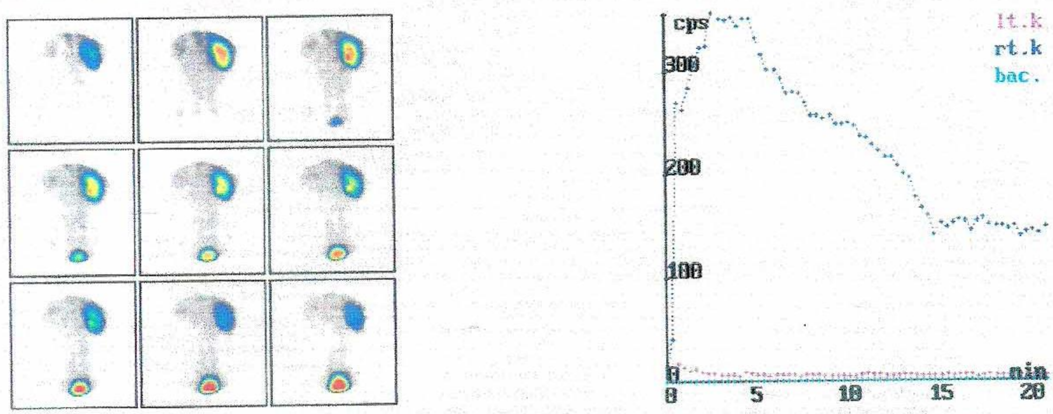


Fig. 3.4.C
AP. Abd. 1 hr. p.i

Patient No. 31



Relative perfusion			
Area		Curve	
lt.k	8.0 %	Maximal value :	40.94
rt.k	92.0 %	Maximal value :	400.3



KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 6.0 %
	Right Kidney	: 94.0 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 2.667 min

Fig. 3.4

Presentation Patient No . "31 A19 year old male

Conc : Normal function left kidney ,Post renal obstructive nephropathy

Patient No. 32

Rt Lt

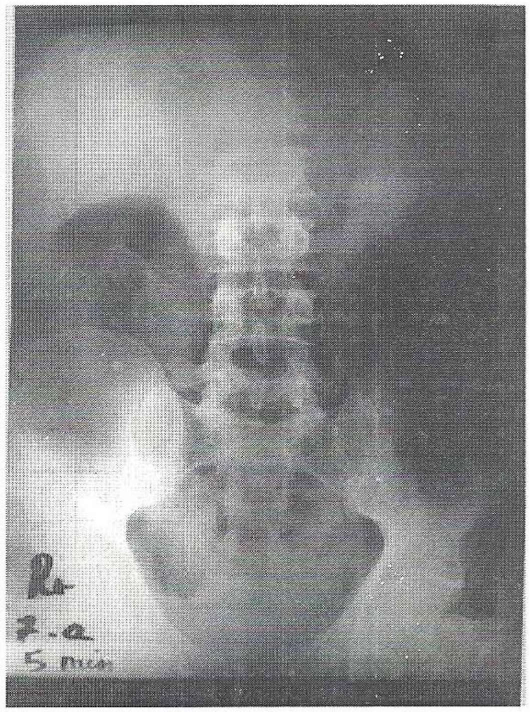


Fig. 3.5.A
AP. Abd. 5 min p.i.

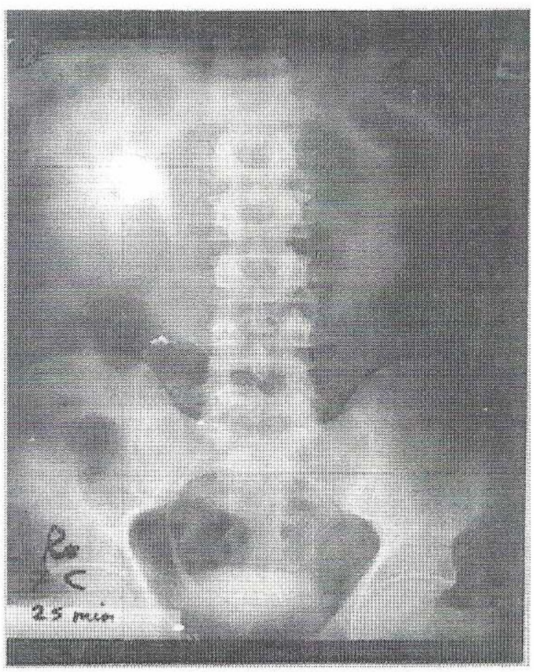


Fig. 3.5.B
AP. Abd. 25 min p.i.

