Sudan University of Science & Technology
College of Graduate Studies

Characterization of the Spleen in Long Standing Hemodialysis Patients Using Ultrasound

مظهر الطوحال عند المرضى المداومين على الاستصفاء الدموى
بواسطة الموجات فوق الصوتية

A thesis Submitted For Partial Fulfillment For The Requirement of MSc degree in Medical Diagnostic Ultrasound

By:
Elbadri Hussein Hamid Elmanzoul
MBBS ALFashir University

Supervisor
Dr: Mona Ahmed Mohammed

March 2015

(ٱقۡرَأۡ بِٱسۡمِ رَبِّكَ ٱلَّذِى خَلَقَ (*) خَلَقَ ٱلۡإِنسَـٰنَ مِنۡ عَلَقٍ (*)ٱقۡرَأۡ

وَرَبُّكَ ٱلۡأَكۡرَمُ (*) ٱلَّذِى عَلَّمَ بِٱلۡقَلَمِ (*) عَلَّمَ ٱلۡإِنسَـٰنَ مَا لَمۡ يَعۡلَمۡ (*))

الايات (1 —5) سورة العلق

Abstract

This study had been done in the renal dialysis center in sennar teaching hospital in ultrasound department in the period from august 2014 to march 2015. The main goal of this is study is to evaluate the spleen of long standing hemodialysis patients by using ultrasound apparatus, with a probe of 3.5 MHz frequency. The study data is 50 cases under regular hemodialysis for 5 years or more, collected using data sheet collection include patient personal data plus ultrasound finding using computer program for analysis. The study showed that there was an increasing in spleen volume comparing with normal range , and also there was an increasing in length and thickness comparing with normal range but the width in not significantly change due to hemodialysis, because mostly due to the presence of the stomach and diaphragm from above and the left kidney from below . The measurement of the spleen (length, thickness and volume) all were increasing when age increasing. Also it showed that there was decreasing in echogenecity when there was increasing in all measurements' of spleen; also the texture change from homogenecity to heterogenecity when there was increasing in all measurements of spleen. This research showed that ultrasound is a very good tool for studding a short and long term hemodialysis patient and their follow up, and determined a suitable time for intervention and management.

الخلاصة

تم اجراء هذه الدراسة بمركز الكلى للاستصفاء الدموى بمستشفى سنار التعليمى بقسم الموجات فوق الصوتية فى الفترة من اغسطس 2014 وحتى مارس 2015 . وكان الهدف الاساسى من هذه الدراسه هو تقييم مظهر الطوحال عندالمرضى المداوميين على الاستصفاء الدموى باستخدام جهاز سونار به مسبار تردده الموجى 3.5 ميقاهيرتز .

تمت الدراسه على50 حاله من المرضى المداوميين علي الاستصفاء الدموى لفترة 5سنوات او اكثر باستخدام استبيان يحوى البيانات الشخصية بالاضافه الى نتائج فحص الموجات فوق الصوتية .

كانت نتائج الدراسة أن حجم الطوحال عند المرضى المداومين على الاستصفاء الدموى يزيد عن المعدل الطبيعى لحجم الطوحال وان الطول و السمك يزيدان عن المعدل الطبيعى لطول وسمك الطوحال الطبيعى بينما متوسط عرض الطوحال عندهم يزيد بزيادة لا تذكر نسبه لوجود المعدة والحجاب الحاجزمن الاعلى والكليه اليسرى من الاسفل .وان قياسات الطوحال (الطول ، العرض ، السمك والحجم) عند المرضى المداومين على الاستصفاء الدموى تزيد بزيادة العمر . كما اظهرت الدراسة أن صدى جميع قياسات الطوحال (الطول ، العرض ، السمك والحجم) ينخفض عندما تزيد هذه القياسات .

كما بينت الدراسه ايضا ان مستوى الصدى(homogenecity) يتغير من منتظم (homogenous)الى غير منتظم (heterogeneous)عند زيادة كل قياسات الطوحال .

أظهرت *الدراسة ان للموجات* فوق الصوتية قدرة فائقة على دراسة هذه الحالات ولها القدرة على المساعدة في اتخاذ القرارات والتدابير المناسبة بشأنها .

Dedication

To my family the source of love , patient and care of my life. To my wife who has taught me what life is . To those who have been the source of light and encouragement. To all those who are fetching for more knowledge and really interested on this field I dedicate this simple work.

AKNOWLEDGEMENT

My sincere thanks to Dr Mona who helped me to arrange my thoughts, words and data together. Her eyes for accuracy and details has been outstanding in the production of this thesis, as I believed that she tried honestly to transfer her experience to all her students . Other people who need special acknowledgement are my family who have always stood with me in difficult time and proved to be helpful and supportive in all types of creative work in my life. My thanks also to everyone who helped me in this work.

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List of Abbreviations

MHz	Megahertz
NO	Number
DRA	Dialysis Related Amyloidosis
US	Ultrasound
TAS	Trans Abdominal Scan
CKD	Chronic Kidney Disease
MRI	Magnetic Resonance Image
CT	Computed Tomography
ESRD	End Stage Renal Disease

RBC	Red Blood Cell
AKI	Acute Kidney Injury
ARF	Acute Renal Failure
EPO	Erythropoietin
SPSS	Statistical Package for Social Sciences
SD or StD	Stander Deviation

Chapter One
Introduction

Chronic kidney disease is a progressive loss in renal function over a period of months or years. The symptoms of worsening kidney function are non-specific, and might include feeling generally unwelland experiencing a reduced appétit. Chronic kidney disease is identified by blood test for creatinine. Higher levels of creatinine indicate a lower glomerular filtration rate and as a result a decreased capability of the kidney to excrete waste products (Levey et al., 2003) .

There is no specific treatment unequivocally shown to slow the worsening of chronic kidney disease. If there is an underlying cause to CKD, such as vasculities, this may be treated directly to slow the damage. In more advanced stages, treatments may be required for anemia and bone disease. Severe CKD requires renal replacement therapy, which may involve a form of dialysis, but ideally constitutes kidney. There are many complications of hemodialysis like anemia which affect the spleen, neuropathy, blood coagulopathy and amyloidosis. In stage 5 CKD, renal replacement therapy is usually required, in the form of either dialysis or transplant (Levin et al., 2008) . While renal replacement therapies can maintain patients indefinitely and prolong life, the quality of life is severely affected (de Francisco and Pinera, 2006).

Medical sonography (ultrasonography) is an ultrasound-based diagnostic medical imaging technique used to visualize muscles, tendons, and many internal organs, to capture their size, structure and any pathological lesions with real time tomographic images. Ultrasound has been used by radiologists and sonographers to image the human body for at least 50 years and has become a widely used diagnostic tool. The technology is relatively inexpensive and portable,

especially when compared with other techniques, such as magnetic resonance imaging (MRI) and computed tomography (CT). Ultrasound is also used to visualize fetuses during routine and emergency prenatal care. Such diagnostic applications used during pregnancy are referred to as obstetric sonography. As currently applied in the medical field, properly performed ultrasound posses no known risks to the patient. Sonography does not use ionizing radiation , and the power levels used for imaging are too low to cause adverse heating or pressure effects in tissue {citation needed} . Although the long term effects due to ultrasound exposure at diagnostic intensity are still unknown, currently most doctors feel that the benefits to patients outweigh the risks (Aldrich, 2007) .

Ultrasound is very good diagnostic tool in evaluation of normal and abnormal tissue structure especially in spleen, liver and other organs.

1.1Statement of the Problem:-

The hemodialysis now a day is becoming light guide in the darkness of end stage renal disease (ESRD) to whom cannot undergo renal transplantation. This study tries to touch The effect of long term hemodailysis on hemodailysis patient and economic because larged of those patients suffering from it .

1.2Objectives of the study:-

The general objective of this study was to evaluate the spleen in patients underlying hemodialysis for 5years or more using ultrasound imaging.

1.2.1 Specific Objectives:

- To measure the size of spleen.
- To determine the echogenicity and hemogenicity of the spleen of these patients.
- To detect infarctions or micro calcifications.
- To evaluate other associated abnormalities.

1.3 Significance of the study:

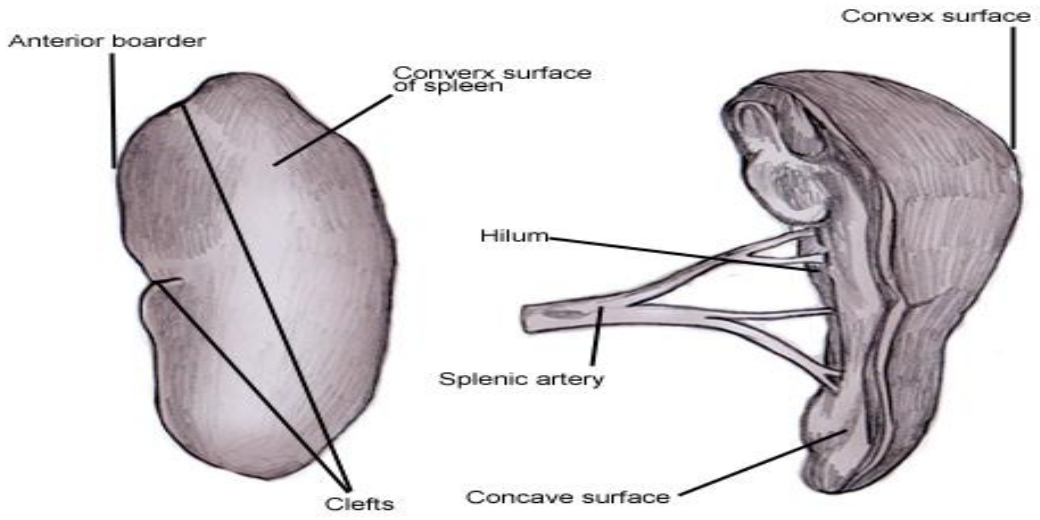
Significance of study came from the effect of chronic renal failure and hemodialysis and their complications on patient life and the cost of treat them on the patient and economic.

Chapter two
literature review and Background Studies

2.1 Anatomy of the spleen:

2.1.1 Introduction:-

The spleen, the largest of the lymphoid organs lies under the diaphragm on the left side of the abdomen, and although not apart of the alimentary tract, it drains to the portal venous system. It lies between the ninth and eleventh ribs. The spleen developed in the dorsal mesogastrium and projects into the greater sac surrounded by the peritoneum of theorigenal left leaf of the dorsal mesogasterium. It lies at the left margin of the lesser sac below the diaphragm, and it is diaphragmatic surface is mounded in to reciprocal convexity figure No 2-1(Chummy s Sinnatomby 1999).

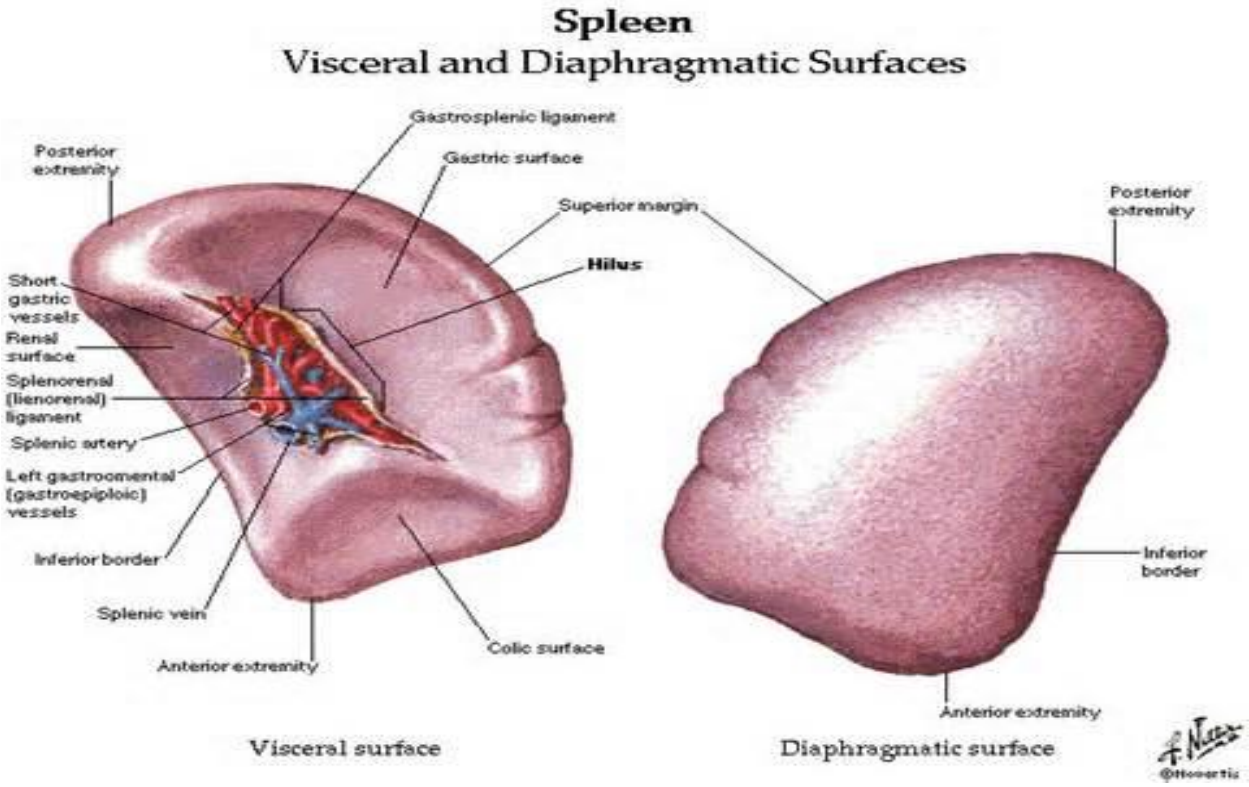


(A) (B)

Figure No (2-1):- Showing (A) lateral surface and (B) hilum of spleen

(http://emedicine.medscape.com)

It is hilum lies in the angle between the stomach and the left kidney. It is long axis lies along the line of the tenth rib. A small colic area lies in contact with the splenic flexure and the phrenicocolic ligament. It is anterior border is notched, a relic of the fusion of the several "slenules" from which the organ arises in the embryo (Chummy s Sinnatomby 1999).



