بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Sudan University for Science and Technology
College of Graduate Studies

Study of Diabetes and Hypertension Effects on Renal Function using Renal Scintigraphy

دراسة آثار مرض السكري و ارتفاع ضغط الدم على وظائف الكلى باستخدام المسح الذري للكلى

A Thesis Submitted for Partial Fulfillment for Requirements of Master Degree in Nuclear Medicine

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بسم الله الرحمن الرحيم

{قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ}

صدق الله العظيم

{ سورة البقرة: الآية (32) }

Dedication:

Dedicated to

My mother the light of my life, my father, my brother

Thank you all for the faith, advice, patience and encouragements.

In honor of

My big family

In memory of

My late loved ones
Gone not yet forgotten

Acknowledgement:

Dr. Eltayeb Wagiallah for his supervision through this study.

My deep appreciation to all the friends who supported and helped me through each step of this achievement, without them it wouldn’t be possible.

Abstract:

The kidneys play key roles in body function by filtering the blood and getting rid of waste products and balancing the electrolyte levels in the body. Chronic diseases such as hypertension (high blood pressure) and diabetes are devastating because of the damage that they can do to kidneys and other organs. This study included population of 100 patients having hypertension or diabetes underwent the renal DTPA scan. The aim of this research is to study diabetes and hypertension effects on renal function using renal scintigraphy. The importance of this study dwells in the possibility of limiting the impact of these chronic diseases and to help preventing any potential kidney damage. The study was conducted at AlNeeleen Medical Diagnostic Center/Nuclear Medicine Department and Royal Care International Hospital/Nuclear Medicine Department between October 2019-February 2020, then analyzed by SPSS statistical program. Results showed that the time of occurrence of hypertension or diabetes individually (HP / DM) has no influence on the kidney function, while the occurrence of the hypertension and diabetes combined (HP + DM) for a long period of time leads to kidney function deterioration, which in turn affect the overall outcome of the renal system. The study recommends assessing the radiation dose administered, body mass index and time contribution to kidney function in presence of hypertension and diabetes. And to increase awareness of a healthy lifestyle and the role of regular examinations to help in early detection which can become an effective factor in limiting the effects of hypertension and diabetes on the renal function.

المستخلص:

تؤدي الكلى أدوارًا رئيسية في وظائف الجسم عن طريق تصفية الدم والتخلص من الفضلات وموازنة مستويات الإملاح في الجسم. الأمراض المزمنة مثل ارتفاع ضغط الدم ومرض السكري مدمرة بسبب الأضرار التي يمكن أن تلحق بالكلى والأعضاء الأخرى. تضمنت هذه الدراسة 100 مريضا يعانون من ارتفاع ضغط الدم أو مرض السكري خضعوا لفحص DTPA الكلوي. الهدف من هذا البحث هو دراسة آثار مرض السكري وارتفاع ضغط الدم على وظائف الكلى باستخدام التصوير الكلوي. تكمن أهمية هذه الدراسة في إمكانية الحد من تأثير هذه الأمراض المزمنة والمساعدة في منع أي تلف محتمل للكلى.

اجريت الدراسة في مركز النيلين للتشخيص الطبي / قسم الطب النووي ومستشفى رويال كير العالمي / قسم الطب النووي بين (اكتوبر 2019– فبراير 2020) ثم تم تحليلها بواسطة برنامج SPSS الاحصائي. أظهرت النتائج أن زمن حدوث مرض ارتفاع ضغط الدم او السكري بشكل منفرد (HP / DM) ليس له تأثير على وظائف الكلى ، في حين أن حدوث مرض ارتفاع ضغط الدم والسكري مجتمعين (HP + DM) لفترة طويلة من الزمن يؤدي إلى تدهور وظائف الكلى، مما يؤثر بدوره على النتيجة الاجمالية للجهاز الكلوي .توصي الدراسة بتقييم الجرعة الاشعاعية التي يتم اعطاؤها ومؤشر كتلة الجسم ومساهمة الزمن في وظائف الكلى في حالة وجود مرض ارتفاع ضغط الدم و السكري. وزيادة الوعي المتعلق بأسلوب الحياة الصحي ودور الفحوصات المنتظمة للمساعدة في الكشف المبكر الذي يمكن أن يصبح عاملاً فعالاً في الحد من آثار مرض ارتفاع ضغط الدم و مرض السكري على وظائف الكلى.

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CHAPTER ONE

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1.1. Introduction:

The kidneys are located in the abdomen toward the back, normally one on each side of the spine. They play key roles in body function by filtering the blood and getting rid of waste products and balancing the electrolyte levels in the body (Urologyhealth.org, 2018).

Kidney disease is a global public health problem affecting 850 million people world wild, but most people don't realize that it is a major health issue. They noted that kidney diseases often cause no early symptoms and people aren't aware of their risk for more problems (HealthDay, 2018).

Rates of kidney disease vary substantially across the world and are defined by socioeconomic, cultural factors leading to significant disparities (Crews, Bello and Saadi, 2019).

Chronic diseases such as hypertension (high blood pressure) and diabetes are devastating because of the damage that they can do to kidneys and other organs (Medicine Net, 2018).

Diabetes is a disease in which the body does not make enough insulin or cannot use normal amounts of insulin properly. Insulin is a hormone that regulates the amount of sugar in the blood (National Kidney Foundation, 2017).While hypertension is a condition in which the blood vessels have persistently raised pressure (World Health Organization: WHO, 2019).

World Health Organization statistics of hypertension and diabetes cleared that the prevalence of hypertension increased from 594 million in 1975 to 1.13 billion in 2015(World Health Organization: WHO, 2019), also showed that the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014. And the increase of prevalence seen largely and more rapidly in middle-low-

income countries (World, 2018).International diabetes federation clarified that Sudan has over 2.247.000 cases of diabetes in adults out of 39 million people in the Middle East and North Africa region (idf.org, 2019).While Sudanese society of hypertension stated that hypertension has the highest prevalence among the major of non-communicable diseases (prevalence of 23.6 in Khartoum state) (AHMED ALI, 2014).

The effect diabetes and hypertension have on kidneys that diabetes injures the small blood vessels in the body which leads to weakening the kidney's ability to clean the blood properly, and the body will retain more water and salt than it should (National Kidney Foundation, 2017).While uncontrolled high blood pressure affect a network of blood vessels with high volumes of blood flow through them which supply the nephrons in the kidneys, leading the arteries around the kidneys to narrow, weaken or harden. These damaged arteries are not able to deliver enough blood to the kidney tissue (www.heart.org, 2016).

1.2. Objectives of the study:

1.2.1. General objectives:

To study diabetes and hypertension effects on renal function using renal scintigraphy.

1.2.2. Specific objectives:

- To evaluate a renal function on behalf of diabetes mellitus and hypertension.
- To find out relationship between the age or gender and weight with hypertension and diabetes.
- To study the impact of hypertension and diabetes in the renal outcome.

- To correlate between the occurrence of hypertension and diabetes with the final diagnosis.

1.3. Problem of the study:

From a local cultural point of view about the appropriate health care attitudes for Sudanese people neglecting periodic checkups and medical orientation might result in discovering renal diseases in advanced prognosis which limits controlling the damage. In this research, we want to reveal to what extent the incidence of diabetes and hypertension affects the renal function.

1.4. Significance of the study:

This study importance arises from knowing to which degree diabetes and hypertension affect the kidney function, if this research served well and the goals achieved it could help in limiting the effect of these chronic diseases on the renal function and prevent any possible damage to the kidneys.

CHAPTER TWO

THEORETICAL BACKGROUND and LITERATURE REVIEW

CHAPTER TWO

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and LITERATURE REVIEW

2.1. Theoretical background:

2.1.1. Anatomy and Physiology of the Renal System:

The renal system is a group of organs in the body that filters out excess fluid and other substances from the bloodstream. These organs include the kidneys, ureters, bladder, and urethra.

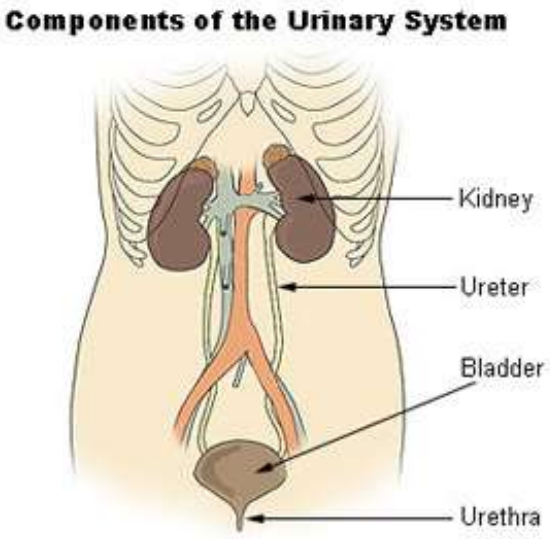

Figure 2.1: shows Components of the renal system.

Kidneys are the most complicated and critical part of the urinary system. The primary function of the kidneys is to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism. The kidneys have an extensive blood supply from the renal arteries that leave the kidneys via the renal vein. Nephrons are the main functional component inside the parenchyma of the kidneys, which filter blood to remove urea which is a waste product formed by the oxidation of proteins, as well as ions like potassium and sodium.