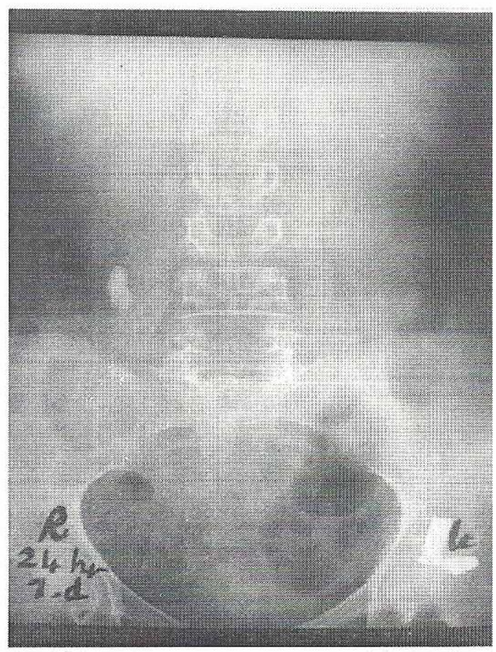
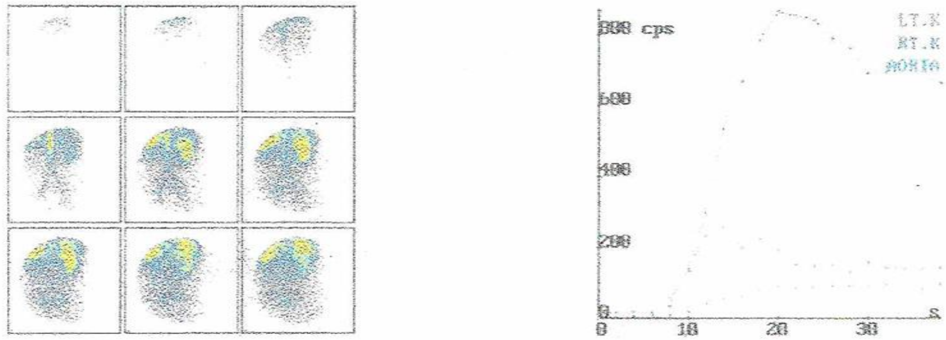
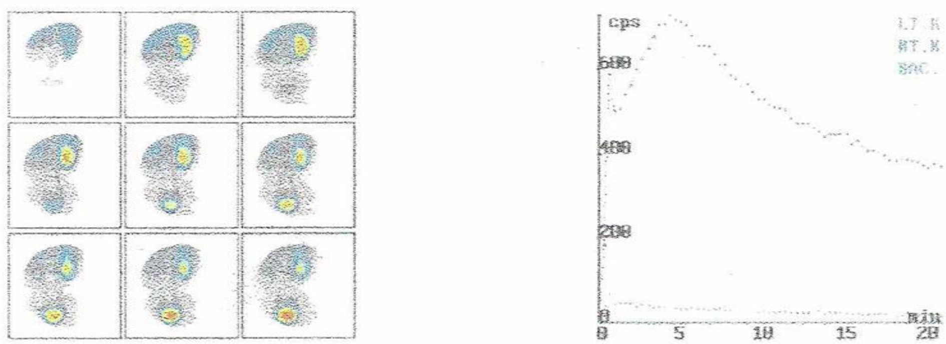


Fig. 3.5.C
AP. Abd. 24 hr p.i.

Presentation Patient No . "32" - A 51 year old male



Relative perfusion			
Area		Curve	
LT.K	10.4 %	Maximal value :	107.2
RT.K	89.6 %	Maximal value :	867.1



KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 5.5 %
	Right Kidney	: 94.5 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 4.333 min

Fig. 3.5

Presentation Patient No . "32"- A 51 year old male

Conc : Normal function right kidney, non function left kidney.

Rt **Patient No. 33** Lt

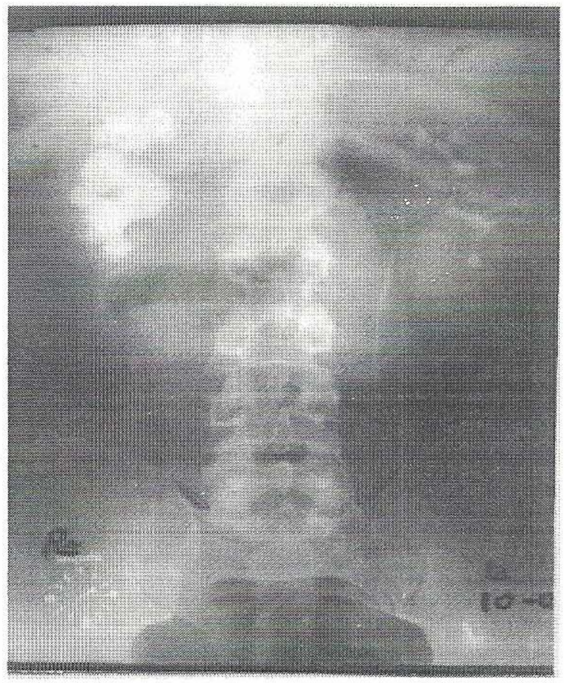


Fig. 3.6.A
AP. Abd. 10 min p.i.

Fig. 3.6.B
AP. Abd. 20 min p.i.