(A) (B)

Figure No (2-2) Showing Visceral surface (A) and Diaphragmatic surface (B)

It is visceral peritoneum or a serous coat , invests all surface " gastric , diaphragmatic , colic and renal ". The leaves of the greater omentum pass from the hilum forwards to the greater curvature of the stomach "gastrosplenic ligament , and backwards to the front of the left kidney lienorenal ligament". The hilum of the spleen makes contact with the tail of the pancreas . In enlargement of the spleen, it is long axis extends down and forwards along the tenth rib in the direction of umbilicus , and it is anterior border approaches the costal margin to the left of the greater curvature of the stomach . A palpable spleen is identified by the notch in it is anterior border (Richard L et al 2005).

2.1.2 Spleen location:-

The spleen lies against the diaphragm there for in the left upper quadrent , or left hypochondrium of the abdomen. Spleen surrounded by visceral peritoneum except in the area of the hilum on the medial surface of the spleen . The spleen contact with the adrenal gland , upper pole of the left kidney , the tail of the pancreas from anterior and Lower part of the left lung ,left pleura and nine,ten and eleven ribs of the left side from posterior (Snell. Richard S 2004) .

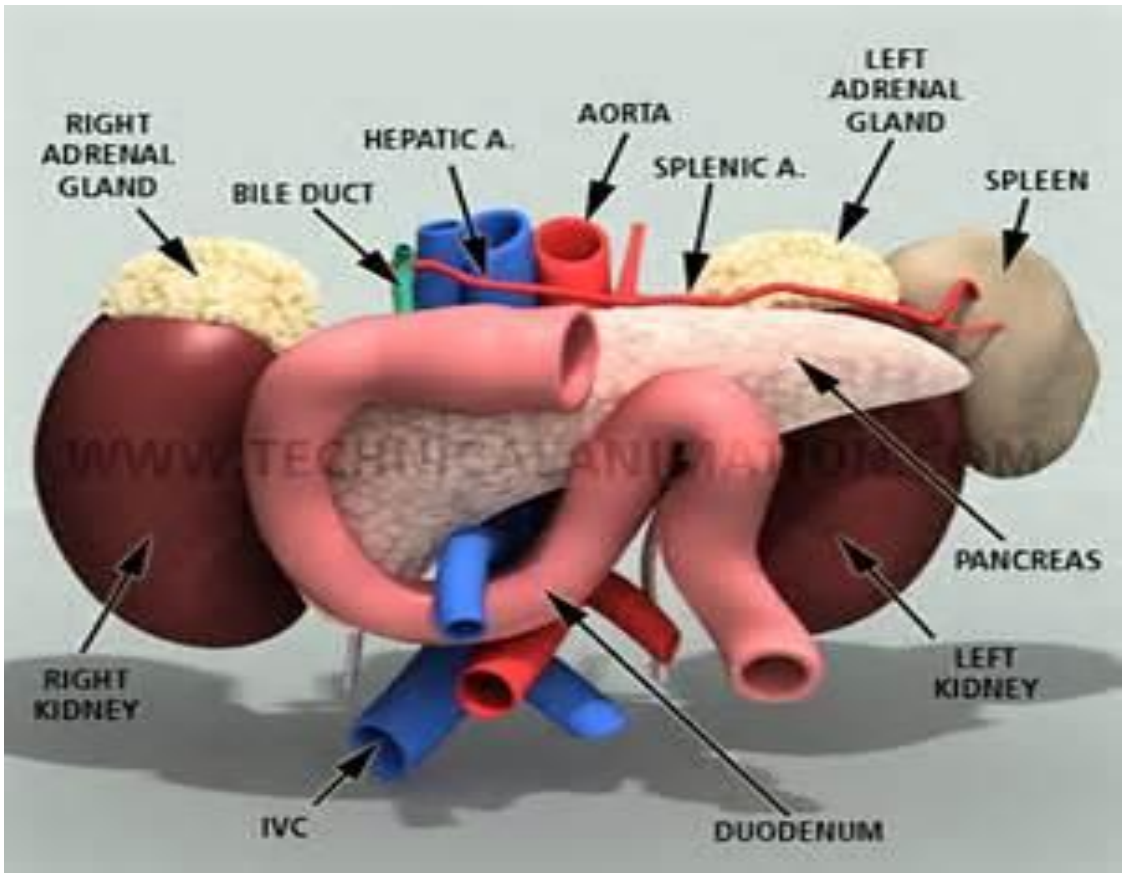


Figure (2-3):-Showing location of Spleen

www.turbosquid.com

2.1.3 Spleen weight:-

The normal size and weight of the spleen is varying at different period of life in different individual . In adult 8-13 cm in length, 7-8 cm in anteroposreior diameter , and less than 6 cm in thickness also measures 1 x 3 x 5 inches . It is weight in adult is ranged between 80 to 300 gram average of 150 gram . These are average measures and the size of the spleen varies considerably(Arther.C et al 2001) .

2.1.4 Spleen shape:-

The spleen is an organ shaped like a shoe that lies relative to the 9th and 11th ribs and is located in the left hypochondrium and partly in the epigastrium. Thus, the spleen is situated between the fundus of the stomach and the diaphragm. The spleen is very vascular and reddish purple in color; its size and weight vary. A healthy spleen is not palpable (Richard L et al 2005).

2.1.5 Blood Supply:

Splenic artery, the largest branch of the celiac trunk , passes between the layers of the lienorenal ligament and at the hilum divides into two or three main branches , from which five or more branches enter the spleen . Veins accompany the arteries and unite together to form the splenic vein (Chummy s Sinnatomby 1999)

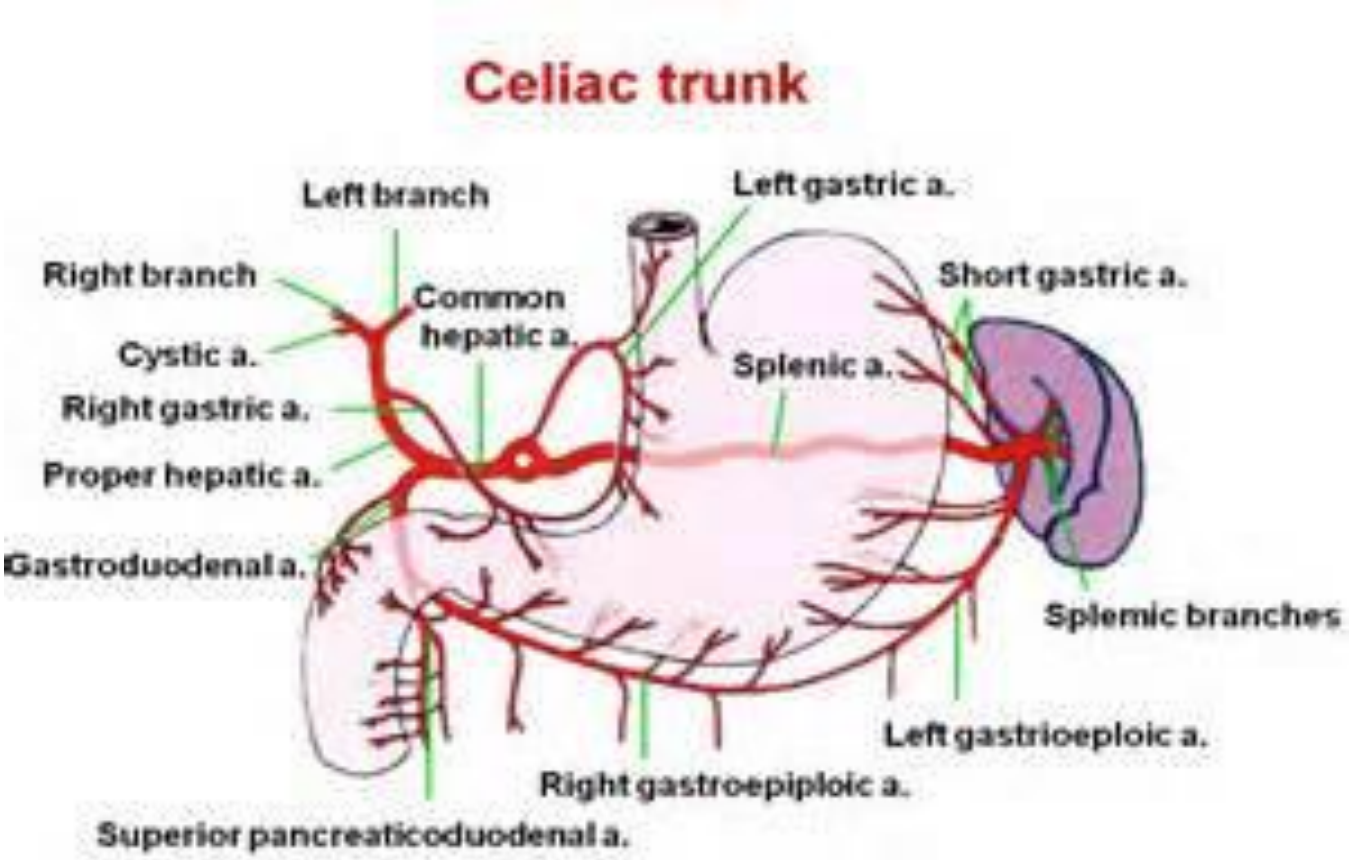


Figure (2-4):- Showing celiac trunk and blood supply of spleen

2.1.6 Nerve Supply:

The spleen is supplied by the celiac plexus with sympathetic fibers only (Snell. Richard S 2004) .

2.1.7 Lymph Drainage:

Lymph drains into several nodes in the hilum , by way of the pancreaticosplenic nodes to the celiac nodes in upper abdomen (Snell. Richard S 2004) .

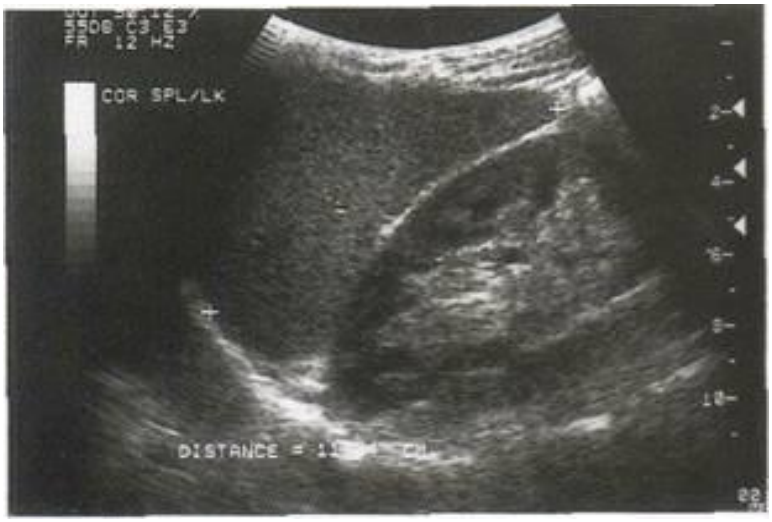
2.1.8 Development:

Spleen begins to develop in sixth weeks as several condensation of mesodorsal cells in the dorsal mesogasterium . Then the spleen come to lie at left margin of the lesser sac . Accessory spleens are the result of lack of fusion , occur about twenty percent of population and rarely bigger than 2 cm in diameter. The spleen develops in the cephalic part of dorsal mesogastrium (from its left layer; during the sixth week of intrauterine life) into a number of nodules that fuse and form a lobulated spleen. Notching of the superior border of the adult spleen is evidence of its multiple origin (Arthur.C et al 2001).