The nephrons are made up of capsule capillaries (the glomerulus) and a small renal tube. This renal tube consists of a network of tubules and loops that are selectively permeable to water and ions.

Many hormones involved in homeostasis will alter the permeability of these tubules to change the amount of water that is retained by the body.

Ureter: tubes act as a pathway of urine from the renal tube into the bladder.

Bladder: it is flexible and used as storage until the urine is allowed to pass through t he urethra and out of the body.

Urethra: The female and male renal system are very similar, differing only in the length of the urethra.

The renal system has many functions such as: Removal of metabolic waste products from the body, Regulation of electrolyte balance (e.g., sodium, potassium, and calcium). Also, play a very large role in human osmoregulation by regulating the amount of water reabsorbed from the glomerular filtrate in kidney tubules this is controlled by hormones such as antidiuretic hormone (ADH), renin, aldosterone, and angiotensin I and II.

The renal system alters water retention and thirst to slowly change blood volume and keep blood pressure in a normal range and regulation of acid-base homeostasis and blood pH, a function shared with the respiratory system (Lumenlearning.com, 2019).

2.1.2. Pathology of the Renal System:

Most common diseases of the renal system:

Urinary tract infections (UTIs): occur when bacteria enter the urinary tract; they can affect the urethra, bladder, or even the kidneys. UTIs are typically treated with antibiotics.

Interstitial cystitis (IC): also called painful bladder syndrome, is a chronic bladder c ondition, primarily in women, that causes bladder pressure and pain, it can cause bl adder scarring, and can make the bladder less elastic.

Prostatitis: swelling of the prostate gland. Often caused by advanced age, symptoms include urinary urgency and frequency, pelvic pain and pain during urination.

Kidney stones: are clumps of calcium oxalate that can be found anywhere in the urinary tract. They are formed when chemicals in the urine become concentrated enough to form a solid mass. They can cause pain in the back and sides, as well as b lood in the urine (Kim Ann Zimmermann, 2018).

Glomerulonephritis: is an inflammation of the glomeruli. Glomeruli are extremely small structures inside the kidney that filter the blood. Glomerulonephritis can be caused by infections, drugs or congenital abnormalities.

Polycystic kidney disease: is a genetic disorder that causes numerous cysts (sacs filled with fluid) to grow in the kidney. These cysts can interfere with kidney function & cause kidney failure (Johnson, 2012).

Hydronephrosis is a condition that typically occurs when a kidney swells due to urine failing to properly drain from the kidney to the bladder. It's a secondary condition that results from some other underlying disease. It's structural and is the result of a blockage or obstruction in the urinary tract. Mild symptoms of hydronephrosis include an increased urge to urinate, pain in the abdomen, and

incomplete voiding of the bladder. Normally, urine flows through the urinary tract with minimal pressure. Pressure can build up if there's an obstruction, after urine builds up for an extended period, the kidney enlarges and may become so engorged with urine that it starts to press on nearby organs (Wint, 2018).

Kidney failure: is defined when kidneys stop functioning normally.

Initially, kidney failure may not produce any symptoms (asymptomatic). As kidney function decreases, it leads to the inability to regulate water and electrolyte balances, clear waste products from the body, and promote red blood cell production. Symptoms associated with kidney failure include weakness, shortness of breath, lethargy, swelling, confusion, and Inability to remove potassium from the bloodstream may lead to abnormal heart rhythms and sudden death.

Some causes of kidney failure are treatable and the kidney function may return to normal. Unfortunately, kidney failure may be progressive in other situations and may be irreversible.

Kidney failure may occur from an acute situation that injures the kidneys or from chronic diseases that gradually cause the kidneys to stop functioning

Acute kidney failure: kidney function is lost rapidly and can occur from a variety of insults to the body. Causes of acute kidney failure: these causes are often categorized based on where the injury has occurred, Divided into:

Prerenal causes which are due to decreased blood supply to the kidney, renal causes of kidney failure (damage directly to the kidney itself) include: the body's immune system is overwhelmed from infection causes inflammation leading to kidneys shutdown, and postrenal causes are due to factors that affect the outflow of the urine.

Chronic kidney failure: it develops over months and years.

The most common causes of chronic renal failure are related to: poorly controlled diabetes, poorly controlled high blood pressure, and chronic glomerulonephritis.

While the less common causes include: Polycystic kidney disease, Reflux nephropathy (damage caused by urine backflow from the bladder into the ureters and kidney), Kidney stones, and Prostate disease.

Once kidney failure is present, the goal is to prevent further deterioration of renal function by using different classes of medications to preserve kidney function. If ignored, the kidneys will progress to complete failure that is when the treatment options are limited to dialysis or kidney replacement by transplantation which depends on the patient's illness and their past medical history along with other issues (Medicine Net, 2018).

2.1.3. Diabetes mellitus:

Diabetes mellitus, disorder of carbohydrate metabolism characterized by impaired ability of the body to produce or respond to insulin and thereby maintain proper levels of sugar (glucose) in the blood.

Diabetes is a major cause of morbidity and mortality, though these outcomes are not due to the immediate effects of the disorder they are instead related to the diseases that develop as a result of chronic diabetes mellitus. These include diseases of large blood vessels (macrovascular disease, including coronary heart disease and peripheral arterial disease) and small blood vessels (microvascular disease, including retinal and renal vascular disease), as well as diseases of the nerves.

Insulin is a hormone secreted by beta cells, which are located within clusters of cells in the pancreas called the islets of Langerhans. Insulin’s role in the body is to trigger cells to take up glucose so that the cells can use this energy-yielding sugar. Patients with diabetes may have dysfunctional beta cells, resulting in decreased insulin secretion, or their muscle and adipose cells may be resistant to the effects of insulin, resulting in a decreased ability of these cells to take up and metabolize

glucose. In both cases, the levels of glucose in the blood increase, causing hyperglycemia (high blood sugar).

As glucose accumulates in the blood, excess levels of this sugar are excreted in the urine. Because of greater amounts of glucose in the urine, more water is excreted with it, causing an increase in urinary volume and frequency of urination as well as thirst (diabetes mellitus Definition, Types, Symptoms, &Treatment, 2019).

There are two major forms of the disease: Type 1 diabetes and Type 2 diabetes.

Type 1 diabetes: formerly referred to as insulin-dependent diabetes mellitus (IDDM) or juvenile-onset diabetes

It accounts for about 5 to 10 percent of cases of diabetes. Most cases of type 1 diabetes develop in children. Most patients present with symptoms of hyperglycemia, but some patients present with diabetic ketoacidosis, a clear indication that insulin secretion has significantly deteriorated.

Type 1 diabetes is usually caused by autoimmune destruction of the islets of Langerhans of the pancreas. Patients with type 1 diabetes have serum antibodies to several components of the islets of Langerhans, including antibodies to insulin itself. The antibodies are often present for several years before the onset of diabetes, and their presence may be associated with a decrease in insulin secretion. Some patients with type 1diabetes have genetic variations associated with the human leukocyte antigen (HLA) complex, which is involved in presenting antigens to immune cells and initiating the production of antibodies that attack the body's own cells (autoantibodies). However, the actual destruction of the islets of Langerhans is thought to be caused by immune cells sensitized in some way to components of islet tissue rather than to the production of autoantibodies.

Type 2 diabetes: formerly called non-insulin-dependent diabetes mellitus (NIDDM) or adult-onset diabetes.

It is far more common than type 1 diabetes, accounting for about 90 percent of all cases. Most patients with type 2 diabetes are adults, often older adults, but it can also occur in children and adolescents. There is a stronger genetic component to type 2 diabetes than to type 1 diabetes. Many patients with type 2 diabetes are asymptomatic, and they are often diagnosed with type 2 diabetes when routine measurements reveal high blood glucose concentrations. Other patients present with symptoms of hyperglycemia that have been present for months or with the sudden onset of symptoms of very severe hyperglycemia and vascular collapse.

Type 2 diabetes is strongly associated with obesity and is a result of insulin resistance and insulin deficiency. Insulin resistance is a very common characteristic of type 2 diabetes in patients who are obese, and thus patients often have serum insulin concentrations that are higher than normal. However, some obese persons are unable to produce sufficient amounts of insulin, and thus the compensatory increase in response to increased blood glucose concentrations is inadequate, resulting in hyperglycemia. If blood glucose concentration is increased to a similar level in a healthy person and in an obese person, the healthy person will secrete more insulin than the obese person.

People with type 2 diabetes can control blood glucose levels through diet and exercise and, if necessary, by taking insulin injections or oral medications. Despite their former classifications either type of diabetes can occur at any age (diabetes mellitus Definition, Types, Symptoms, &Treatment, 2019).

Normal diabetic blood sugar ranges for healthy individuals are: between 4 to 5.4mmol/L when fasting and up to 7.8mmol/L 2hours after eating. And for people with diabetes, the ranges are: before meals: 4 to7mmol/L for people with type1 or type2, and after meals: under 9mmol/L for people with type 1 and under 8.5mmol/L for people with type 2 diabetes (Diabetes.co.uk, 2019).