Rt **Patient No. 33** Lt

Fig. 3.6.C
AP. Obli. Bladder
25 min p.i.

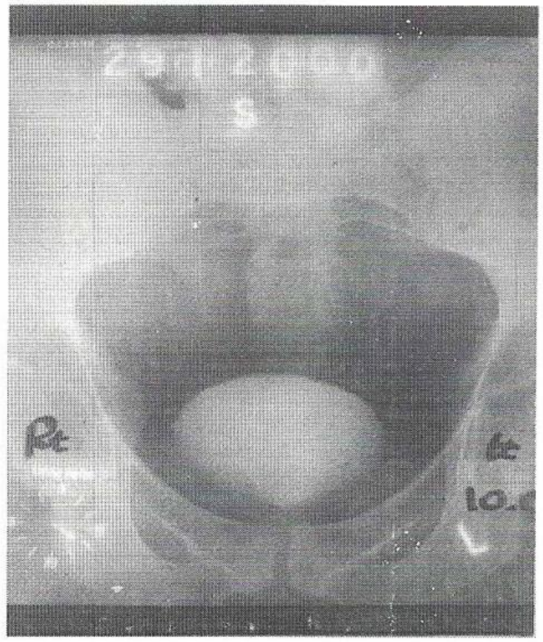
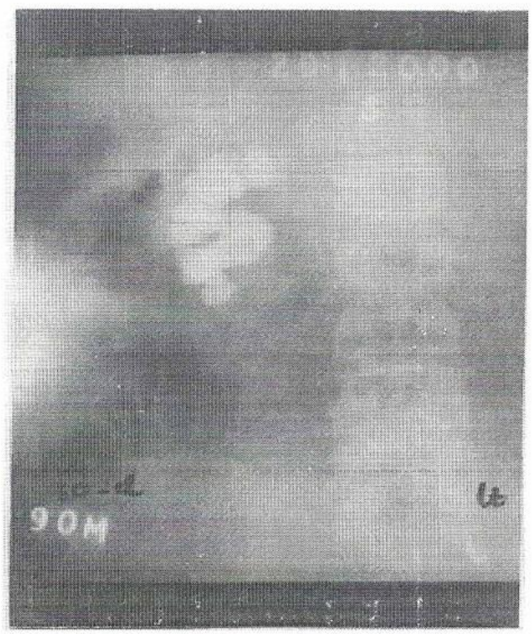
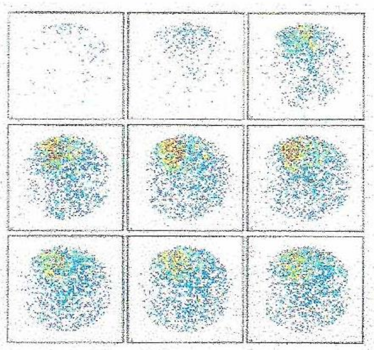
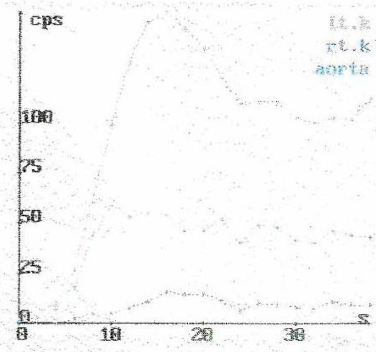


Fig. 3.6.D
AP. Abd. 1 hr p.i.

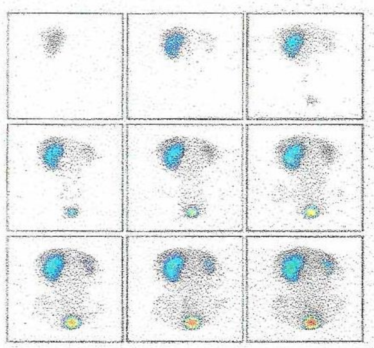


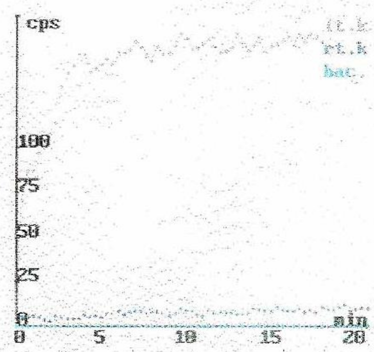
Patient No. 33





Relative perfusion			
Area		Curve	
lt.k	92.1 %	Maximal value :	161.6
rt.k	7.9 %	Maximal value :	16.06





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 97.3 %
	Right Kidney	: 2.7 %
Time of Max.	Left Kidney	: 19.000 min
	Right Kidney	: 19.333 min

Fig. 3.6

Presentation Patient No . "33" A 36 year old male

Conc: Poor function Right kidney, left kidney with Consistency obstructivene phropathy