2.2 Normal ultrasound appearance of the spleen:-

The spleen has uniform homogeneous echo pattern ,its slightly less echogenic than the liver . There are no absolute criteria for the size of the spleen on ultrasound .When normal, is a little larger than or about the same size as the left kidney . The length should not exceed 14cm in the major axis . The volume and weight depend on the circulating blood volume. It calculated by the equation (volume = length x width x thickness x.523) and the normal volume is, $(124.1 \pm 51.8\ cm3)$. And the weight is calculated by the equation (length x width x thickness x0.43

gm) and the normal weight range between 80 and 300 gm . Splenic length was measured along the long axis, from the dome to the tip of the spleen, in the sagittal plane. The width was the longest (straight) organ diameter in the transverse plane. The thickness was the distance between the center (inner) and peripheral (outer) surface, measured at the level of the splenic hilum on the transverse plane (Aldrich,J.E 2007).



Figure(2-5):- Ultrasound image, transabdominal showing

Long axis of normal ultrasound appearance of spleen with Lt kidney

2.3 Physiology of the spleen :

The spleen is not essential for life and there is no obvious effect in the body if the spleen is removed . It is a large mass of lymphoid tissue that is a part of the reticuloendothelial system . The spleen has many functions to do as follow:

1- Responsible for antigenic challenge by production of cells making anti bodies

2- Destruction of all the abnormal shaped or rigid red cells by culling and pitting . Normal red blood cells life span approximately 120 days .

3- Phagocytosis of foreign substances by reticuloendothelial macrophages .

4- Spleen do as platelets reservoir and normally sequester 30—40 % of blood platelets. Life span of platelets is about 10 days .

5- Spleen do as erythrocytes production and normally spleen produced red blood cells in fetal life from the fourth month of development until birth .

6- The spleen filters foreign materials from the blood and , from antibodies and also break down hemoglobin as blood reservoir and important for blood formation in the fetal life and when there is severe anemia (Arther.C et al 2001).

7- After antigenic stimulation, increased formation of plasma cells for humoral responses and increased lymphopoiesis for cellular responses occurs.

8- One of the spleen's most important functions is phagocytosis. The spleen is a component of the reticuloendothelial system. The splenic phagocytes include reticular cells, free macrophages of the red pulp, and modified reticular cells of the ellipsoids. Phagocytes in the spleen remove debris, old and effete red blood cells (RBCs), other blood cells, and

microorganisms, thereby filtering the blood. Phagocytosis of circulating antigens initiates the humoral and cellular immune responses(Arther . C. Guyton et al 2006).

9- The spleen is an important hematopoietic organ during fetal life; lymphopoiesis continues throughout life. The manufactured lymphocytes take part in immune responses of the body. In the adult spleen, hematopoiesis can restart in certain diseases such as chronic myeloid leukemia and myelosclerosis.

10- The RBCs are stored in the spleen. Approximately 8% of the circulating RBCs are present within the spleen; however, this function is seen better in animals than humans (Andrew. Davies et al 2001).

2.4 Pathology of Spleen:

The spleen is an organ located under the ribs on the left side of the body. It is part of the lymphatic system, which is composed of lymph nodes, lymph vessels, lymphatic fluid, the tonsils, thymus, spleen, and lymphoid tissue of the digestive tract. The spleen filters the blood and helps the body fight infections(Cotran.Kumar Collins 2004).

2.4.1 Congenital Anomalies:-

Complete absence of spleen is rare, and is associated with other congenital anomalies. Accessory spleens are common and it could be single or multiple . They are usually small and are situated in the gastrosplenic ligament or the tail of the pancreas(Mohmd.I.Danish 2009).

2.4.2 Splenic Infarcts:-

Are a common lesions caused by occlusion of the major splenic artery or any of its branches,due to emboli that arise in the heart. The infarct may be small or large , multiple or single and sometimes involve the entire organ (Mohmd.I.Danish 2009).

2.4.3 Splenomegally:-

Splenic enlargement may be important diagnostic clue to existence of an underlying disorder, but the condition itself may cause problems . When sufficiently enlarged, the spleen may cause dragging sensation in the left upper quadrant and discomfort after eating . The storage function may lead to the sequestration of significant numbers of blood elements, leading to hypersplenism which characterized by " splenomegally, reduction of one or more of the cellular elements of the blood leading to anemia , leucopenia, thrombocytopenia " in association with hyperplasia of the bone marrow (Cotran.Kumar Collins 2004) .

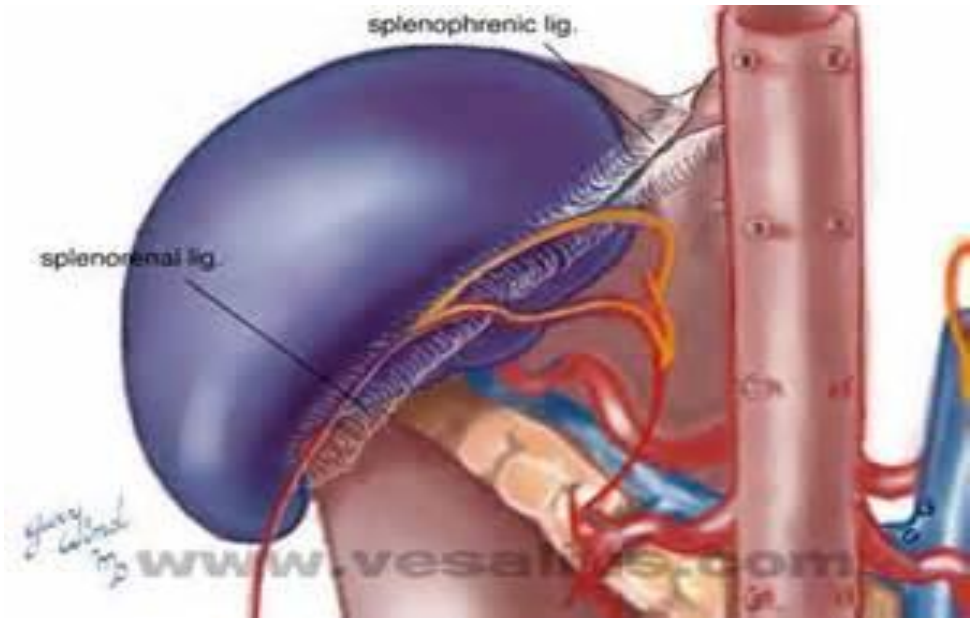


Figure No (2-6) Showing splenomegally

2.4.4 Rupture Spleen:-

Usually caused by crushing injury or severe blow or may be spontaneous “non-traumatic” . spontaneous ruptures encountered most often in infectious mononucleosis, malaria, typhoid fever and leukemia. Rupture spleen is usually followed by extensive or massive intraperitoneal hemorrhage (Mohmd.I.Danish 2009) .

2.4.5 Amyloidosis of Spleen:-

It is an immunological mechanism contributing to a large number of diseases . A myeloid is a pathologic proteinaceous substance deposited between cells in various tissues and organs . Amyloidosis of the spleen may cause moderate to marked splenomegally “800 gm” . The deposit is largely limited to the splenic follicles producing tapioca like granules “sago spleen” or involves the wall of the splenic tissue and connective tissue framework then red pulp . Fusion of deposits give rise to lardaceous spleen(Cotran.Kumar Collins 2004).

2.4.6 Sarcoidosis of Spleen:-

Is a systemic disease of unknown cause characterized by non caseating granulomas in many tissues or organs . The spleen is affected microscopically in about 75% of cases, but enlarged in 18%. On occasion granulomas coalesce to form small nodules and the splenic capsule is not involved(Mohmd.I.Danish 2009) .

2.4.7 Neoplasm’s of Spleen :-

Neoplastic involvement of the spleen is rare except in tumors of the lymph hematopoietic system, then induce splenomegally . The benign tumors of spleen like fibromas , osteomas, chondromas, lymphangiomas and hemangiomas(Cotran.Kumar Collins 2004).

2.4.8 Lymphoma and leukemia:-

Most splenic cancers do not start in the spleen, and those do are almost always lymphomas. Lymphoma is a type of blood cancer that develops in the lymphatic system. It is more common for a lymphoma to start in another part of the lymphatic system and invade the spleen than it is for lymphoma to start in the spleen itself. Leukemia's, which start in the bone marrow, are another type of blood cancer that can invade the spleen. Uncommonly, some other types of cancers that are located elsewhere in the body can spread, or metastasize, to the spleen. These include lung cancers, stomach cancers, pancreatic cancers, liver cancers, and colon cancers (Mohmd.I.Danish 2009).

Symptoms of spleen cancer can be vague and may resemble those of a cold. If the spleen enlarges, pain or fullness of the upper abdomen may be noticed. Treatment of spleen cancer depends on the cause of the cancer and the extent to which it has spread. Complications of spleen cancer requiring emergency care are rare, but may include severe infection or rupture of the spleen**.** Seek immediate medical care (call 911) for symptoms such as night sweats, difficulty breathing, pale or blue lips and fingernails, rapid heart rate (tachycardia), confusion or loss of consciousness, or fever and chills(Cotran.Kumar Collins 2004).

2.5 Ultrasound Background :-

2.5.1 Introduction :-

Ultrasound is anon-invasive procedure which can be used to assess the health of organs and soft tissues in the second world war in various centers around the world . In spite of other workers in United States of America, Japan and Europe, the work of professor Lan Donald and his colleagues in Glasgow in the mid 1950s facilitate the development of practical technology

and applications . This led to wide range of use of ultrasound in medical practice in subsequent decades(Aldrich.J.E 2007) .

From 1960s , technical advances lead to a rapid growth in the use and applications of ultrasound . With the technological advances that have been made in ultrasound equipment , the potential of ultrasound technology is not yet fully realized . The rapid growth in digital imaging and knowledge processing coupled with advances in formation technology place ultrasound in a strong position to play a greater role in healthcare in the future(Aldrich.J.E 2007).

Because dialysis cannot maintain completely normal body fluid composition and cannot replace all the multiple functions performed by the kidneys, the health of patients maintained on artificial kidneys usually remains significantly impaired. A better treatment for permanent loss of kidney function is to restore functional kidney tissue by means of a kidney transplant(Aldrich.J.E 2007).

2.5.2 Clinical ultrasonographic physics:

Understanding the basic physics of ultrasound is essential for acute care physicians who perform point-of-care ultrasound to make accurate critical decisions. Ultrasound is made up of mechanical waves that can transmit through different materials like fluids, soft tissues and solids. It has a frequency higher than the upper human auditory limit of 20 KHz. Ultrasound frequency is defined as the number of ultrasound waves per second, and medical ultrasound machines use waves with a frequency ranging between 2 and 15 MHz. The velocity of ultrasound in a specific medium equals the frequency of ultrasound multiplied by its wave length (PN,W 1998).

2.5.3 Basic physics:

Medical ultrasound machines generate ultrasound waves and receive the reflected echoes. Brightness mode (B mode) is the basic mode that is usually used. The B mode gives a two dimensional (2D) black and white image that depends on the anatomical site of the slice. The body can be imaged in different planes depending on the position of the probe. These thin slices are of less than 1 mm each and can be sagittal, coronal, transverse, or oblique. Sound waves are emitted from piezoelectric crystals from the ultrasound transducer. Piezoelectric crystals are fabricated from material that changes electrical signals to mechanical vibrations and changes mechanical vibrations to electrical signals. As ultrasound waves pass through various body tissues, they are reflected back to the transducer creating an image on the ultrasound screen. Acoustic impedance is defined as the resistance for propagation of ultrasound waves. This varies according to the density of the material ultrasound passes through. When the material is more solid, then the particles are denser and sonongraphic waves will reflect more, Fluid transmits more sound waves than solid material. So less ultrasound waves will reflect back from fluids. This produces an echogenic “black” image. Stones and bones reflect more sound waves than fluid and produce “white” bright images. Since ultrasound waves cannot transmit through stones, a black acoustic shadow will be present behind them. Air is a strong ultrasound beam reflector making it difficult to visualize structures behind it. The denser a material is the more it reflects the sonographic waves. Fluid (like blood) transmits ultrasound waves and have minimum waves reflected back. This yields a black “an echogenic” image. Stones yield white images with a shadow (A. S, 2008).