2.1.4. Hypertension:

Blood pressure is the force exerted by circulating blood against the walls of the body's arteries. Hypertension is when blood pressure is too high (World Health Organization: WHO, 2019).

Narrow arteries increase resistance. The narrower the arteries are, the higher the blood pressure will be (Holland, 2014).

Blood pressure is written as two numbers. The first (systolic) number represents the pressure in blood vessels when the heart contracts or beats. The second (diastolic) number represents the pressure in the vessels when the heart rest between beats. Hypertension is diagnosed when it is measured on two different days, the systolic blood pressure readings on both days is ≥140 mmHg and /or the diastolic blood pressure readings on both days is ≥90mmHg(World Health Organization: WHO, 2019).

There are five categories that define blood pressure readings for adults:
Healthy: A healthy blood pressure reading is less than 120/80 millimeters of mercury (mm Hg).
Elevated: The systolic number is between 120 and 129 mm Hg, and the diastolic number is less than 80 mm Hg.
Stage 1 hypertension: The systolic number is between 130 and 139 mm Hg, or the diastolic number is between 80 and 89 mm Hg.
Stage 2 hypertension: The systolic number is 140 mm Hg or higher, or the diastolic number is 90 mm Hg or higher.
Hypertensive crisis: The systolic number is over 180 mm Hg, or the diastolic number is over 120 mm Hg. Blood pressure in this range requires urgent medical attention (Holland, 2014).

Hypertension is called a "silent killer". Most people with hypertension are unaware of the problem because it may have no warning signs or symptoms. When symptoms do occur, they can include early morning headaches, nosebleeds, irregular heart rhythms, vision changes, and buzzing in the ears. Severe hypertension can cause fatigue, nausea, vomiting, confusion, anxiety, chest pain, and muscle tremors (World Health Organization: WHO, 2019).

Hypertension typically develops over the course of several years. It can cause damage to your blood vessels and organs, especially the brain, heart, eyes, and kidneys.

There are two types of hypertension:

Primary hypertension develops over time with no identifiable cause. Some factors may play a role which includes: genes, physical changes, and environment.

Secondary hypertension: often occurs quickly and can become more severe than primary hypertension. May be caused by: As a side effect of medications, use of illegal drugs, alcohol abuse, adrenal gland problems and certain endocrine tumors

If hypertension isn’t treated, it may cause serious, even fatal, complications such as damaged arteries, healthy arteries are flexible and strong. Blood flows freely and unobstructed through healthy arteries and vessels. Hypertension makes arteries tougher, tighter, and less elastic. This damage makes it easier for dietary fats to deposit in your arteries and restrict blood flow. This damage can lead to increased blood pressure, blockages, and, eventually, heart attack and stroke (Holland, 2014).

2.1.5. Renal scintigraphy:

Renal scintigraphy, also known as "renal scans" refers to several examinations using radiopharmaceuticals that evaluate the function and anatomy of the kidneys. Renal scintigraphy is one of many imaging methods used to evaluate the kidneys.

The different types of renal scans are used to examine different functional aspects of the kidneys; however, all of these procedures involve the injection of a radiopharmaceutical or radiotracer that emits a tiny amount of radioactivity into the patient.

Four types of renal imaging help determine whether the kidneys are working normally or abnormally:

I. Renal cortical scintigraphy detects the amount of functioning renal cortical tissue through images taken with a gamma camera approximately two hours after radiopharmaceutical injection.

II. Renal perfusion and functional imaging examines blood flow to the kidneys and identifies potential narrowing of the renal arteries. Through a series of images taken over 20 to 30 minutes immediately after radiopharmaceutical injection, it also helps determine how well the kidneys are working.

III. Diuretic renal scintigraphy detects kidney blockages or obstruction of urine Flow-through images taken before and after the introduction of a diuretic to move urine through the kidneys.

IV. ACE-inhibitor renal scintigraphy helps determine if the cause of a patient's high blood pressure is coming from the kidneys, due to narrowing of the renal artery or arteries, by comparing kidney images before and after taking a b lood pressure medication called an "ACE-inhibitor."

These procedures can be valuable for identifying kidney failure and/or transplant-related complications, as well as discovering kidney-related injuries.

The preparation of the scan can vary widely based on the type of scan being conducted. The patient may be asked to drink extra fluid or possibly receive intravenous (IV) fluids. Also may be given a diuretic to increase urine production. specific instructions will be received based on the type of scan.

The equipment used to image the scan is called a scintillation camera, which Detects radioactive energy that is emitted from the patient's body and converts it into an image. The patient lies on the examination table which slides in between two parallel gamma camera heads that are positioned above the patient (RSNA, 2019).

A series of images are taken at regular intervals. Processing then involves drawing a region of interest (ROI) around both kidneys, and a computer program produces a g raph of radioactivity inside the kidney with time representing the quantity of tracer, from the number of counts measured inside in each image (Elgazzar,2019).More inf ormation can be gathered by calculating time- activity curves(Sandler,2003). That c urves show the transit of the tracer through the kidneys.

The kidney activity-time curve is a combination of three factors: uptake into the kidney, transit through the kidney and elimination from the kidney. Uptake depends on blood activity, which varies with Speed of injection, kidney Function, a function of the other kidney and Recirculation of tracer.

Renogram curve is a superimposition of the desired kidney activity and unwanted b ackground activity (Lawson, 2010).

Renogram normal results:

Both kidneys visualizing about the same size and intensities with smooth renal contour.

Peaking with parallel up-slope and within 3 seconds of aortic peak and

dropping off (excretion) at the same rate.

Time-to-peak concentration is 3 to 5 minutes, Clearance t1/2 is 12 to 15 minutes.

Furosemide t1/2 washout time from the injection is suggested at < 15 minutes; 15–20 minutes is indeterminate.

Curves are declining and continue to do so after administration of diuretic (Shackett, 2019).

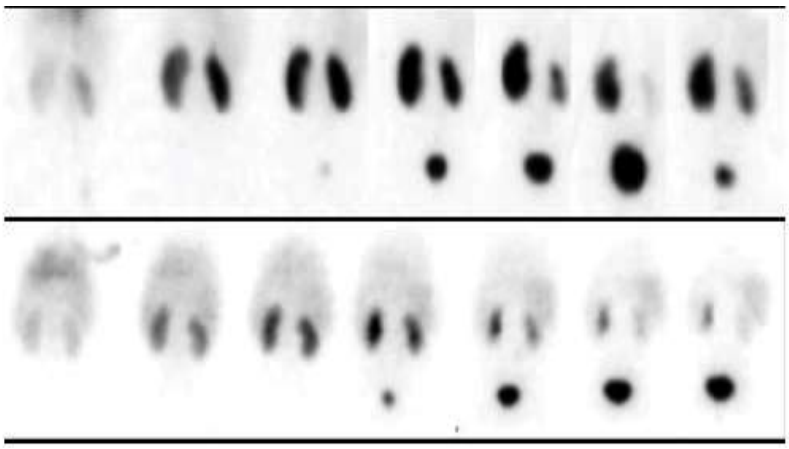

Figure 2.2: shows Normal DTPA renography.

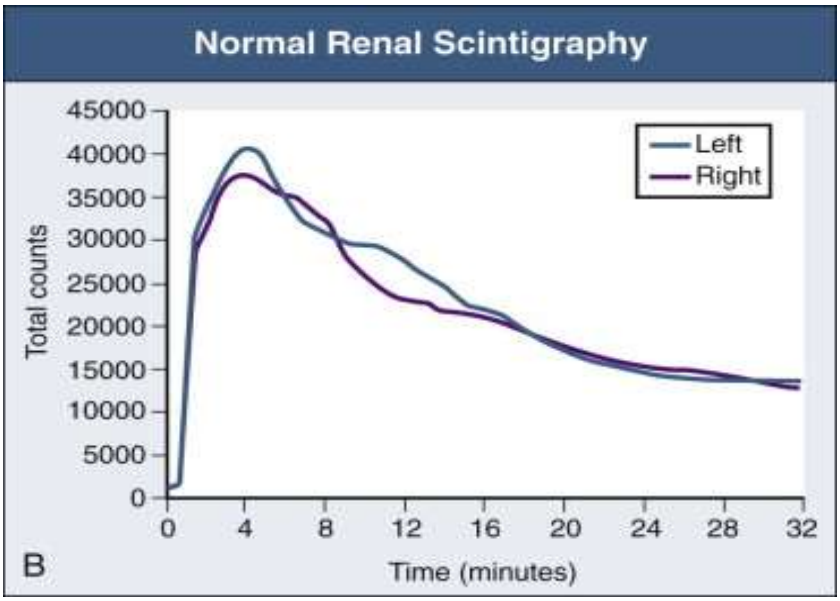

Figure 2.3: shows Normal Time curve activity.