Patient No. 34

Rt Lt

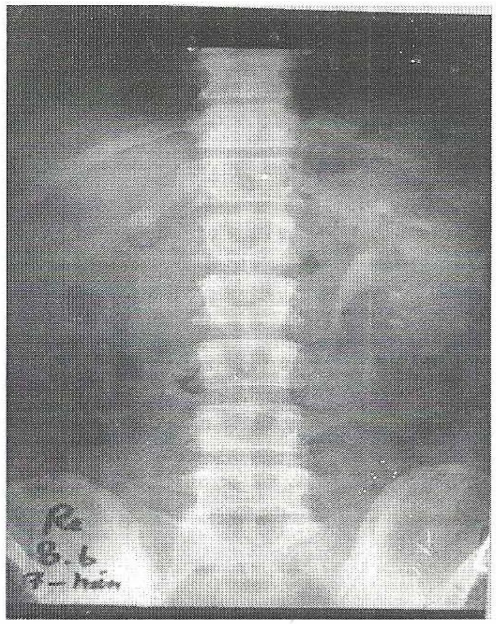


Fig. 3.7.A
AP. Abd. 7 min p.i.

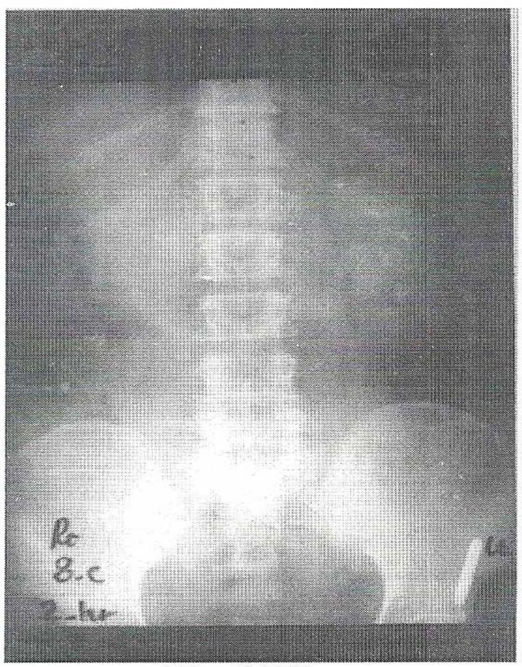


Fig. 3.7.B
AP. Abd. 2hr p.i.

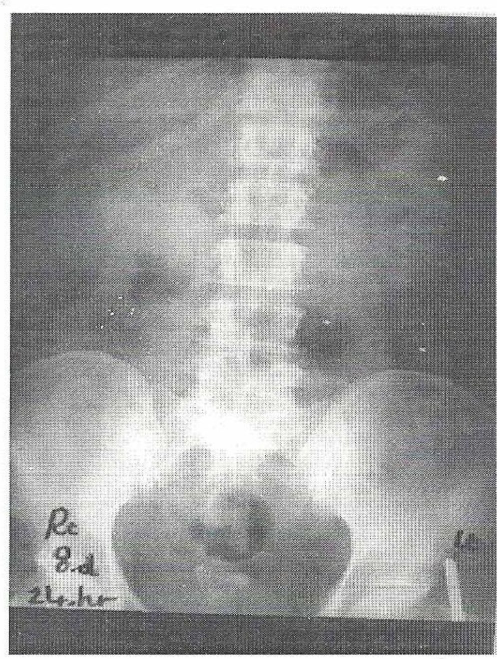
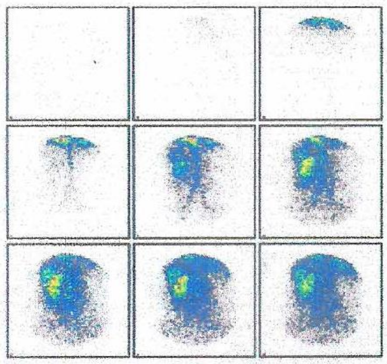
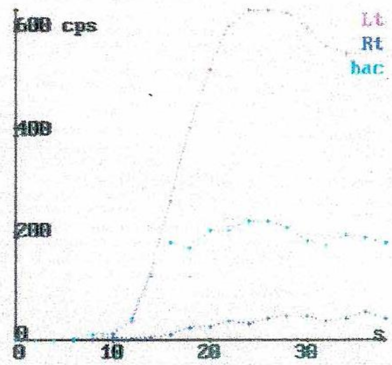


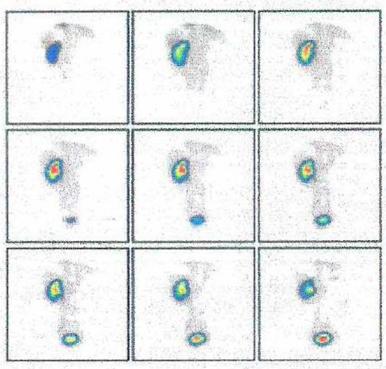
Fig. 3.7.C
AP. Abd. 24 hr p.i.