2.5.4 Controlling ultrasound wave:

There are different methods that control the way ultrasound waves are emitted from the ultrasound transducers. Emission of ultrasound waves can be either interrupted or continuous. Interrupted emission of ultrasound waves generates brightness (B mode) images while continuous emission generates Doppler mode. Imaging one line over time is called the moving mode (M Mode). Changing the frequency of ultrasound waves will control the penetration and resolution of the images. The higher the frequency, the better is the resolution; however the depth of penetration decreases. The opposite will happen when using lower frequency transducers. Longer distances and higher frequencies result in greater attenuation. This implies that for obese patients and deep structures, probes of low frequencies should be used while probes of high frequency should be used for superficial structures. The received ultrasound signal can be amplified by increasing the gain. Decreased gain yields a black image and details are masked, while increased gain yields a whiter image. Time gain compensation will change the gain factor so that equally reflective structures will be displayed with the same brightness regardless of their depth (PN,W 1998).

Ultrasound waves are emitted perpendicular to the surface of the transducer. It is possible to widen the deep sonographic field by bending the surface of the transducer (convex array transducer). Waves will be parallel to each other when the probe surface is flat (linear array transducer). Linear array transducers usually have high frequencies (10-12 MHz), less penetration, and excellent resolution. The ultrasound images obtained by a linear array transducer will be rectangular in shape while those obtained by a convex array transducer will be wider with increased depth. Reducing the surface of the transducer and using fan shaped sectors will enable the examiner to visualize thoracic structure between the ribs. Changing the shape of

the surface of the probe and its size gives different types of sectors used for different applications (Whittingham, 2007).

(A) (B) (C)

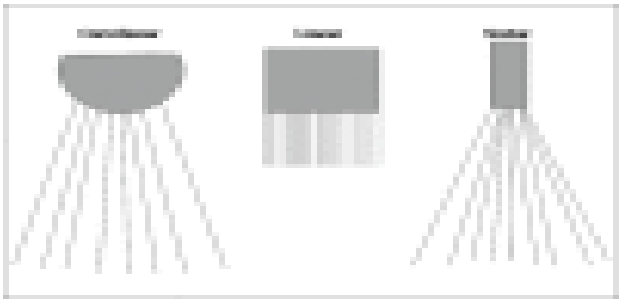


Figure (2-7):- Types of transducers:

(A) convex, (B) linear , (C) sector

(www.ncbi.nlm.n.h.gov)

2.5.5 Sonographic artifacts:-

2.5.5.1 Introduction:-

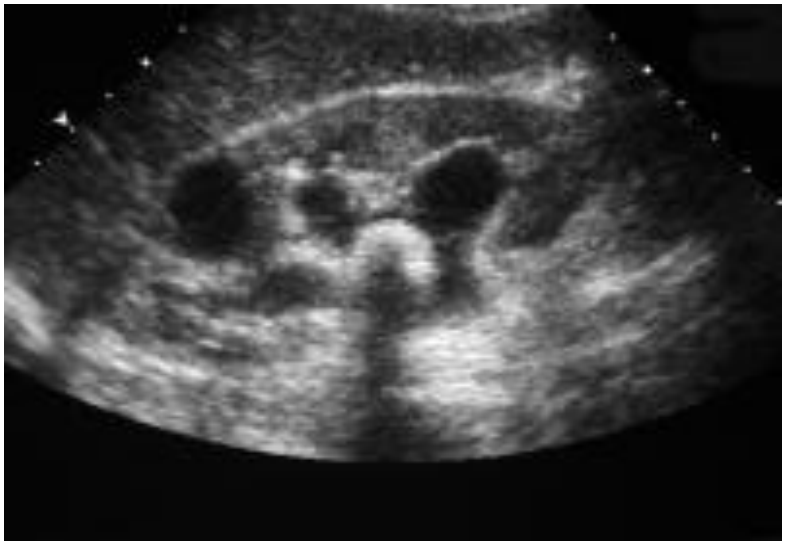
The operator should be especially knowledgeable about sonographic artifacts that can mislead him/her. Artifacts may distort the size, position and shape of the studied structures or even show structures that are not present. Some artifacts are very useful for diagnosing different conditions (Feldman et al., 2009). .

2.5.5.2 Shadowing artifacts:-

Ultrasound is unable to transmit through solid structure like the stones or ribs. This causes a shadow artifact behind the solid structures . Shadow artifact is very useful for diagnosing gall stones [figure2-5]. Posterior enhancement artifact may occur when imaging fluid filled structures (like the gall bladder or urinary bladder), (Feldman et al., 2009) .

2.5.5.3 Enhancement artifacts:-

The posterior enhancement will increase the gain behind the urinary bladder, and it is important to reduce the gain when looking for small amounts of pelvic fluid in Pouch of Douglas, otherwise it can be missed. More ultrasound waves will penetrate the fluid filled structure, and a white enhancement area will appear behind It. The edge (refraction) artifact occurs when a beam of ultrasound refracts at the edge of a rounded structure like a kidney or urinary bladder. This artifact may disappear when changing the angle of the ultrasound beam clarifying the nature of the artifact (Rose JS, 2006).



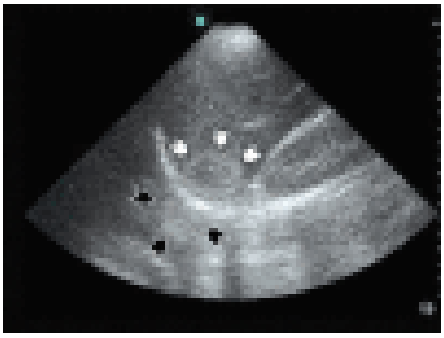
Figure(2-8) :- Ultrasound image, transabdominal showing

Rt Renal stone with shadowing artifacts.

(emedicine. Medscape.com)

2.5.5.4 Mirroring artifact:-

The mirror artifact occurs when the sonographic waves are reflected by an angle by a high acoustic impedance tissue, for example like the diaphragm. The mirror artifact will mimic a virtual object similar to a true mirror on the opposite side of the structure . The mirror image is more hypoechoic and somewhat more blurred and distorted than the image of the original structure as a result of absorption the of the ultrasound beam when passing through a long pathway Coronal section of the liver using a curvilinear probe showing a haemangioma under the dome of the diaphragm and its mirror artifact above the diaphragm Notice that the mirror artifact is more blurred and distorted. (Rose JS, 2006) .



Figure(2-9):- Ultrasound image, transabdominal showing

Mirroring artifact

(www.ncbi.nlm.n.h.gov)

2.5.5.5 Reverberation artifact:-

Reverberation artifact occurs when ultrasound bounces between two interfaces especially with high acoustic impedance like the pleura. The waves will move forward and backward between these interfaces. The machine will recognize these waves as parallel lines with equal distances between them, and decreased density for the deeper lines, because the reflected waves become gradually lesser in number. This results in a stripped pattern having alternating dark and clear lines at regular intervals [figure] (DA, 2010) . Reverberation artifact of the lung occurs as ultrasound waves bounce between the transducer and the pleura. The pleura is shown as a hyper dense white line (black arrow). The reverberation lines (white arrows) represent repetition of the pleural line ((Rose JS, 2006).

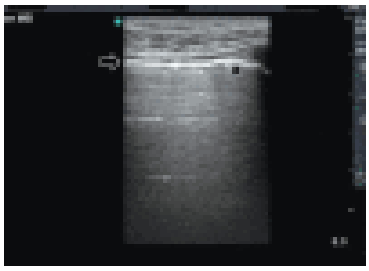


Figure (2-10):- Ultrasound image, transthoracic showing

Reverberation artifact of the lung

(www.ncbi.nlm.n.h.gov)

2.5.6 Ultrasound Instrumentation:-

There are different types of ultrasound machines , which can scan most of the body soft tissues , organs and can reach the real diagnosis which cannot be diagnosed by other investigations . There are normal scanning machines , 2 dimensional , 3 dimensional , 4 dimensional Doppler and others with variable frequencies , which can image all organs in the human body . It is still very useful , quick , noninvasive , relatively inexpensive , unbiguitous technique(Aldrich.J.E 2007).

2.5.7 Safety of Ultrasound:-

The most wonderful that ultrasound is just a sound that is above the range of human hearing . Human can hear sound with the frequency ranges of about twenty to twenty thousand Hertz , so any sound above twenty KHz is an ultrasound . Most of ultrasound are familiar with the idea that unborn babies can be photographed by using ultrasound . It is safe as compared to X—rays , which may damage the child apart from giving parents the first photographs for their babies , it allows doctors to check for certain birth defects ,checking it is size and their gender and even if there is more than one " multiple pregnancy" . Also it can determined the site of placenta and the amount of liquer . Also it can be used in scanning fetal for beyond pregnancies . Many other parts of the body are analyzed using it like " Urinary Bladder , Gall Bladder , Heart ,……. Etc. But it does not stopped their . Also Aero plane wings can be checked from crack that could be invisible on the surface . Ships using sonar to determine the depth of water they are in , they use ultrasound(Sandra. L .Hargen- Ansert 2001).

2.6 Renal Failure:-

2.6.1 Introduction:-

Kidney failure or renal insufficiency is a medical condition in which the kidneys fail to adequately filter waste products from the blood. The two main forms are acute kidney injury, which is often reversible with adequate treatment, and chronic kidney disease, which is often not reversible. In both cases, there is usually an underlying cause. Renal failure is mainly determined by a decrease in glomerular filtration rate, the rate at which blood is filtered in the glomeruli of the kidney. This is detected by a decrease in or absence of urine production or determination of waste products (creatinine or urea) in the blood. Depending on the cause, hematuria (blood loss in the urine) and proteinuria (protein loss in the urine) may be noted in renal failure, there may be problems with increased fluid in the body (leading to swelling), increased acid levels, raised levels of potassium, decreased levels of calcium, increased levels of phosphate, and in later stages anemia. Bone health may also be affected. Long-term kidney problems are associated with an increased risk of cardiovascular disease (Arthur. C. Guyton, 2006) .

2.6.2 Types of Renal Failure:-

Renal failure can be divided into two categories: acute kidney injury or chronic kidney disease. The type of renal failure is differentiated by the trend in the serum creatinine; other factors that may help differentiate acute kidney injury from chronic kidney disease include anemia and the kidney size on sonography as chronic kidney disease generally leads to anemia and small kidney size(HADA, R. 2009).

2.6.2.1 Acute Kidney Injury:

Acute kidney injury (AKI), previously called acute renal failure (ARF), is a rapidly progressive loss of renal function, generally characterized by oliguria (decreased urine production, quantified as less than 400 ml per day in adults, less than 0.5 ml/kg/h in children or less than 1 ml/kg/h in infants); and fluid and electrolyte imbalance. AKI can result from a variety of causes, generally classified as *prerenal*, *intrinsic*, and *post renal*. The underlying cause must be identified and treated to arrest the progress, and dialysis may be necessary to bridge the time gap required for treating these fundamental causes (HADA, R. 2009).

2.6.2.2 Chronic kidney disease:-

Chronic kidney disease (CKD) can also develop slowly and, initially, show few symptoms. CKD can be the long term consequence of irreversible acute disease or part of a disease progression (HADA, R. 2009).

2.6.2.3 Acute-on-chronic renal failure:-

Acute kidney injuries (AKI) can be present on top of chronic kidney disease, a condition called acute-on-chronic renal failure (AoCRF). The acute part of AoCRF may be reversible, and the goal of treatment, as with AKI, is to return the patient to baseline renal function, typically measured by serum creatinine. Like AKI, AoCRF can be difficult to distinguish from chronic kidney disease if the patient has not been monitored by a physician and no baseline (i.e., past) blood work is available for comparison (HADA, R. 2009).