Abnormal results can indicate:

Kidney disease, presence of cyst or tumors, blockage of a renal artery due to injury or trauma, a blockage that restrict the flow of urine from the kidney to the bladder, renovascular hypertension, problems with kidney transplant and kidney failure (Giorgi, 2012).

furosemide distinguishes between dilated systems from mechanical obstruction. Furosemide abnormal t1/2 washout time is 20 minutes or greater from the injection. With dilated non-obstructive studies (curves rising), after diuretic injection the system releases urine (curves decline). In mechanical obstruction, the c urves rise and continue to do so after diuretic is administered (Shackett, 2019).

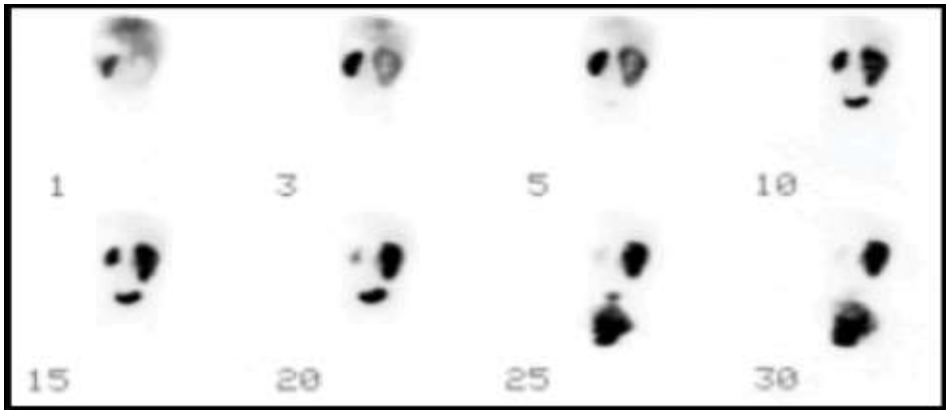

Figure 2.4: shows Obstructed Rt. kidney DTPA renography.

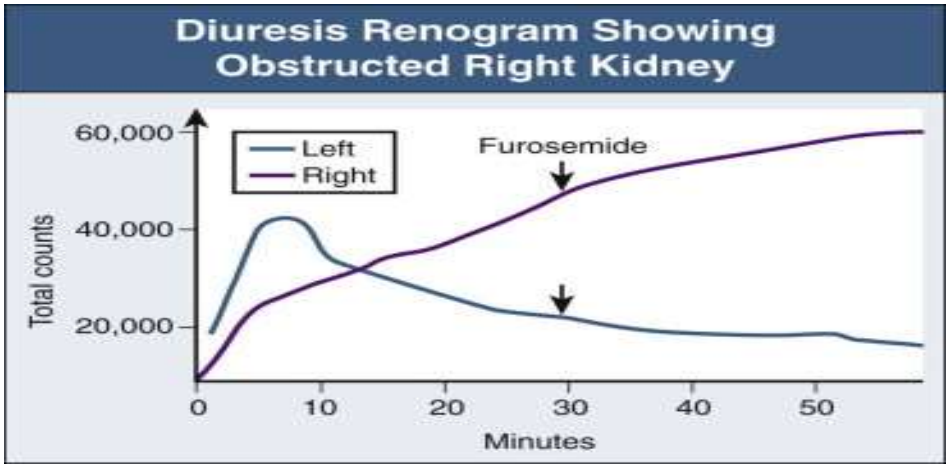

Figure 2.5: shows Obstructed Rt. Kidney time activity curve.

Nuclear renal scan has both benefits and risks which include:

Benefits: The information provided by nuclear renal imaging is unique and often unattainable using other imaging procedures. Renal imaging yields useful information needed to make a diagnosis or to determine the appropriate treatment.

Risks: Because only a small dose of radiotracer is used, nuclear medicine exams have relatively low radiation exposure. This is acceptable for diagnostic exams. Thus, the radiation risk is very low when compared with the potential benefits. Nuclear medicine diagnostic procedures have been used for more than five decades, and there are no known long-term adverse effects from such low-dose exposure. The doctor shall inform the patient of all significant risks prior to the scan. Allergic reactions to radiotracers are extremely rare and usually mild.

The limitation of nuclear renal images that it cannot reliably differentiate between c ysts and tumors and the procedures can be time-consuming and the resolution of str uctures of the body with nuclear medicine may not be as clear as with other imaging techniques, such as CT or MRI.

However, nuclear medicine scans are more sensitive than other techniques for a variety of indications, and the functional information gained from nuclear medicine exams are often unobtainable by any other imaging techniques (RSNA, 2019).

2.2. Literature review:

Abboud, Osman and Musa, 1989 studied the etiology of chronic renal failure in adult Sudanese patients. One hundred adult Sudanese patients who presented to Soba University Hospital (SUH) with established chronic renal failure (CRF) were studied to determine the etiology. Thirty-eight had chronic glomerulonephritis, twelve renal calculi, nine diabetic renal diseases, seven chronic pyelonephritis, five squeal of acute renal failure (ARF), four renal vascular disease, three polycystic diseases of the kidneys, and two obstructive uropathy. In 20 patients the etiology was not determined because of late presentation to hospital. These results were compared with those of the developed countries, which differ greatly from Sudan in climate, diet, race, culture and social habits.

Awadalla et al., 2018 discussed the hypertension in Sudanese individuals and associated risk factors: the critical intersection between salt and sugar intake
The aim of this study was to assess the prevalence of hypertension and impact of salt and sugar intake in Sudanese population.it was accomplished by Including 323 of participants in Khartoum state. The data collection was performed to gather demographic information, physical activity and dietary habits. In addition to measurement of blood pressure (BP), weight and height measurement for calculation of body mass index (BMI).Results showed that among the 323 respondents (males were 171), 29 (9%) are known hypertensive, 60 (18.6%) are diagnosed to be hypertensive. Therefore, the prevalence of hypertension is 27.6%. Hypertension was significantly associated with male sex, increasing age, obesity, and high salt and sugar intake.

Brown et al., 2003 investigated about early detection of kidney disease in community settings: the kidney early evaluation program (KEEP)

Early identification of persons at risk for kidney disease provides an opportunity to prevent or delay its progression and decrease morbidity and mortality. The implementation of a targeted screening program in communities with high-risk populations would detect previously unidentified persons with or at high risk for chronic kidney disease (CKD) with a prevalence that exceeds that predicted for CKD in the general population. Utilizing the screening method of Persons with hypertension or diabetes or a first-order relative with hypertension, diabetes, or kidney disease for kidney disease risk factors, by evaluating Blood pressure, blood glucose level, serum creatinine level, hemoglobin level, microalbuminuria, hematuria, pyuria, body mass index, and estimated glomerular filtration rate (EGFR). And results obtained from Six thousand seventy-one eligible persons Were screened from August 2000 through December 2001 that 27% met the screening definitions for diabetes; 64%, for hypertension; 29%, for microalbuminuri a; 8%, for anemia; 18%, for hematuria; 13%, for pyuria; 5%, for elevated serum cre atinine level; 16%, for reduced EGFR; and 44%, for obesity.

Among participants without a reported history of specified conditions, screening identified 82 participants (2%) with diabetes, 1,014 participants (35%) with hypertension, 277 participants (5%) with elevated serum creatinine levels, 839 participants (14%) with reduced EGFRs, and 1,712 participants (29%) with microalbuminuria. Targeted screening is effective in identifying persons with previously unidentified or poorly controlled kidney disease risk factors, as well as p ersons with a moderately decreased EGFR.

Brown and Whitworth, 1992 worked on studying the progression of renal failure-the role of hypertension.

High blood pressure plays a key role in the progression of renal failure. Hypertension is both cause and consequence of renal failure. There is strong evidence that hypertension accelerates the progression of experimental renal disease. Results revealed that blood pressure control is very effective in retarding renal disease progression and reduce the associated morbidity and mortality.

Goldberg and Krause emphasize the role of gender in chronic kidney disease

Chronic kidney disease (CKD) is a common disease worldwide and is associated with high rates of morbidity and mortality. This study discusses several aspects of the relationship between gender and CKD. While the prevalence of CKD tends to be higher in women, the disease is more severe in men, who also have a higher prevalence of end-stage renal disease. Most of the evidence in the current literature suggests a higher progression rate and mortality risk of CKD in men compared with women, except in post-menopausal women and diabetic patients. However, the decrease in glomerular filtration rate and the increase in the level of albuminuria are more prominent mortality risk factors among women.

Lambers Heerspink et al., 2011 discussed Monitoring kidney function and Albuminuria in Patients with Diabetes

It is beyond doubt that patients with diabetes are at high risk of developing renal and cardiovascular disease. Both outcomes have significant clinical implications

and are associated with high additional costs. Several traditional (blood pressure, HbA1c, cholesterol) and novel cardiovascular biomarkers (C-reactive protein, pro-brain natriuretic peptide) are at hand to identify those individuals who will develop end-stage renal or cardiovascular disease, as early as p ossible. The traditional biomarkers have been successfully applied in clinical practice and have proven their clinical usefulness. Renal biomarkers, in particular, a lbuminuria and estimated glomerular filtration rate (eGFR), have been added to the bio- marker armamentarium. Both are indeed associated with renal and cardiovascular disease in individuals with diabetes and may be used to identify individuals at risk of long-term complications. Although identifying individuals at ri sk is important, even more important is the question whether we can lower this risk by changing renal biomarkers through pharmacological (or other) intervention.