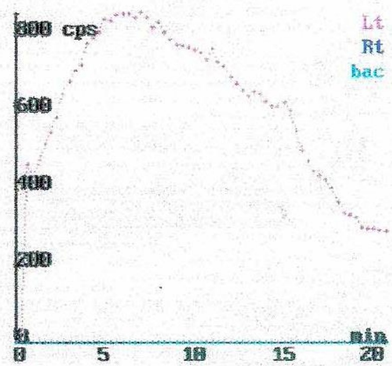
Patient No. 34





Relative perfusion	
Area	Curve
Lt 93.7 %	Maximal value : 647.5
Rt 6.3 %	Maximal value : 55.23





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 100.0 %
	Right Kidney	: 0.0 %
Time of Max.	Left Kidney	:7.000 min
	Right Kidney	: 0.677 min

Fig. 3.7

Presentation Patient No . "34" A 55 year old male

. **Conc : Non function Right kidney, function Left kidney.**

Rt **Patient No. 36** Lt

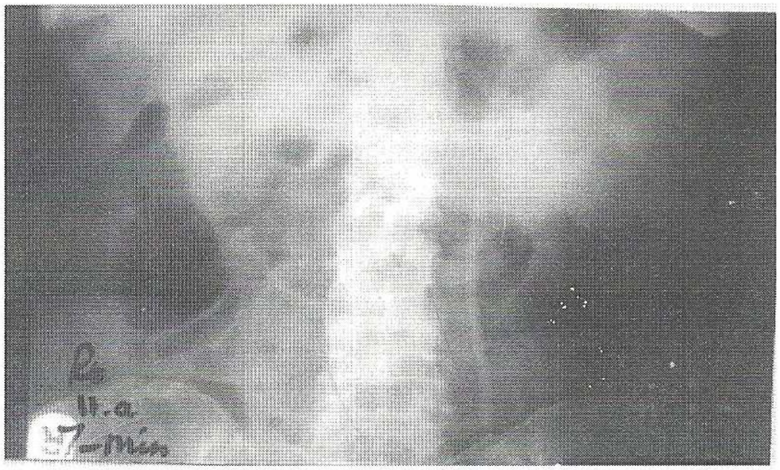


Fig. 3.8.A
AP. Abd. 7 min p.i.

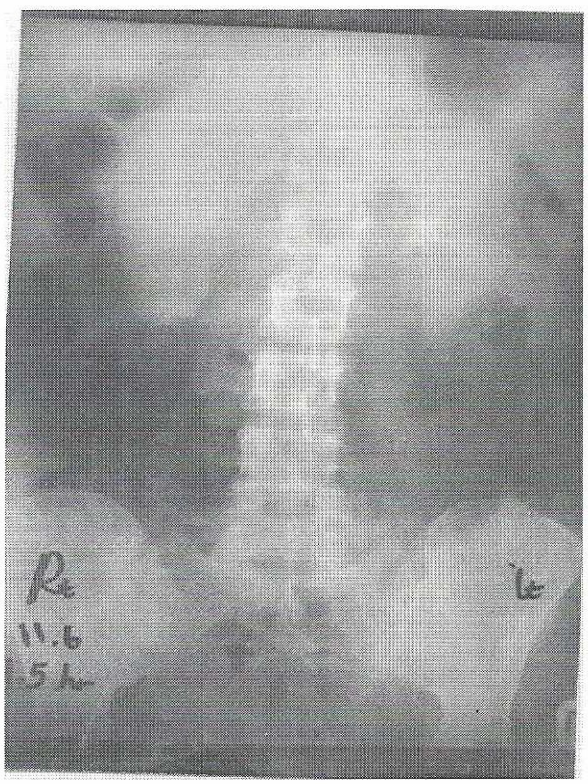


Fig. 3.8.B
AP. Abd. 1.5 hr p.i.