2.6.3 Treatment of Chronic Renal Failure:-

Severe loss of kidney function, either acutely or chronically, is a threat to life or requires removal of toxic waste products and restoration of body fluid volume and composition towards normal. This can be accomplished by dialysis with an artificial kidney. In certain types of acute renal failure, an artificial kidney may be used to tide the patient over until the kidneys resume their function. If the loss of kidney function is irreversible, it is necessary to perform dialysis chronically to maintain life. Because dialysis cannot maintain completely normal body fluid composition and cannot replace all the multiple functions performed by the kidneys, the health of patients maintained on artificial kidneys usually remains significantly impaired. A better treatment for permanent loss of kidney function is to restore functional kidney tissue by means of a kidney transplant (Arthur. C. Guyton, 2006)).

2.6.3.1 Renal transplantation:-

A renal transplant is a surgical procedure to place a kidney from a live or deceased donor into a person whose kidneys no longer function properly (Arthur. C. Guyton, 2006).

2.6.3.2 Hemodialysis:

A medical procedure to remove fluid and waste products from the blood and to correct electrolyte imbalances. This is accomplished using a machine and a dialyzer, also referred to as an "artificial kidney." It is also used to treat both acute (temporary) and chronic (permanent) kidney failure. Is the most common method used to treat advanced and permanent kidney failure. Since the 1960s, when hemodialysis first became a practical treatment for kidney

failure, hemodialysis treatment more effective and minimize side effects. In recent years, more compact and simpler dialysis machines have made home dialysis increasingly attractive. But even with better procedures and equipment, hemodialysis is still a complicated and inconvenient therapy that requires a coordinated effort from the patient and the whole health care team, including the nephrologists, dialysis nurse, dialysis technician, dietitian, and social worker.The most important members of the health care team is the patient and his family. By learning about the treatment, the patient can work with his health care team to give himself the best possible results, and he can lead a full, active life. Healthy kidneys clean the blood by removing excess fluid, minerals, and wastes. They also make hormones that keep the bones strong and the blood healthy. When the kidneys fail, harmful wastes build up in the body, the blood pressure may rise, and the body may retain excess fluid and not make enough red blood cells. When this happens, the patient needs treatment to replace the work of the failed kidneys. In hemodialysis, the blood is allowed to flow, a few ounces at a time, through a special filter that removes wastes and extra fluids. The clean blood is then returned to the patient body. Removing the harmful wastes and extra salt and fluids helps control the blood pressure and keep the proper balance of chemicals like potassium and sodium in the body. One of the biggest adjustments the patient must make when he starts hemodialysis treatments is following a strict schedule. Most patients go to a clinic—a dialysis center—three times a week for 3 to 5 or more hours each visit. For example, it may be on a Monday-Wednesday-Friday schedule or a Tuesday-Thursday-Saturday schedule. The patient may be asked to choose a morning, afternoon, or evening shift, depending on availability and capacity at the dialysis unit. The dialysis center will explain to the patient the options for scheduling regular treatments. Researchers are exploring whether shorter daily sessions, or longer sessions performed overnight while the patient sleeps, are more effective in

removing wastes. Newer dialysis machines make these alternatives more practical with home dialysis. But the Federal Government has not yet established a policy to pay for more than three hemodialysis sessions a week. Several centers around the country teach people how to perform their own hemodialysis treatments at home. A family member or friend who will be the patient helper must also take the training, which usually takes at least 4 to 6 weeks. Home dialysis gives the patient more flexibility in his dialysis schedule. With home hemodialysis, the time for each session and the number of sessions per week may vary, but the patient must maintain a regular schedule by giving himself dialysis treatments as often as he would receive them in a dialysis unit((Arthur. C. Guyton, 2006).

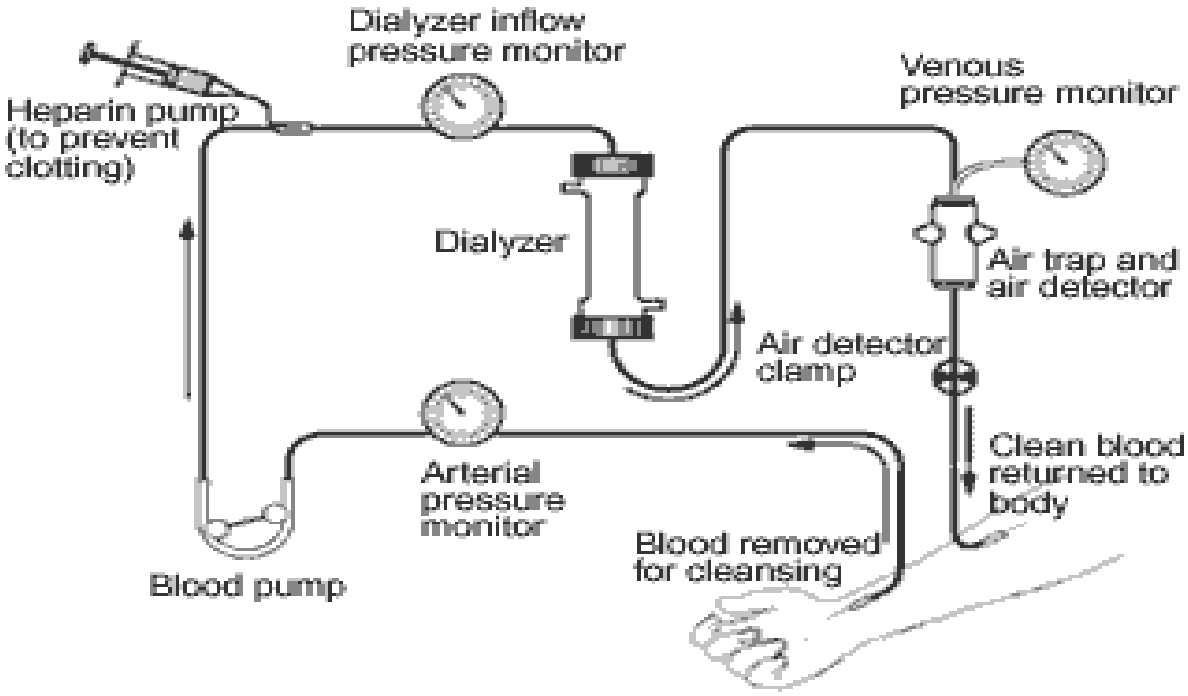


Figure No (2-11):- Schematic Diagram Showing Hemodialysis Circuits

(www.medicinenet.com)

2.6.4 Complications of Dialysis and Kidney Failure:-

2.6.4.1 Introduction;-

When the kidneys stop working, the patient may face a variety of problems. This is because the kidneys don't just remove waste. They also make hormones and balance chemicals in all system. Some of the more common conditions caused by kidney failure are:

2.6.4.2 Common Complications:-

1 Hypotension (20-30%)

2 Muscle cramps, Nausea and Vomiting

3 Disequilibrium Syndrome and Extreme tiredness

4 Headache, Chest Pain and Bone problems

5 Itching, Fever and Chills

6 Pyrogen reaction

7 Joint problems and Restless legs (Hada, 2009).

2.6.4.3 Technical Complications:-

1 Clotting and Blood leak

2 Power failure and Hemolysis

3 Air Embolism and Air in bloodlines

4 Exsanguinations and Dialyzer reactions (Hada, 2009) .

2.6.4.4 Chronic complication:-

2.6.4.4.1 Introduction:-

The kidneys from patients with end stage renal disease who have under gone prolong dialysis some time exhibit numerous complications cortical and medullary cysts. the cyst measure 0.5to 2 cm in diameter, contain clear fluid, and are lined by either hyper plastic or flattened tubular epithelium, and often contain calcium oxalate crystals. The probably form as result of obstruction of tubule by interstitial fibrosis or by oxalate crystal (Hada, 2009).

2.6.4.4.2 Anemia:-

Anemia is also a common condition related to kidney failure. Anemia is when the volume of red blood cells is low, causing a person to tire easily. Kidneys usually produce a hormone called erythropoietin,"EPO", which stimulates the bone marrow to produce red blood cells. Diseased kidneys often don't make enough EPO, so fewer red blood cells are made. EPO is commonly given to patients on dialysis to prevent anemia(Hada, 2009).

2.6.4.4.3 Osteodystrophy:-

Renal osteodystrophy affects about 90% of dialysis patients. Renal osteodystrophy is a bone disease related to kidney failure. It causes bones to become thin and weak or form incorrectly. Many people who are being treated with hemodialysis experience itchy skin. The itching is often worse during or just after treatment due to the wastes in the blood stream that can't be removed from the blood. Many different treatment options are available for this side effect. Sleep disorders are also common in patients who receive hemodialysis (Hada, 2009).

2.6.4.4.4 Sleep apnea:-

Sleep apnea is one type of sleep disorder that causes an interruption in breathing during sleep. Many people on dialysis also have trouble sleeping at night because of aching, uncomfortable, jittery, or "restless" legs. The causes of restless legs may include nerve damage or chemical imbalances (Hada, 2009).

2.6.4.4.5 Dialysis-related amyloidosis, (DRA):-

If a patient has been on dialysis for more than 5 years, another common condition is dialysis-related amyloidosis, or DRA. DRA develops when proteins in the blood deposit on joints and tendons. This causes pain, stiffness, and fluid in the joints. The proteins that cause DRA are usually filtered out by the kidneys. However, dialysis filters are not effective in removing this protein from the blood. It is important that you follow your doctor's recommendations. Skipping treatment increases the risk of complications, including death (Hada, 2009).

2.6.5 Previous Studies:-

In patients receiving regular haemodialysis, splenic volume was assessed in 34 controls and 149 patients with chronic renal failure. Of the patients, 16 had never received dialysis, 10 were undergoing continuous peritoneal dialysis, 94 were undergoing regular haemodialysis, and 29 had undergone successful renal transplantation more than nine months previously. Mean splenic volume was increased only in the patients who were receiving haemodialysis. Splenic enlargement was probably not due to iron overload as it occurred in all patients who had received haemodialysis, 14 of whom had not received intravenous iron. No patient had had hepatitis. Splenic enlargement was probably related to the process of haemodialysis itself and may have

been due either to red cell damage produced by haemodialysis or to an immunological reaction induced by component of haemodialysis, possibly ethylene oxide.(M M Platts, E Anastassiades, S Sheriff, S Smith, and D C Bartolo).

A prospective study of normal spleen ultrasound-based measurements in 200 Nigerian adults at the University of Benin Teaching Hospital Benin, Nigeria. There were 91 males and 109 females; their age ranged between 20 and 60 years This study has shown the following mean dimensions of splenic sizes, for the males; the mean splenic length, width, depth, and volume were 11.1 cm (±0.9 SD), 4.4 cm (±0.5 SD), 7.8 cm (±0.6 SD), and 202.7 cm^3 (±49.4 SD), respectively, and for the females the corresponding values of splenic length, width, depth and volume were 10.1 cm (±0.7 SD), 4.0 cm (±0.4 SD), 7.1 cm (±0.5 SD) and 153.7 cm^3 (±33.2 SD), respectively. This was not different from other studies in different continents, where the peculiar endemicity in our environment does not exist. (Loftus *et al*). in their study of a Chinese population suggested an upper limit of normal length of 12 cm. Some textbooks of ultrasound and other studies suggested an average splenic length of 12 cm, average width of 5 cm, and average depth (antero-posterior dimension) of 7 cm. These observations suggest that there is no significant racial bias of spleen size in this study as compared with Caucasians. This is similar to results obtained in other studies.(Mustapha *et al).* in a study of an adult African population found mean spleen volumes that were smaller than data from Western sources and this could not be attributed to difference in body habitus.(Okoye *et al*). found good correlation between subject height and splenic length. (Spielman *et al)* also found a good correlation between subject height and spleen length in their study population which consisted of tall healthy athletes (r=0.4 for males and 0.3 for females). Splenic volumetric index has also been determined using ultrasound scanning by (Pietri *et al).*

CHAPTER THREE

Material and Method

3.1 Materials:-

3.1.1 Machine Used:-

A highly designated ultrasound machine was used (Aloka PHD prosound ssd-4000sv version) with a convex probe (3.5 MHz Frequency).

3.1.2 Method of data acquisition (Technique):-

The patient was comfortably lying on supine and right oblique (30 degree) position. Applying ultrasound gel liberally over the left lower chest, the upper abdomen and left flank. The patient took a deep breath and holds it in during scanning. Longitudinal scans from anterior to posterior axillary lines and transverse upper abdomen scans was performed. Scanning from below the costal margin, angling the beam towards the diaphragm was performed, then in the ninth intercostals spaces to scan the spleen in all axes(Sandra. L .Hargen- Ansert 2001).