Osman, H. M., 2015 analyzed a comparative study on the occurrence of renal failure among Sudanese people .This study was aimed to compare the occurrence of renal failure among Sudanese people. Eighty patients with renal failure (RF) registered at hospitals in Khartoum State agreed to participate in this study between April - May / 2015. Data was collected from each patient using a specific q uestionnaire designed for this purpose. Results revealed that the high percentage of RF was among men (62.5%) compared to 37.5% among females. Moreover, 40% of these patients were found to smoke cigarettes. Regarding family history, 35% of t hose having high percentage of RF had a family history while 65% without family history. Also of these patients 65% were reported suffering from chronic diseases before RF onset and 35% did not show any sign of disease before it. The chronic diseases included hypertension (58%), diabetes mellitus (30.7%) and

heart disease (3.7 %%). In the meantime, 5% of those reported with renal failure was observed to be susceptible to other diseases.

Pecoits-Filho et al.,2016 worked on Interactions between kidney disease and diabetes: dangerous liaisons

Type 2 diabetes mellitus (DM) globally affects 18–20 % of adults over the age of 65years.Diabetic kidney disease (DKD) is one of the most frequent and dangerous complications of DM2. The kidneys play an important role in glycemic control, particularly due to renal contribution to gluconeogenesis and tubular reabsorption of glucose. The study detail the relationship between diabetes and kidney disease, addressing the care in the diagnosis, the difficulties in achieving glycemic control and possible treatments that can be applied according to the different degrees of impairment, based on a report of discussions from an interdisciplinary group of experts in the areas of endocrinology, diabetology and nephrology.

The results showed that glucose homeostasis is extremely altered in patients with DKD, who are exposed to a high risk of both hyperglycemia and hypoglycemia. Both high and low glycemic levels are associated with increased morbidity and shortened survival in this group of patients. And appropriate glycaemic monitoring and control tailored for diabetic patients is required to avoid hypo-glycaemia and other glycaemic disarrays in patients with DM2 and kidney disease. Understanding the renal physiology and pathophysiology of DKD has become essential to all specialties treating diabetic patients. Disseminating this knowledge and detailing the evidence will be important to initiate breakthrough research and to encourage proper treatment of this group of patients.

Sofia, K. Manickavasakam and Walter. 2016 worked on the Prevalence and risk factors of kidney stone.

Kidney stone affect 10-12% of the population in industrialized countries. The etiology of this disorder is multi factorial and is strongly related to dietary lifestyle habits or practices. Increased rates of hypertension, diabetes and obesity contribute to an increase in stone formation. The Aim of this study is to assess the prevalence of kidney stone among patients and also to find out the risk factors influencing the development of kidney stones especially Family history, inadequate fluid intake, Stress, over weight and Obesity, Dietary habits and lifestyle modifications, association with other diseases (diabetes, hypertension).The study was conducted among 666 kidney stone patients. Results revealed a high prevalence of kidney stone is due to low fluid intake 72.07%, dehydration 67.56%, and dietary habits of mixed diet 91.59%, high intake of coffee and tea 57.50%, sodium 64.26%, sugar 49.84%. Life style modifications of smoking 36.03%, alcohol consumption 41.59%, lack of physical activity 42.79%, obesity 54.80% also revealed a high prevalence of this disease.

Wasen et al, .2004 worked on renal impairment associated with diabetes in the elderly. This Study performed to characterize renal impairment associated with diabetes in older adults by evaluating serum markers of glomerular filtration rate an d microalbuminuria tests. Population consisted of 187 diabetic and 1,073 nondiabetic subjects (age range 64–100 years) participating in a cross-sectional, Population-based survey in southwestern Finland. Renal function was estimated by serum cystatin C (Cys C), serum creatinine (Cr), and the urinary albumin-to-

creatinine ratio and determinants of elevated levels were assessed by multivariate an alysis. Results showed that Diabetes, compared to hypertension, was a more powerful determinant of elevated Cys C and Cr levels in the very old (age ≥80 years), whereas the impact of hypertension was more pronounced in the younger group (age <80 years). Serum markers of glomerular filtration rate and microalbuminuria identify renal impairment in different segments of the diabetic population, indicating that serum markers as well as microalbuminuria tests should be used in screening for nephropathy in diabetic older people.

CHAPTER THREE

MATERIALS and METHODS

CHAPTER THREE

MATERIALS and METHODS

3.1. Materials:

3.1.1: Dose calibrator:

The ionization chamber was constructed to measure the number of ions within the medium. It's usually consisting of gas-filled enclosure between two conducting electrodes when gas is ionized by radioactive emission. The ions & disassociated electrons move to the electrode with opposite polarity creating an ionization current that can be measured.

The ionization chamber is used to determine the exact activity of radioactive dose administered to the patient (Iaea.org, 2014).

Figure: 3.1: Dose calibrator.

3.1.2: Gamma camera:

Gamma camera consists of NAI crystal optically coupled to an array of photomultiplier tubes (head) & gantry is responsible for acquisition & storage of acquired images.

gamma photon comes from radiopharmaceuticals injected to the patient, when it reaches the crystal it scintillate, this gamma photon is then converted to light photon then the photomultiplier tubes (PMT's) convert it to electric signal `& amplify it. The computer reconstructs& display two-dimensional image on the monitor (Institute of Physics, 2019).

Figure 3.2: Dual-head gamma camera.

3.1.3: Renal scan:

Radionuclide: 99mTc t1/2: 6 hours (Energies: 140 keV, Type: IT, γ, and generator)

Radiopharmaceutical: 99mTc-DTPA (diethylenetriaminepentaaceticacid).

Localization: Compartmental, blood flow.

Quality Control: 99mTc DTPA: chromatography >90%, use within 1 hour.

Adult Dose Range:

99mTc: 3–20 mCi (111–740 MBq) generally10 mCi (370 MBq) for most studies.

Method of Administration: Bolus intravenous injection.

If the study includes a diuretic use butterfly or IV catheter (furosemide 20–40 mg).

Equipment:

Camera: Large field of view.

Collimator: 99mTc: low energy, all-purpose, or low energy, high resolution.

Computer Set-up:

Dynamic: 20–60 sec/frame for 1800 seconds.

Patient preparation:

Instruct the patient to hydrate well and void just before the test.

Post study voiding is recommended to lessen bladder exposure.

PROCEDURE:

Place the patient in a supine position, camera under the table.

Position camera by point source over xiphoid, umbilicus, pubic symphysis, and sides in field of view.

Insert intravenous butterfly with 3-way stopcock, inject normal saline flush and inject a bolus of a radiotracer, wait until they see activity blush in the abdomen (the "umbrella" effect caused by the heart-liver-spleen and descending aorta) then start the camera.

Inject furosemide after 15 to 20 minutes the start of the scan.

Acquire serial (dynamic) 1-minute images for 30 minutes.

Processing:

Generate time/activity curve graphs.

Generate percent uptake of each kidney.

Select frame of dynamic study that appears to have the most counts .draw ROI to give the counts within the area.

add two counts together for total, divide each by total to give percent uptake for each kidney, combined percent's should equal 100.(Shackett, 2019).

3.2. Methods:

3.2.1. Study design:

This study is retrospective descriptive case-control study.

3.2.2. Area of study:

AlNeeleen Medical Diagnostic Center/Nuclear Medicine Department.

Royal Care International Hospital/Nuclear Medicine Department.

3.2.3. Duration of the study:

This study conducted from OCT2019-FEB2020.

3.2.4. The Population of the study:

3.2.4.1. Inclusion criteria:

The population of this study was a data set of adult renal patients with diabetes and hypertension of both genders.

3.2.4.2. Exclusion criteria:

Individuals with renal impairment issues and free from hypertension and diabetes mellitus.

3.2.5. Sample size:

Applied on 100 patients undergoing renal scintigraphy.

3.2.6. Ethical consideration:

Permission letter from the nuclear medicine department for the collection of data

Patient's permission was taken before conducting the study.

3.2.7. Data analysis and presentation:

The data was collected using a data collection sheet which was prepared specially for this task.

Data were analyzed by using Microsoft excel and statistical package for the social sciences SPSS software.

CHAPTER FOUR

RESULTS

CHAPTER FOUR

RESULTS

Class	Frequency	Percent
Male	59	59%
Female	41	41%
Total	100	100%

Table 4.1: shows distribution of sample according to gender.

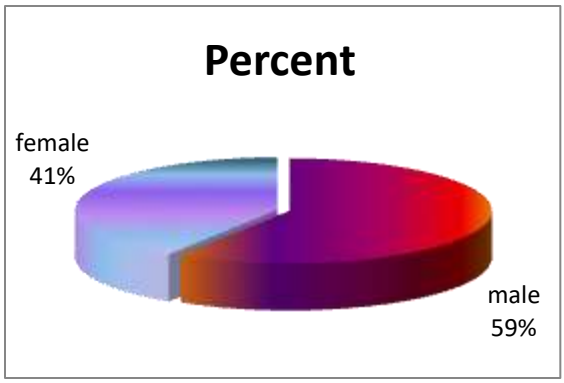

Figure 4.1: shows distribution of sample according to gender.