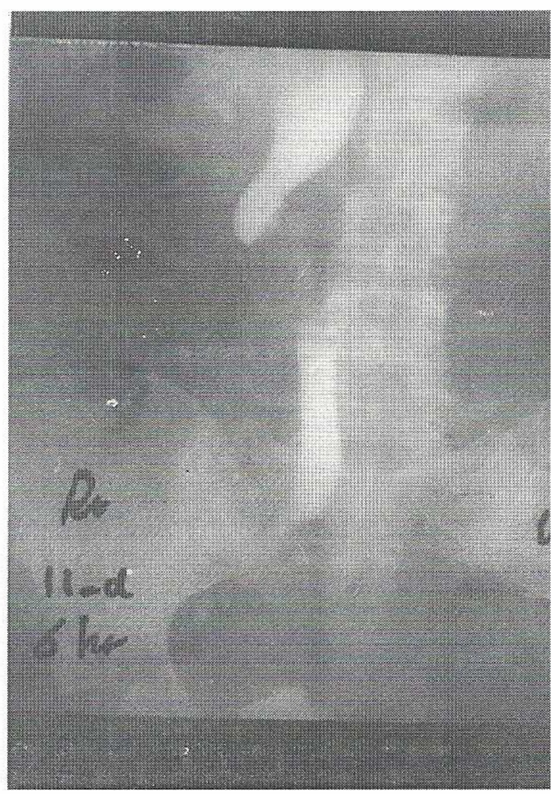
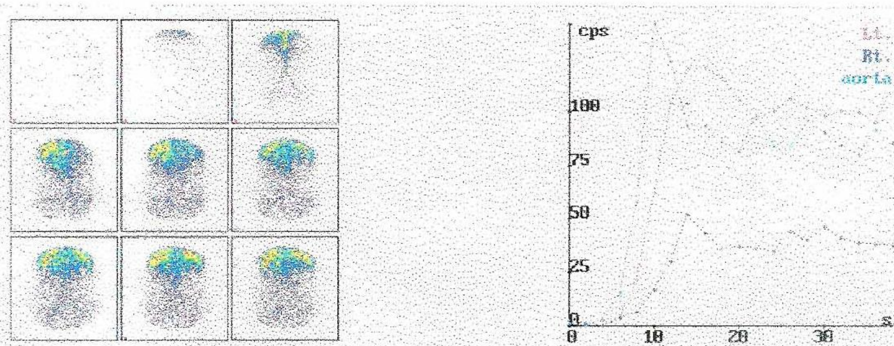
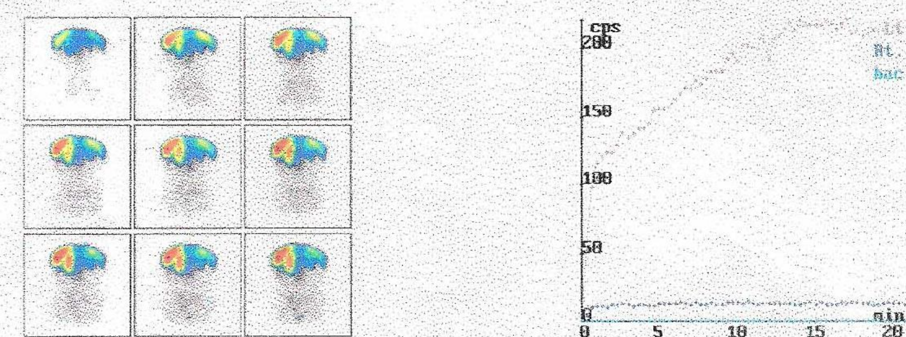


Fig. 3.8.C
AP. Abd. 6 hr p.i.

Patient No. 36



Relative perfusion			
Area		Curve	
Lt.	72.9 %	Maximal value :	121.3
Rt.	27.1 %	Maximal value :	52.07



KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 96.4 %
	Right Kidney	: 3.6 %
Time of Max.	Left Kidney	: 17.000 min
	Right Kidney	: 10.667 min

Fig. 3.8

Presentation : Patient No . "36" - A 35 year old female :

Conc: Noun function Right kidneyfunction, Left kidney with dilated pelvicalceel system

Rt

Patient No. 38

Lt

Fig. 3.8.A
AP. Abd. 7 min p.i.

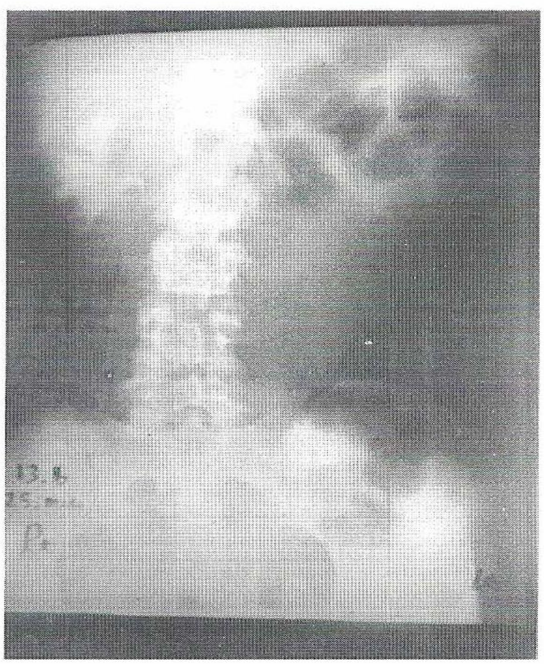


Fig. 3.9.B
AP. Abd. min p.i.