3.1.3 Design of the study:-

This is descriptive cross sectional study where the data collected prospectively.

3.2 Populations:-

Fifty patients on hemodialysis for more than 5 years came to hospital for hemodialysis and ultrasound examination for check up were included in the study, their including and excluding criteria as follows:

3.2.1 Including Criteria:-

Patients came to hospital for hemodialysis and ultrasound examination for check up, with fifteen years old or more on hemodialysis for five years or more

3.2.2 Excluding Criteria:-

- Patient less than fifteen years old
- Patient on hemodialysis for less than five years

3.3 Data Collection:-

Data collected from two sources

1 – exclusive history of the patient

2 - Careful study of ultrasound finding of the spleen.

Figure (3-1):- Master sheet (data collection sheet)

No	age	Sex	Length	Width	Thickness	Echo	Homo	Volume	

3.4 Data analysis:

Descriptive statistics was used to describe the study variables, using the Statistical package software (SPSS) to analyze these variables.

Chapter four

The Result

Table (4 -1):- Showing age groups and their frequency

AGEG ROUP	Frequency	%
15-30	15	30
31-45	14	28
46-60	19	38
>60	2	4
Total	50	100

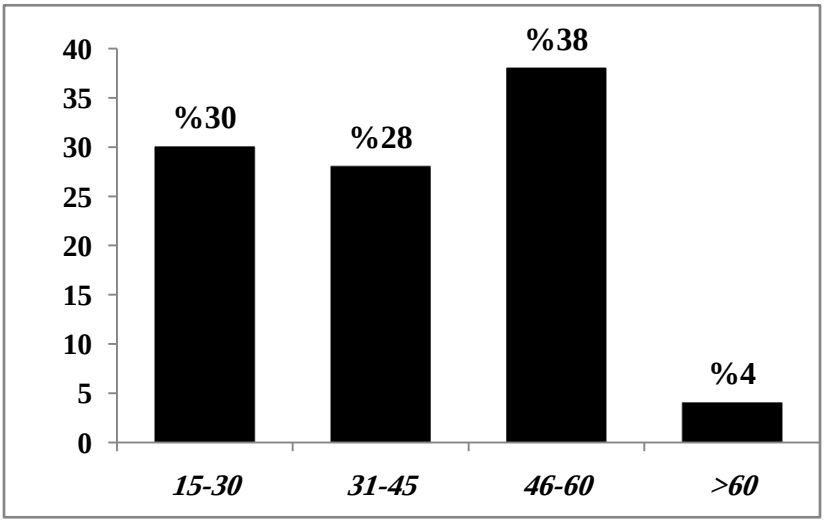


Figure 4 -1: Showing age group bar chart.

Table 4-2:- Showing the distribution of patients according to gender.

Gender	Frequency	Percent
Male	25	50.0
Female	25	50.0
Total	50	100.0

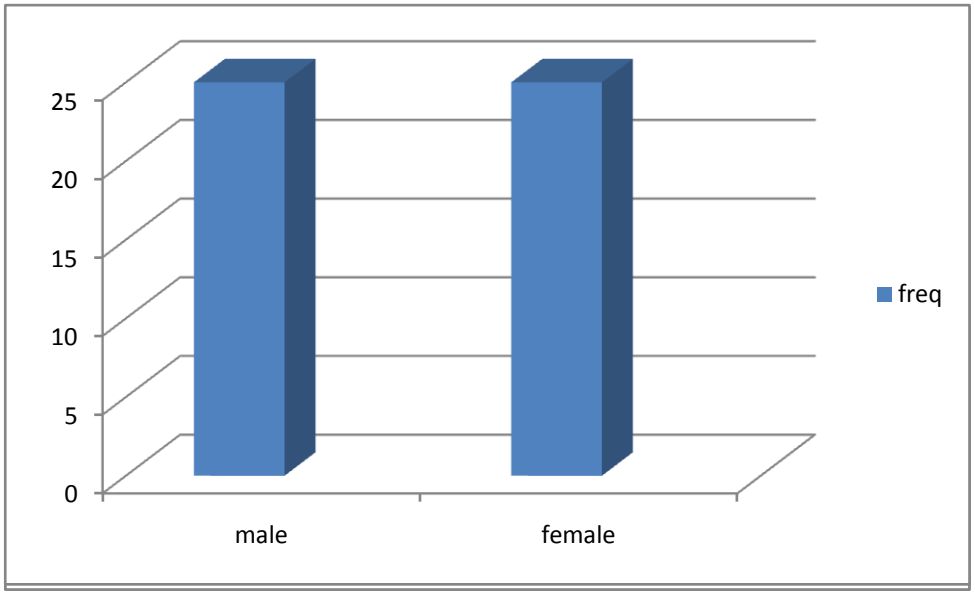


Figure (4-2):- Bar chart showing the distribution of patients according to gender.

Table 4-3:- Showing the distribution of spleen according to echogenecity

Echo	Frequency	Percent
Isoehoic	34	68.0
hyperechoic	2	4.0
hypoechoic	14	28.0
Total	50	100.0

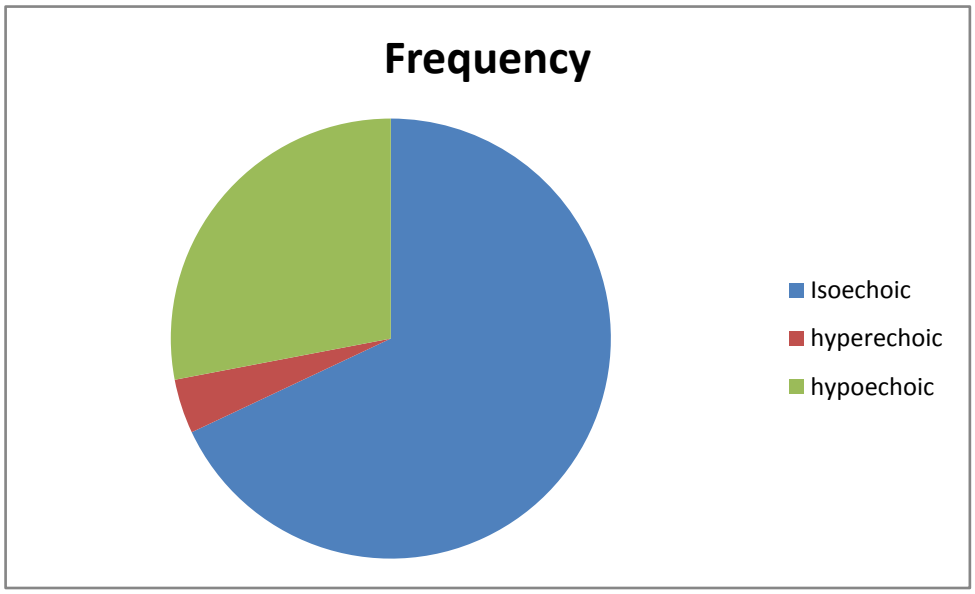


Figure (4-3):- Pie chart showing the distribution of spleen according to echogenecity

Table 4-4:- Showing the distribution of spleen according to homogeneity

homogenety	Frequency	Percent
homogenous	33	66.0
hetrogenous	17	34.0
Total	50	100.0

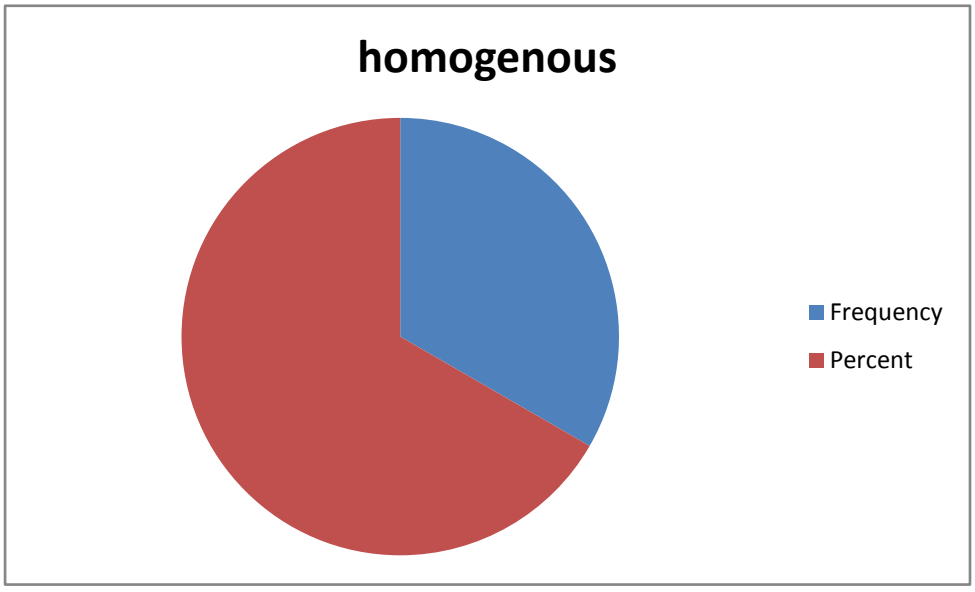


Figure (4-4):- Pie chart Showing the distribution of spleen according to homogeneity

Table 4-5 Showing means and stander deviations of the measurement variables

Variable	mean±SD
age	42.0±13.7
Length	11.7±2.3
Width	06.9±1.2
Thickness	06.0±1.2
Volume	281.0±151.6

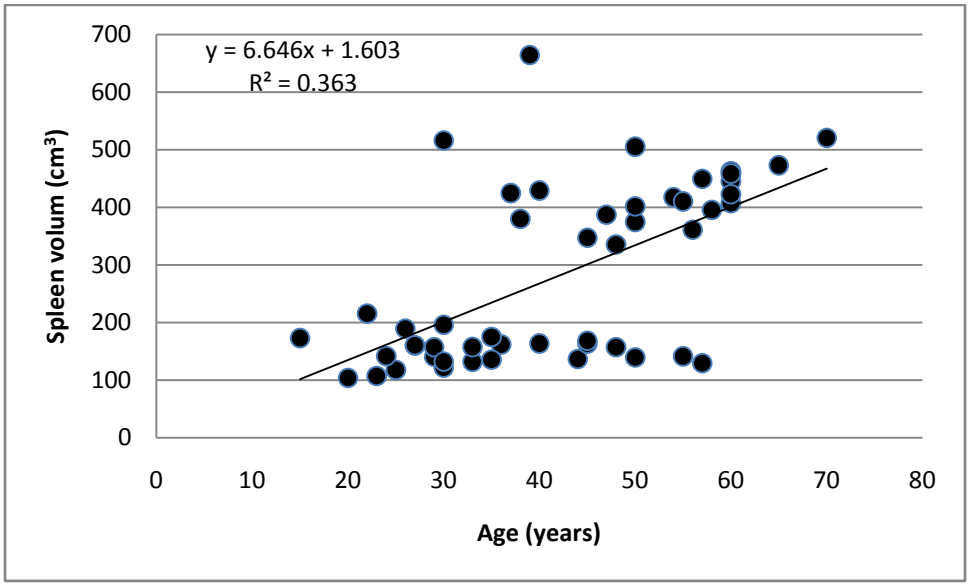
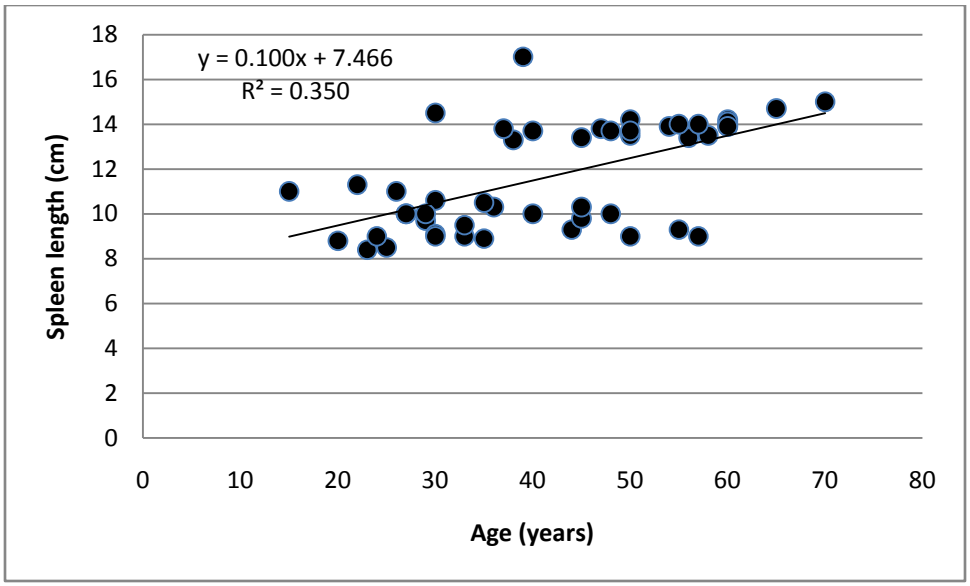