Class	Frequency	Percent
15-25	16	16%
31-45	25	25%
46-60	22	22%
61-75	27	27%
above 75	10	10%
Total	100	100%

Table 4.2: shows distribution of sample according to age.

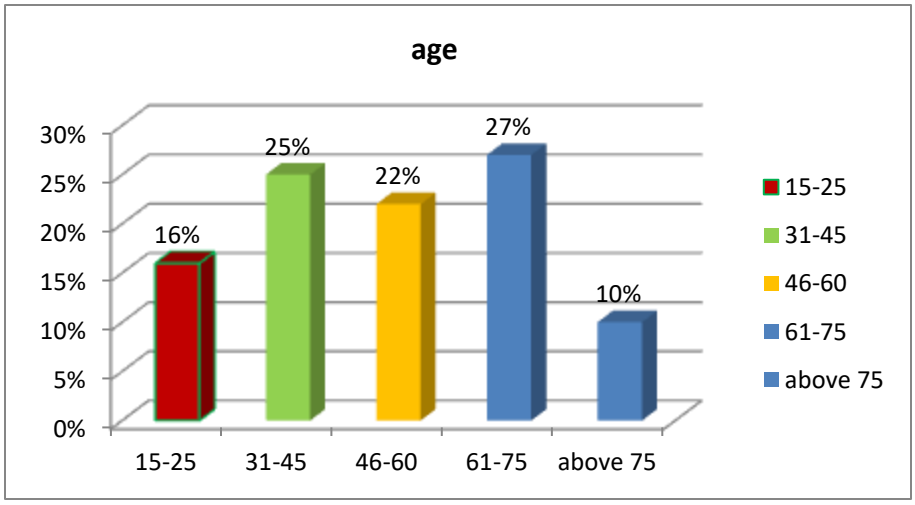

Figure 4.2: shows distribution of sample according to age.

Class	Frequency	Percent
less than 18.5	7	7%
Normal	46	46%
over weight	25	25%
Obese	22	22%

Table 4.3: shows distribution of sample according to BMI.

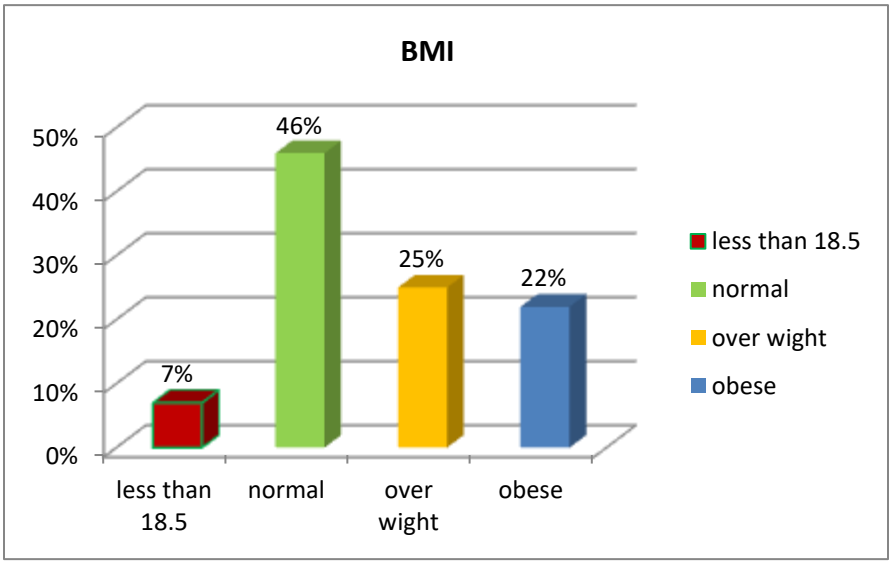

Figure 4.3: shows distribution of sample according to BMI.

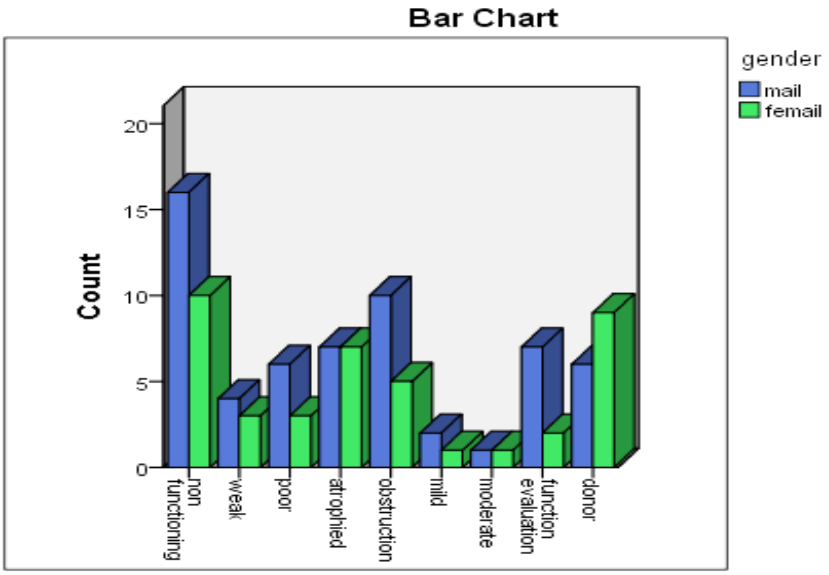

Figure 4.4: shows relation between gender and renal diagnosis.

diagnosis * gender Cross tabulation				
		Gender		Total
		Male	female	
Diagnosis	non functioning	16	10	26
	Weak	4	3	7
	Poor	6	3	9
	atrophied	7	7	14
	obstruction	10	5	15
	Mild	2	1	3
	moderate	1	1	2
	function evaluation	7	2	9
	Donor	6	9	15
Total		59	41	100

Table 4.4: shows relation between gender and renal diagnosis.

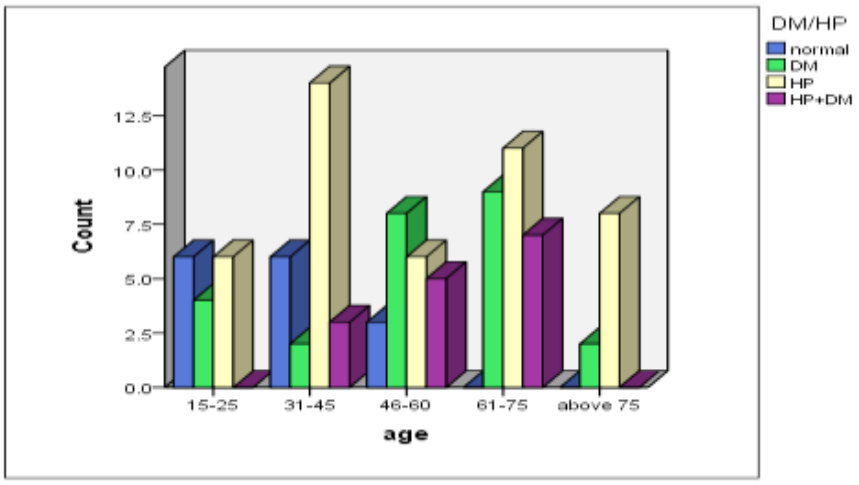

Figure 4.5: shows relation between age and presence of HP/DM.

Cross tabulation age * HP/DM					
	DM/HP				
age	normal	DM	HP	DM+HP	Total
15-25	6	4	6	0	16
31-45	6	2	14	3	25
46-60	3	8	6	5	22
61-75	0	9	11	7	27
above 75	0	2	8	0	10
Total	15	25	45	15	100

Table 4.5: shows relation between age and presence of HP/DM.

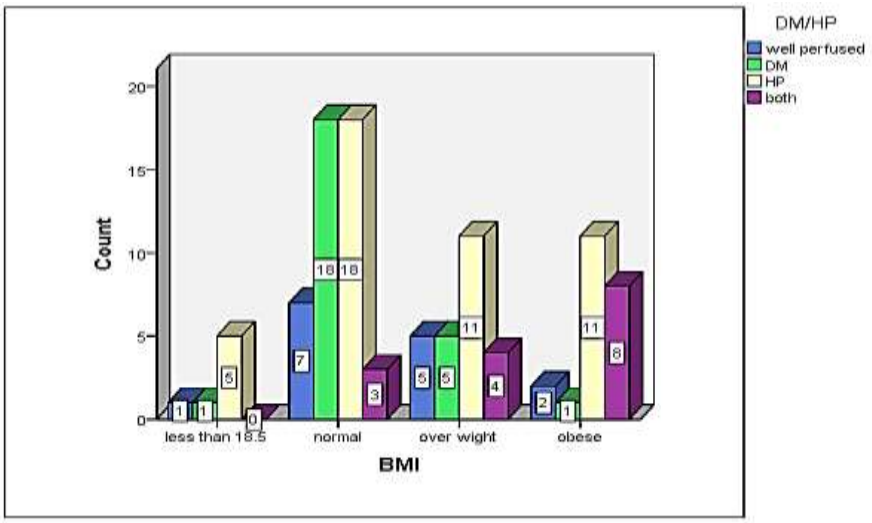

Figure 4.6: shows relation between BMI and presence of HP/DM.