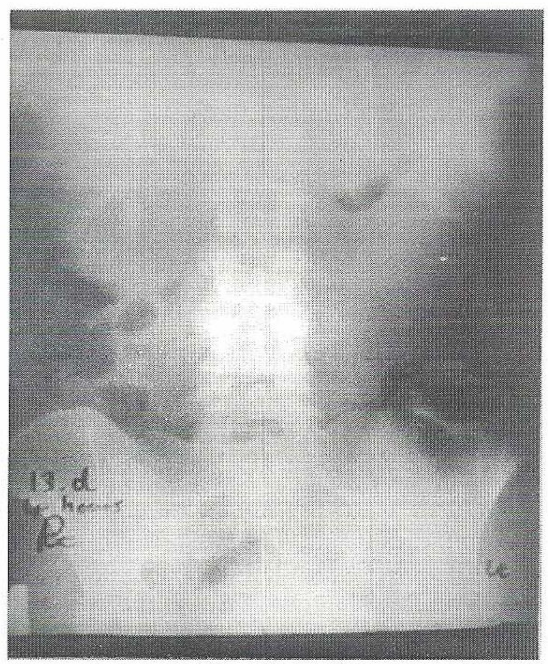
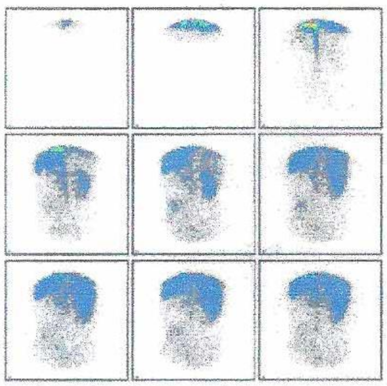
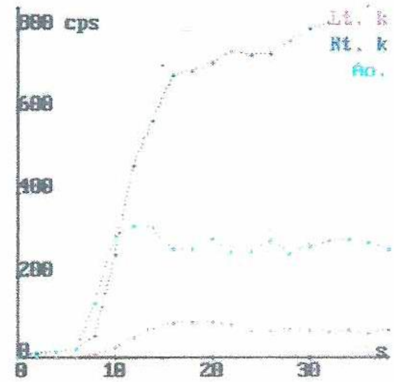


Fig. 3.9.C
AP. Abd. 4 hr p.i.

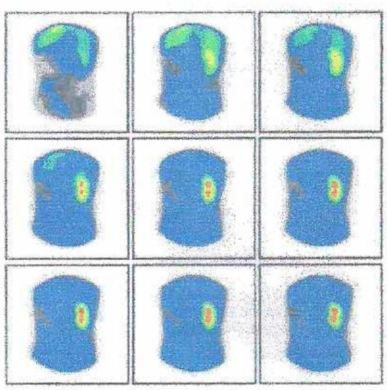
Fig. : 3.9 (a)

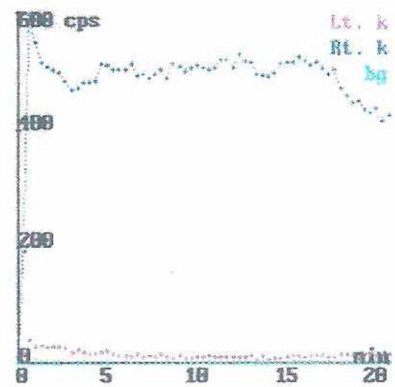
Patient No. 38





Relative perfusion			
Area		Curve	
Lt. k	9.7 %	Maximal value :	92.83
Rt. k	90.3 %	Maximal value :	852.8





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 2.9 %
	Right Kidney	: 97.1 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 0.667 min

+ 40 mg Lasi

Fig. : 3.9 (b)

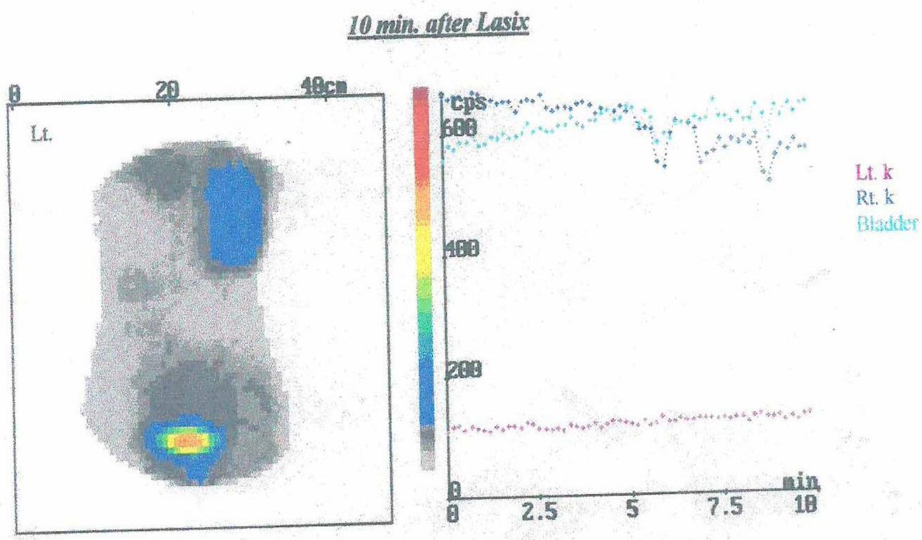


Fig : 3.9 (c)

Presentation Patient No . "38" - A 32 year old female

Conc : Non function Left kidneyRight kidney function with diluted pelvicalceel system