Figure (4-5):- Scatter plot showing the relationship between spleen volume and age



Figure(4-6):- Scatter plot showing the relationship between spleen length and age

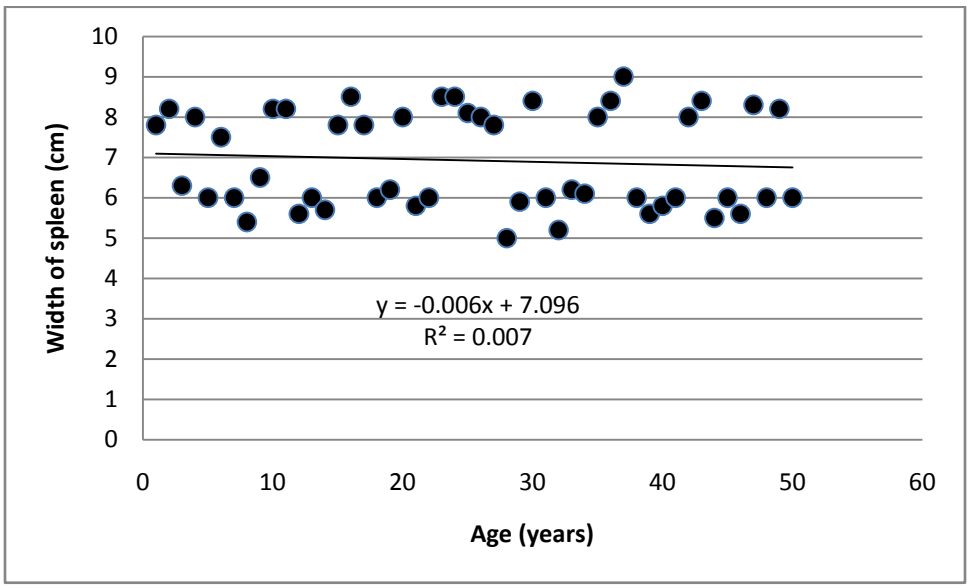
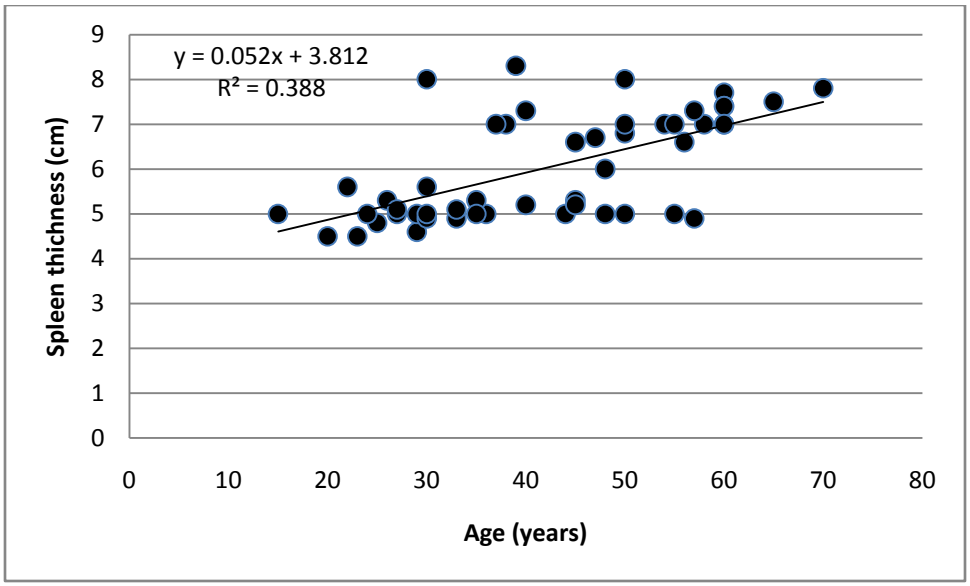


Figure (4-7):- Scatter plot showing the relationship between spleen width and age



Figure(4-8):- Scatter plot showing the relationship between spleen thickness and age

Table (4-6):- measurement variables in relation to sex and their means ± Std

Sex		Mean	Std. Deviation
Length	Male	12.200	2.4922
	Female	11.180	2.0893
Width	Male	7.292	1.1942
	Female	6.604	1.0937
Thickness	Male	6.380	1.2244
	Female	5.668	.9936
Volume	Male	323.37	165.672
	Female	238.65	125.561

Table (4-7):- Showing independent samples test(homogenecity)

Independent Samples Test		
	t-test for Equality of Means	
	t	Sig. (2-tailed)
Length	1.568	.123
Width	2.103	.041
Thickness	2.258	.029
Volume	2.038	.047

Table (4-8):- homogenecity of the spleen in relation to measurements

Homo		Mean	Std. Deviation
Length	homogenous	11.421	2.3733
	hetrogenous	12.212	2.2302
Width	homogenous	6.825	1.1634
	hetrogenous	7.159	1.2273
Thickness	homogenous	5.912	1.1610
	hetrogenous	6.241	1.1635
Volume	homogenous	265.82	153.774
	hetrogenous	310.48	147.430

Table (4-9):- Showing the measurements of spleen in relation to echogenecity

measurements	isoechoic	hyperechoic	hypoechoic
Length	10.774	8.600	14.357
Width	6.473	5.200	8.293
Thickness	5.524	4.500	7.457
Volume	214.18	105.15	468.43

Table 4-10 :-

Showing Independent Samples Test (echogenecity)

	t-test for Equality of Means	
	t	Sig. (2-tailed)
Length	-1.138	.261
Width	-.938	.353
Thickness	-.949	.348
Volume	-.986	.329

CHAPTER FIVE

5.1 Discussion

This study has been conducted in renal center in Sennar teaching hospital on 50 patients on hemodialysis for 5 years or more. 2 5 of them are male which is 50% and 25 are female which is 50% categorize age wise in to 4 group (table 4-2) and (figure4-2).

In this study the most frequent group is 46 to 60 years old composed of 19 patients which is 38% and the next group is15 to 30 years old which composed of 15 patients which is 30% the third group from 31 to 45 years old composed of 14 patients which is 28% and the last group more than 60 years old show only 2 patients which 4% very small group (table 4-1) and (figure 4-1).

The study showed 34 patients have isoechoic splenic texture which is 68% , 14 patients have hypoechoic texture which is 28% and only 2 patients have hyper echoic texture which is 4% table (4-3) figure (4-4) depending on hemodialysis and the age .

This thesis showed 33 patients have homogenous spleen which is 66% while 17 patients have heterogeneous spleen which is 34% table (4-4) figure (4-5) .

This study proved that the mean age for data were 42.0±13.7, the mean length 11.7±2.3, the mean width were 06.9±1.2, the mean thickness 06.0±1.2 this give mean volume for spleen 281.0±151.6 table (4-5) .

This study showed that the volume of spleen figure (4-5) ,the spleen length figure (4-6) and thickness figure (4-8) were increasing with age and hemodialysis, this finding is similar to that

study done by (M M Platts et al) on (1984) mean splenic volume was increased in the patients who were receiving haemodialysis. Splenic enlargement was probably not due to iron overload as it occurred in all patients who had received haemodialysis, despite of the width figure (4-7) there is no significant change mostly due to the presence of the stomach and diaphragm from above and the left kidney from below .

From table (4-8) the homogenecity changed to heterogenicity when there is increasing in length, thickness, width and volume which is similar to the study done by(M M Platts et al) on (1984) that showed hemodialysis decrease the echogenecity of spleen depending on the duration of dialysis.

In this study the mean dimensions of splenic sizes for the males; the mean splenic length, width, thickness, and volume were 12.200 cm (±2.4922 SD), 7.292 cm (±1.1942 SD), 6.380 cm (±1.2244 SD), 323.37 cm (±165.672 SD), and for the females the corresponding values of splenic length, width, thickness and volume were 11.180 cm(±2.0893 SD), 6.604cm(±1.0937 SD),5.668cm(±.9936 SD), 238.65 cm(±125.561SD) which were increasing except the thickness which is not change in comparison to the study done in Nigerian adults their ages ranged between 20 and 60 years which shown the following mean dimensions of splenic sizes, for the males; the mean splenic length, width, thickness, and volume were 11.1 cm (±0.9 SD), 4.4 cm (±0.5 SD), 7.8 cm (±0.6 SD), and 202.7 cm^3 (±49.4 SD), respectively, and for the females the corresponding values of splenic length, width, depth and volume were 10.1 cm (±0.7 SD), 4.0 cm (±0.4 SD), 7.1 cm (±0.5 SD) and 153.7 cm^3 (±33.2 SD), respectively this study done by(Nigerian Med J .2011 Jul-Sep) and also corresponding to the study done by (Toshio monohoshi) on 1977 which shown that the hemodialysed spleen seemed to be enlarged independently from the term or number of hemodialysis program.

5.2 Conclusion:

This study was done for 50 patients on hemodialysis for 5 years or more to evaluate the spleen volume, length, thickness and width, and even the echogenecity and heterogenecity. The results of the study concluded that there was an increasing in spleen volume comparing with normal range , and also there was an increasing in length and thickness comparing with normal range but the width in not significantly change due to the hemodialysis , because mostly due to the presence of the stomach and diaphragm from above and the left kidney from below . The measurement of the spleen (length , thickness and volume) all were increasing when the age was increasing ; furthermore there was decreasing in echogenecity when there was increasing in all measurements of spleen , also the homogenecity was decreased and changed to heterogenecity when there was increasing in all measurements of spleen .

Ultrasound scanning is most important to detect any change that may occur in spleen during long term of dialysis.

5.3 Recommendations:

After the counting of the results that related to the following thesis, there are some ideas which could help in more proper management and follow up of patient in long term hemodialysis and better to recommend the followings:

1. Ultrasound scanning could be used as routine investigation and follow up to help in treatment of chronic renal failure and hemodialysis patient. Ultrasound scanning is very important to end stage renal diseased patients to detect any complications in renal system and other organs .
2. Ultrasound department should be found in any renal center.
3. Further studies must be done to detect the long hemodialysis effect on the blood supply using Doppler ultrasound.
4. Study should be done on effect of hemodialysis on bones using x-ray, CT or MRI.
5. Need further research to detect any abnormalities that may occur in liver, parathyroid gland and heart related to hemodialysis.
6. More research should be done in this field using CT, MRI, Isotopic scanning and microscopic tools.
7. Further researches to study changes that may occur due to hemodialysis in other organs in the body.