Cross tabulation between BMI and HP/DM					
BMI	DM/HP				Total
	Normal	DM	HP	DM+HP	
less than 18.5	1	1	5	0	7
Normal	7	18	18	3	46
over weight	5	5	11	4	25
Obese	2	1	11	8	22
Total	15	25	45	15	100

Table 4.6: shows relation between BMI and presence of HP/DM.

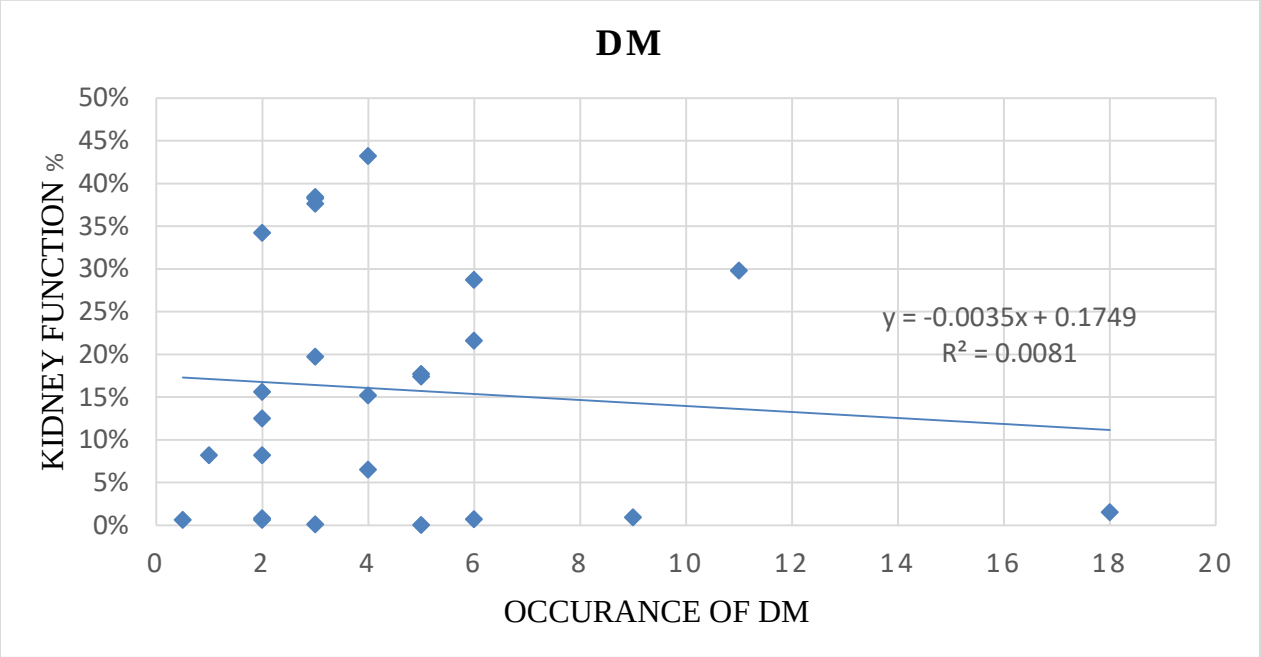

Figure 4.7: scatter plot shows correlation between the occurrence of diabetes mellitus and kidney functions.

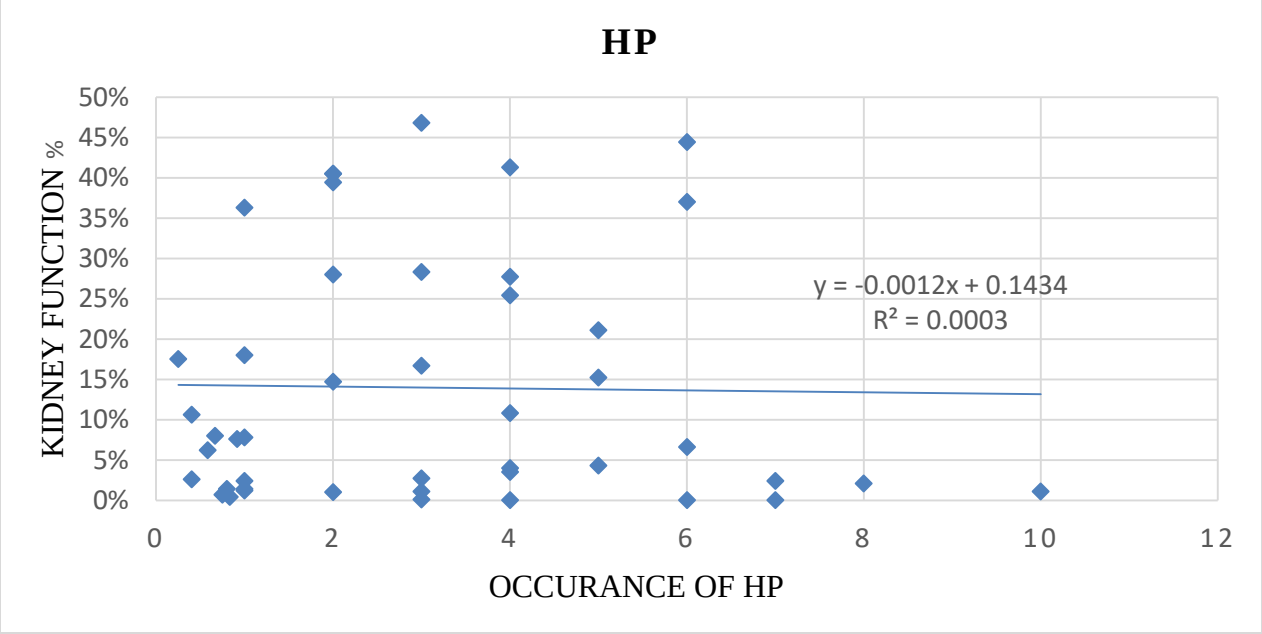

Figure 4.8: scatter plot shows correlation between the occurrence of hypertension and kidney functions.

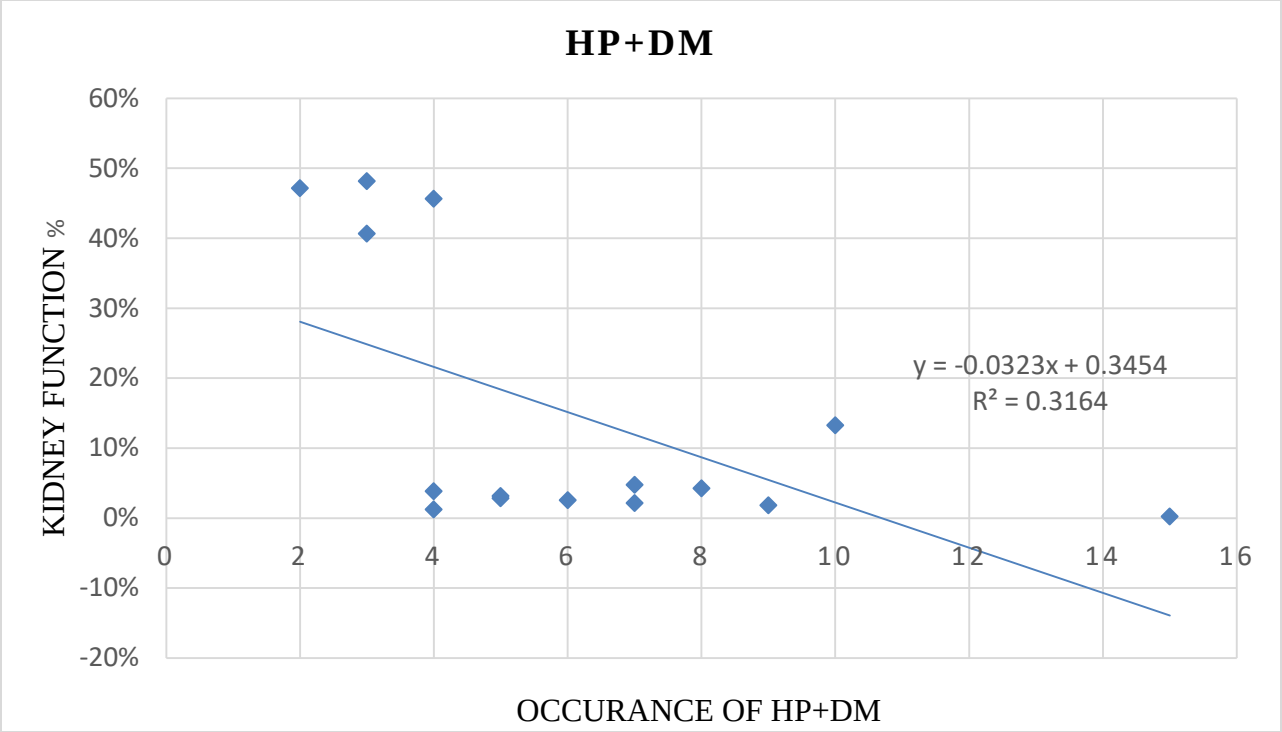

Figure 4.9: scatter plot shows correlation between the occurrence of diabetes mellitus + hypertension (combined) and kidney functions.