Rt **Patient No. 40** Lt

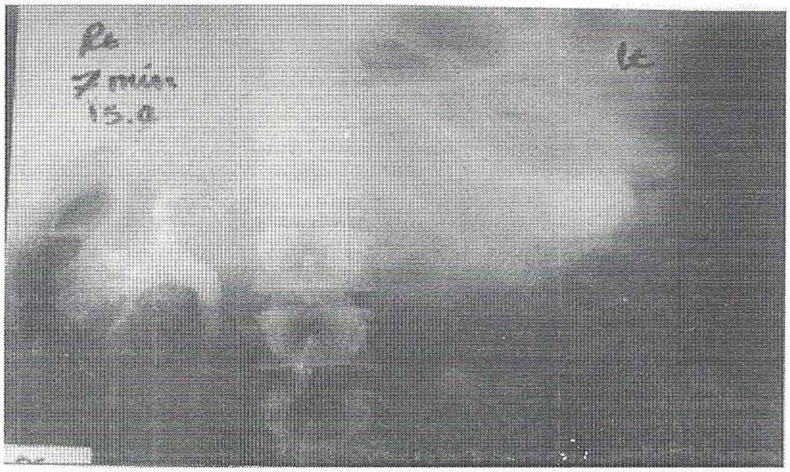


Fig. 3.10.A
AP. Abd. 7 min p.i.

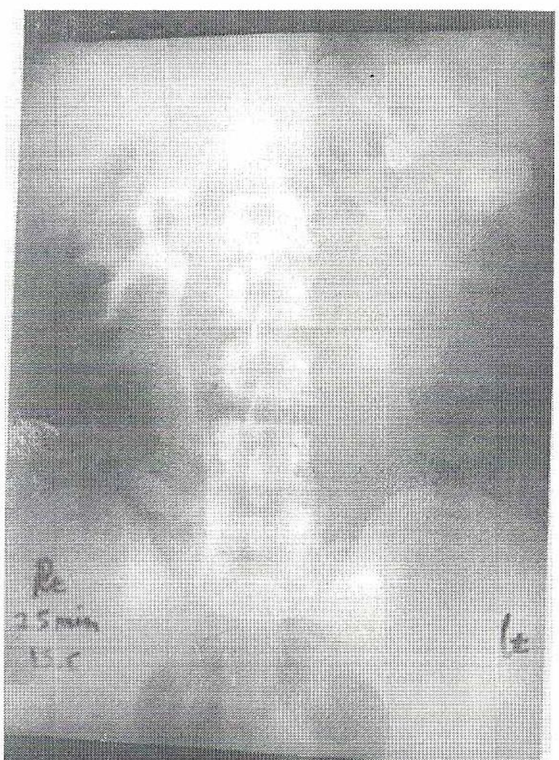
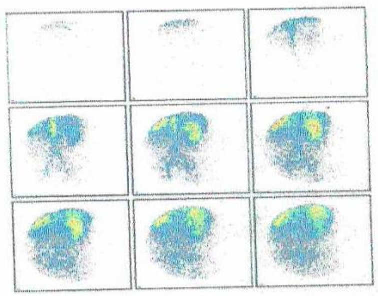
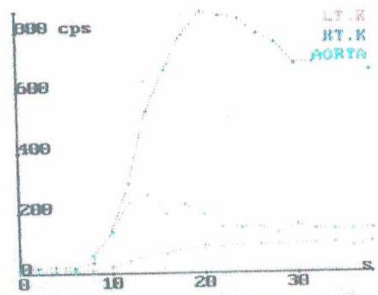


Fig. 3.10.B
AP. Abd. 15 min p.i.

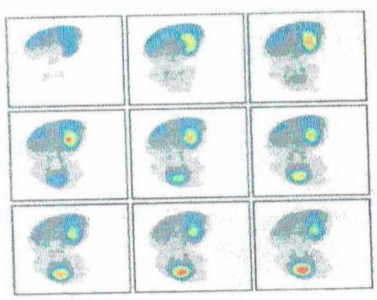
Fig. 3.10.C
AP. Abd. 4 hr p.i.

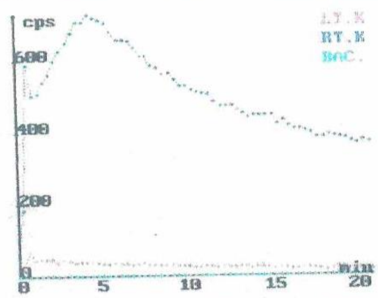
Patient No. 40





Relative perfusion			
Area		Curve	
LT.K	10.4 %	Maximal value :	107.2
RT.K	89.6 %	Maximal value :	867.1





KIDNEY CURVE ANALYSIS		
Relative Function	Left Kidney	: 5.5 %
	Right Kidney	: 94.5 %
Time of Max.	Left Kidney	: 0.667 min
	Right Kidney	: 4.333 min

Fig. 3.10

Presentation : Patient No . "40" - A 30 year old male

Conc : Good function right Kidney . Non function left kidney .