References:

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Appendix

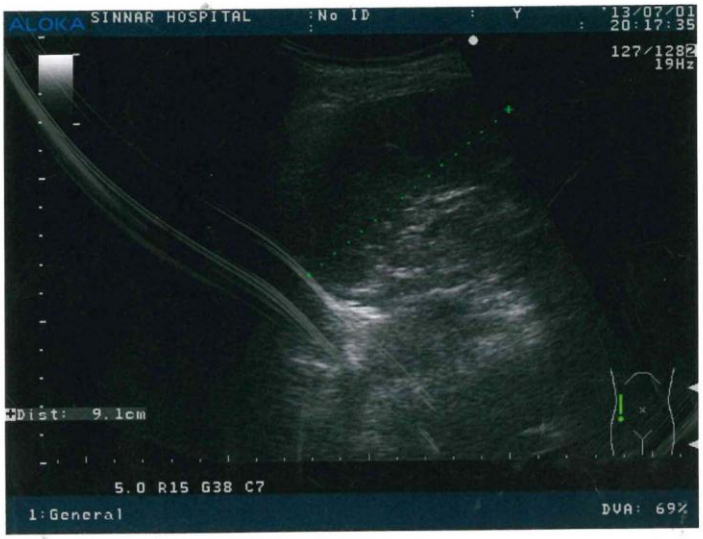
Data Collection Sheet (Master Sheet)

No	age	Sex	Length	Width	Thickness	Echo	Homo	Volume
1	38	1	13.3	7.8	7	1	1	379.79
2	65	1	14.7	8.2	7.5	3	1	472.82
3	30	1	10.6	6.3	5.6	1	1	195.58
4	47	2	13.8	8	6.7	3	1	386.85
5	36	2	10.3	6	5	1	1	161.60
6	45	2	13.4	7.5	6.6	1	1	346.90
7	15	2	11	6	5	1	1	172.59
8	23	2	8.4	5.4	4.5	2	1	106.75
9	22	2	11.3	6.5	5.6	1	1	215.12
10	54	2	13.9	8.2	7	3	1	417.28
11	60	2	14	8.2	7.7	3	1	462.31
12	44	1	9.3	5.6	5	1	1	136.19
13	35	1	10.5	6	5.3	1	1	174.63
14	33	2	9	5.7	4.9	1	1	131.47
15	50	1	13.5	7.8	6.8	1	1	374.49
16	30	1	14.5	8.5	8	3	2	515.68
17	56	2	13.4	7.8	6.6	1	2	360.78
18	29	2	9.7	6	4.6	1	1	140.02
19	33	1	9.5	6.2	5.1	1	1	157.10
20	60	1	13.9	8	7	1	1	407.10
21	35	1	8.9	5.8	5	1	1	134.99
22	45	2	9.8	6	5.3	1	1	162.99
23	50	1	14.2	8.5	8	3	1	505.01
24	70	1	15	8.5	7.8	3	2	520.12
25	60	1	14.2	8.1	7.4	3	2	445.15
26	55	2	14	8	7	3	2	410.03
27	48	2	13.7	7.8	6	1	2	335.33
28	20	2	8.8	5	4.5	2	2	103.55
29	50	1	9	5.9	5	1	1	138.86
30	37	1	13.8	8.4	7	1	2	424.38
31	29	2	10	6	5	1	1	156.9
32	30	2	9.1	5.2	4.9	1	1	121.27
33	26	2	11	6.2	5.3	1	2	189.04
34	27	1	10	6.1	5	1	2	159.52
35	58	1	13.5	8	7	1	2	395.39
36	57	1	14	8.4	7.3	3	1	448.99
37	39	1	17	9	8.3	3	1	664.16
38	48	2	10	6	5	1	1	156.90

39	57	1	9	5.6	4.9	1	2	129.16
40	55	2	9.3	5.8	5	1	1	141.05
41	40	2	10	6	5.2	1	1	163.18
42	50	1	13.7	8	7	1	2	401.25
43	60	1	14.1	8.4	7.4	3	1	458.39
44	25	1	8.5	5,5	4.8	1	1	117.36
45	45	1	10.3	6	5.2	1	2	168.07
46	30	2	9	5.6	5	1	2	131.80
47	60	2	13.9	8.3	7	3	1	422.36
48	27	1	10	6	5.1	1	2	160.03
49	40	2	13.7	8.2	7.3	3	2	428.90
50	24	2	9	6	5	1	1	141.21

equation (volume = length x width x thickness x.523)

1/SEX : 1=MALE, 2=FEMLE. 2/echogenicity: 1=isoechoic, 2=hyperechoic, 3=hypoechoic, 3/Homogenicity. 1=homogenous, 2=hetrogenous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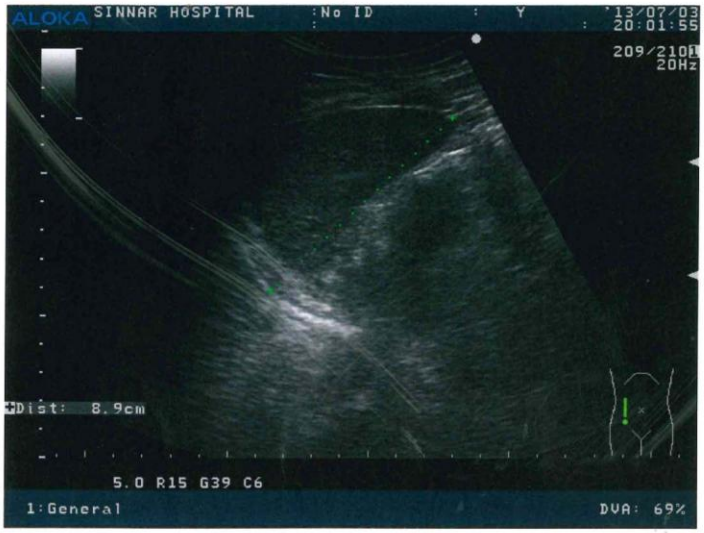
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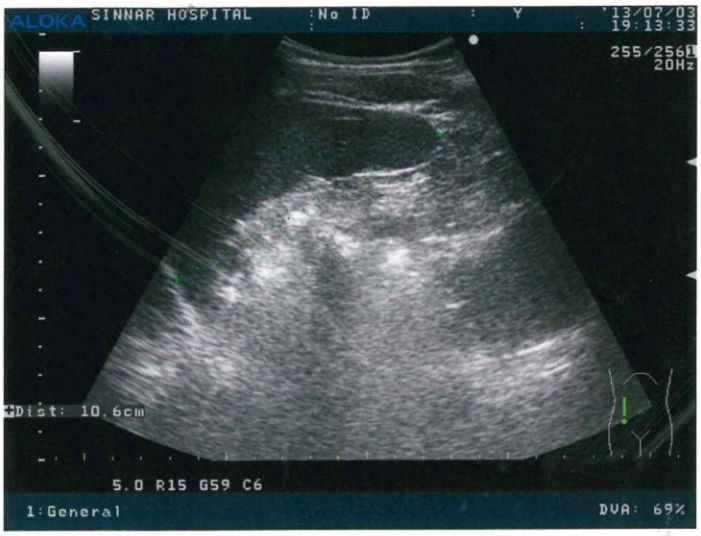
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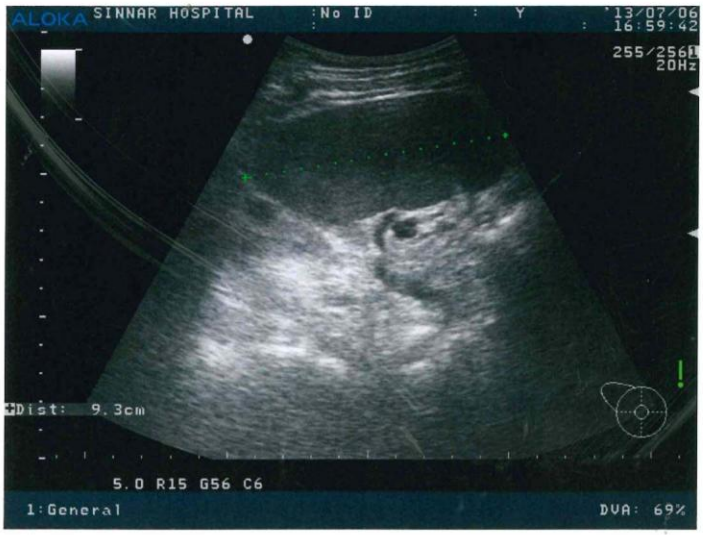
Lt 1
Spleen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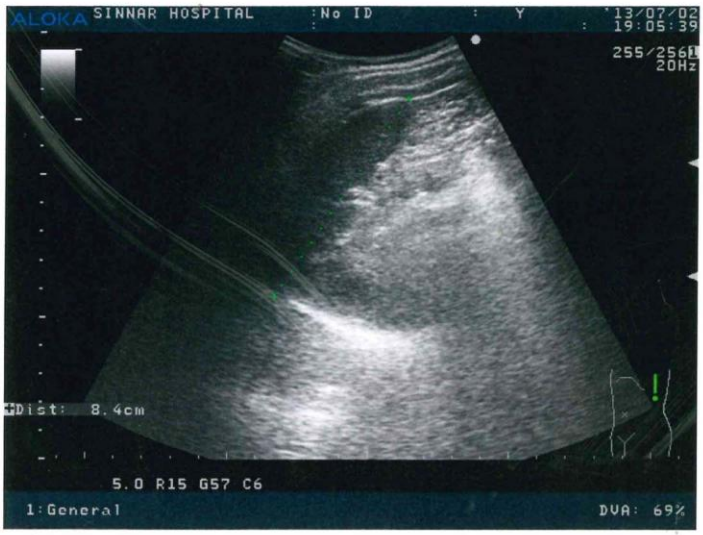
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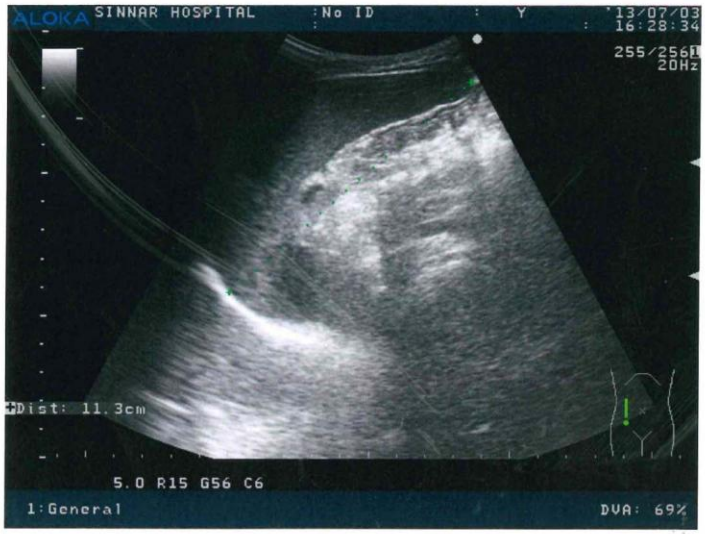
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no
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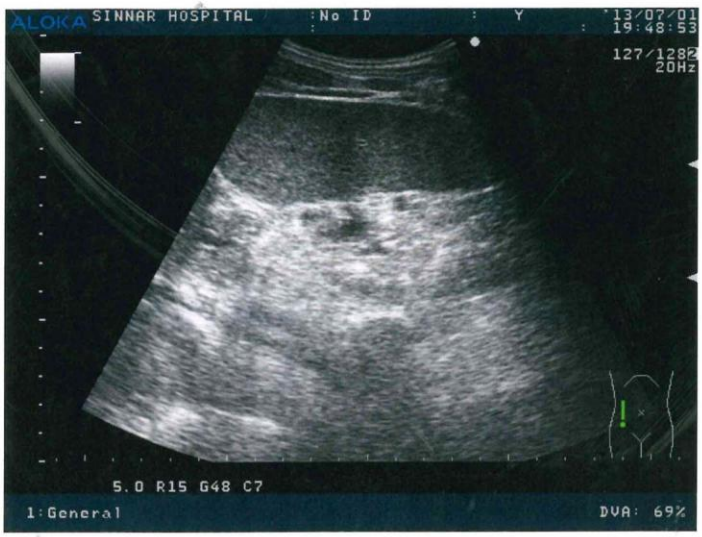
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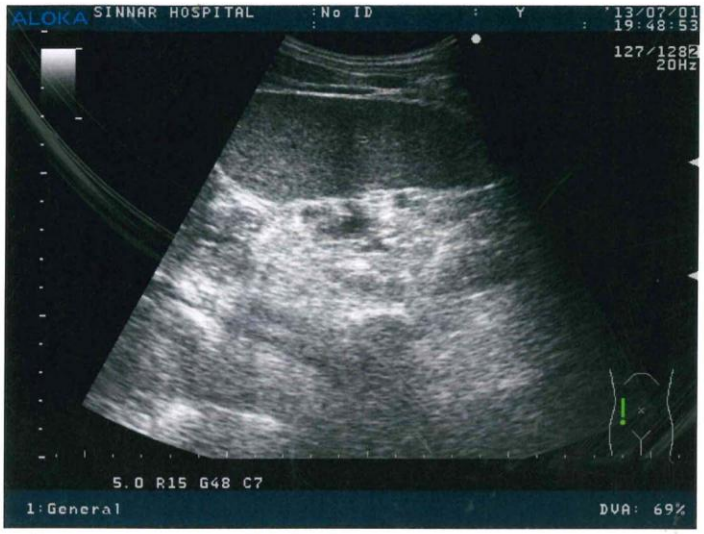
محمد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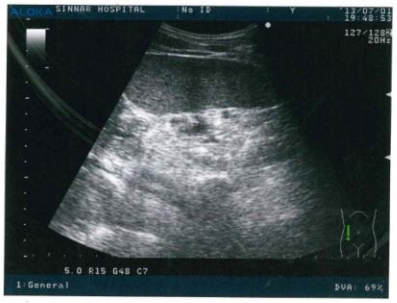
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