CHAPTER FIVE

DISSCUSION, CONCLUSION, and RECOMMENDATIONS

CHAPTER FIVE

DISSCUSION, CONCLUSION, and RECOMMENDATIONS

5.1. Discussion:

The data of this study collected from 100 patients. These 100 patients underwent renal DTPA scan 45 of them were hypertensive, 25 were diabetic, 15 were both hypertensive and diabetic combined and 15 of them were normal.

Population of this study distributed according to gender: 59% of research sample is male and 41% is female. The number of males exceeds the number of females by a ratio of 1.4, which presented in figure 4.1. While the distribution of sample according to Age indicate that most population of research sample is (61 - 75) year age group with Percentage 27%, then (31-45)years age group with Percentage 25%, (46-60) years age group with Percentage 22%, (15-25) years age group with Percentage 16% and (above 75 years) age group with percentage 10% described in Figure 4.2. The distribution of sample according to BMI indicates that 46% of research sample are normal, 25% over Weight, 22% obese, and 7% is less than 18.5 as showed in Figure 4.3.

The study parameters such as gender, age and BMI encountering with the presence of hypertension and diabetes provide that prevalence of hypertension and diabetes is higher in males than females while the prognosis of the renal disease is found to be higher and more severe in males than females as showed in figure 4.4. The prevalence of hypertension and is pronounced in younger age (31-45) years group of population, while diabetes and the combined hypertension and diabetes found in elder (61 - 75) years age group as described in figure 4.5. With regard to prevalence

of hypertension and diabetes is the highest in normal group of body mass index, while prevalence of the combined group of hypertension and diabetes is higher in obese group of BMI as shown in figure 4.6.

The scatter plots described the correlation between the occurrence of HP/DM and kidney function, which explained to what extent the change in kidney function affected by the change in the time of occurrence of HP/DM. The scatter plot represented the correlation between the occurrence of DM with kidney function, and the occurrence of HP with kidney function stated that there is no correlation found, which mean that the occurrence of diabetes or hypertension (HP/DM) had no influence on the kidney function as showed in figures 4.7, 4.8 respectively. While the correlation of the occurrence of hypertension and diabetes combined (HP+DM) with kidney function showed a weak relation between them, which means that the incidence of HP+DM combined for long periods of time cause more kidney function deterioration as described in figure 4.9.

Results showed there is no correlation between the kidney function and the time of occurrence of hypertension or diabetes (HP/DM). Which indicate that there is no influence of the occurrence of hypertension or diabetes (HP/DM) on kidney function. While there is a weak correlation between the occurrence of hypertension and diabetes (HP+DM) combined and kidneys function, meaning that the occurrence of hypertension and diabetes together for a long period of time leads to kidney function deterioration. Which in turn affect the overall outcome of the renal system.

5.2. Conclusion:

The main objective of this study was to reveal to what extent the incidence of diabetes and hypertension affect renal function.

Results showed that the occurrence of hypertension or diabetes (HP/DM) individually had no influence on the kidney function. While the occurrence of hypertension and diabetes together for a long period of time leads to kidney function deterioration. Which in turn affect the overall outcome of the renal system.

5.3. Recommendation:

Establishing a central network system that connects health care institutions to keep completed and updated patients' records which can be useful when needed.

Improve quality of the image obtained by concentrating on dose/body mass index relation and consider elongating the scan time according to kidney condition.

Increase awareness about the importance of regular checkups and a healthy lifestyle to help to control the levels of hypertension or diabetes mellitus which in turn can prevent harming the renal system and preserve the renal function from deterioration.

Further studies shall be obtained on studying the relation between renal function and presence of diabetes / hypertension with the dose administered and glomerular filtration rates measured in considerably bigger population groups (large sample size) in order to reach more efficient results.

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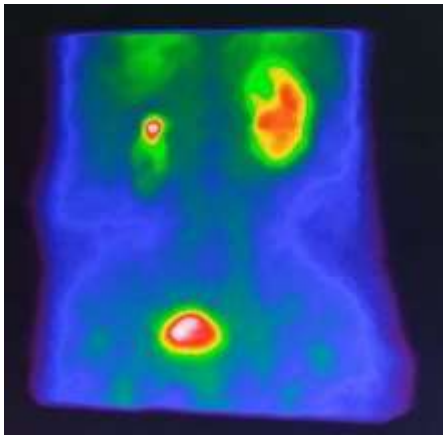
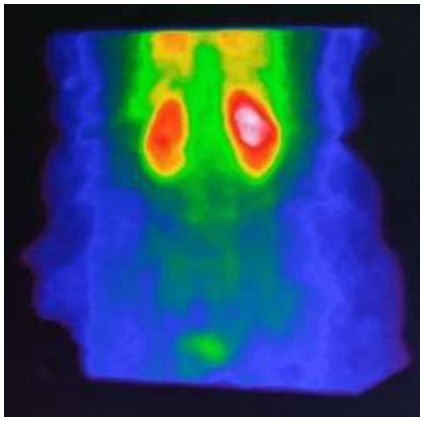
Appendices

Appendix no.1:



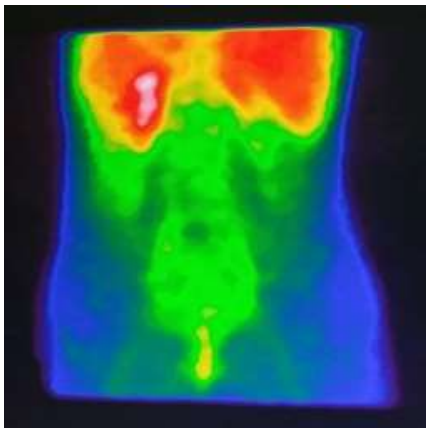
NO.	Age	gender	weight	Height	BMI	Dose	Diagnosis	Rt. kid %	Lt. kid %	overall outcome	occurrence of HP/DM	DM /HP
1	86	M	64	161	24.7	5	evaluation of kidney function for nephrectomy	95.6 %	4.%	Lt. kidney poorly perfused	6 years ago	HP

Appendix no.2:



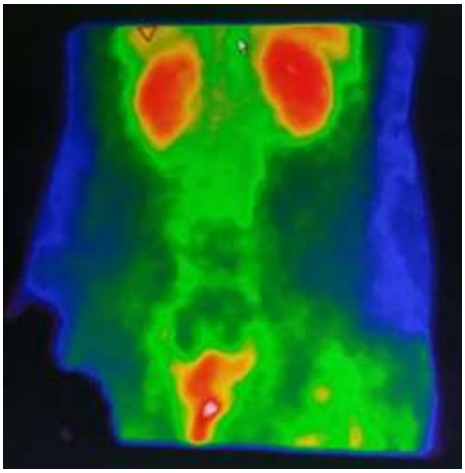
No.	Age	Gender	weight	height	BMI	dose	Diagnosis	Rt.kid%	Lt.kid%	Overall outcome	Occurrence of HP/DM	HP/DM
2	50	F	73	159	28.9	5	Function evaluation	56.8%	43.2%	Moderate perfusion	4 years ago	DM

Appendix no.3:



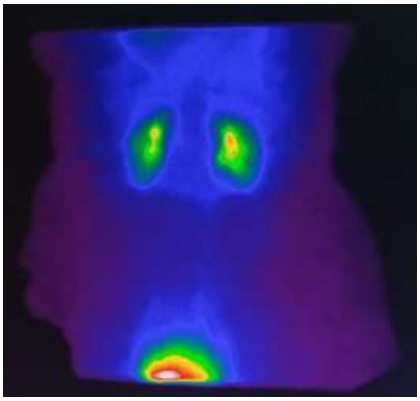
No.	Age	Gender	Weight	height	BMI	Dose	Diagnosis	Rt. kid %	Lt. kid %	Overall outcome	Occurrence of HP/ DM	HP/DM
3	32	M	47	162	17.9	5	Rt.non functioning kidney	37 %	63%	high background activity w Rt.kidney not perfused	6 years ago	HP

Appendix no.4:



No.	age	gender	weight	height	BMI	Dose	Diagnosis	Rt.kid%	Lt.kid%	Overall outcome	Occurrence of HP/DM	HP/DM
4	31	F	74	170	25.6	5	chronic kidney disease	58.1%	41.9%	high background activity w kidneys not perfused	9 years ago	BP+DM

Appendix no.5:



No.	age	gender	Weight	height	BMI	Dose	Diagnosis	Rt.kid %	Lt.kid %	Overall outcome	OCCURRENCE OF HP/DM	HP/DM
5	18	F	42	156	17.3	5	DONOR	51.4%	48.6%	Well perfused	----------	------

Data sheet collection

Patient No:

Age:

Gender: male: ☐ female: ☐

Weight: Height:

Body mass index:

Dose:

Chronic diseases:

Hypertension: ☐ Diabetes: ☐

Both: ☐ None: ☐

Time of occurrence of HP/DM:

Renal diagnosis:

Rt. kidney %:

Lt. kidney %:

Overall outcome: