Sudan University of Science and Technology

College of graduate studies

Measurement of liver dimensions For Sudanese using computed tomography

قياس ابعاد الكبد للسودانيين باستخدام الاشعة المقطعية

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Dedication

First and last extend my thanks to allah , Who help us in the completion of this research alhamdollah (thank Got)

I would like to dedicate to my parent There is no doubt in my mind that without his continued support and counsel I could not have completed this process.

A special feeling of gratitude to Dr. Mona Mohammed Ahmed of encouragement and push for tenacity.

Acknowledgements

- ✓ ***I would like to thanks the inspirational instruction and guidance of Dr. Mona for given me a deep appreciation encouragement and love for the beauty and detail of this subject.***
- ✓ ***Thanks Dr. Sohaiebfor help in analysis of results, I would like to express my gratefulness.***

ABSTRASCT:-

This descriptive study, conducted in the state of Khartoum in the period from April 2016 till October 2016 Hospital Zitouna International Specialist, by checking researcher random sample of Sudanese patients and of 50 patients aged between 32 and greater than 65-year-old goal of a researcher in this study to measure the dimensions of liver Sudanese taking four dimensions the following the measurement of the human liver, , the anterior posterior dimension of the left hepatic lobe equals 0.54 5.28 ± cm. Transverse dimension of the right lobe equals 0.45 6.72 ± cm left hepatic angle the liver limit equal to 0.86 ± 45.22 ± degree transverse dimension of the caudate lobe equals 0.54 4.44 ± cm while the researcher found that the ratio between the caudate lobe to the right lobe equal to 0.14 ± 0.53.

By the end of the study, the researcher suggested that the Sudanese patient is characterized by the dimensions of the liver largest for what is mentiond in the references compared to the dimension of the anterior posterior lobe right, transverse dimension of the lobe Alvela and nook limit left to the liver in addition to the ratio between the lobe Alvela to the right liver lobe, where the accepted universally that the ratio between Alvela to the right prefrontal lobe equal to 0.37 ± 0.16, while he found a researcher mathematically equal to 0.54 ± 0.45 In addition, the researcher found that the anterior lobe of liver dimension rear left equals 0.54 5.28 ± cm while the global dimension of the anterior posterior lobe of liver left equal to 5 cm.

ملخص الدراسة :-

هذه دراسة وصفية ، أجريت في ولاية الخرطوم في الفترة من ابريل 2016 وحتي اكتوبر 2016 بمستشفي الزيتونة التخصصي الدولي ، بها فحص الباحث عينة عشواية من المرضي السودانيين وقدرها 50 مريضاً تراوحت اعمارهم ما بين 32 و أكبر من 65 عاماً هدف الباحث من خلال هذه الدراسة تحديد أبعاد الكبد لدي السودانيين أخذا اربعه ابعاد لقياس الكبد البشريه , وقد توصل الي الاتي , البعد الامامي الخلفي للفص الايسر يساوي0.54 ±5.28 سم . البعد العرضي للفص الايمن يساوي 0.45 ±6.72 سم زاوية الحد اليسر للكبد تساوي 0.86± 45.22± درجة البعد العرضي للفص الذيلي يساوي 0.54 ±4.44 سم بينما وجد الباحث النسبة ما بين الفص الذيلي للفص الايمن تساوي 0.14± 0.53

بنهاية الدراسة توصل الباحث الي ان المريض السوداني يتميز بأبعاد كبد أكبر عن ما مذكور بالمراجع مقارنة بالبعد الامامي الخلفي للفص الايمن , البعد العرضي للفص الذيلي و زواية الحد الايسر للكبد اضافة الي النسبة ما بين الفص الذيلي الي الفص الايمن للكبد حيث أن المتعارف عليه عالمياً ان النسبه ما بين الفص الذيلي الي الفص الايمن تساوي 0.37±0.16 بينما وجدها الباحث حسابيا تساوي0.54± 0.45 اضافة لذلك وجد الباحث ان البعد الامامي الخلفي لفص الكبد الايسر يساوي 0.54 ±5.28 سم بينما عالميا البعد الامامي الخلفي لفص

Abbreviations

CT	Computed tomography
HU	Hounsfield unit
MPR	Multi planer reconstruction
MIP	Maximum intensity projection
SSD	Surface shaded display
IV	Intravenous
AP	Anteroposterio
CAT	Computed axial tomography

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Chapter One

Introduction

Chapter One

1.1 Introduction

The liver size on CT is normally not greater than 15 cm in craniocauded diameter, The CT attenuation of the normal liver is 50 -70 HU within the underhanded liver and the portal vein branches and hepatic veins are seen as low attenuation linear branching structures gas in the billiary tree or in the portal venous system is readily detected by CT the later have a more peripheral distribution and this may extend to within two cm in the capsule. When IV contrast is given artery enhancement begins about 20 s after the start the injection but this can be timed exactly by a bolus tracking device, at 70 s the PV enhancement is optimal. (Valance et al, 1992)

Detection of hepatic abnormalities by computed tomography is dependent on differentiating normal from pathological altered hepatic tissue; abnormalities in the hepatic contour may permit detection of hepatic disease. But most abnormalities are identified on CT by visualizing regions of altered hepatic densities, of at least 10 HU between the normal and abnormal regions of the liver must be present for accurate detection of liver lesions. (Moss et al, 1992)

In conventional radiography, subtle difference of less than about 5 percent in subject contrast is not visible in the image. Each of these difficulties is eliminated in computed tomography. Differences of a few tenths of a percent in subject contrast are revealed in the CT image. With the display of anatomy across planes that are not accessible by conventional imaging techniques, make CT exceptionally useful for visualizing anatomy in many regions of the body. (. Hendee, 2002)

1972, the first head CT scanner was introduced, computed tomography has matured greatly and gained technological sophistication. The invention of the

scanner earned Godfrey Hounsfield of Britain and Allan South Africa the Nobel Prize for Medicine in 1979; Concomitant changes have occurred in the quality of images, it is one of the many technologies that were made possible by the invention of the computer. The clinical potential of CT became obvious during its early clinical use, and the excitement forever solidified the role of computers in medical imaging. CT was the first imaging modality that made it possible to probe the inner depth of the body, slice by slice(Moss et al , 1992)

CT scanner technology today is used not only in medicine but in many other industrial application,such as nondestructive testing and soil core analysis. (bushurg, 2002)

The introdction of spiral CT in the early 1990s constituted a fundamental evolutionary step in the development and ongoing refinement of CT- Imging technique. For the first time volume data could be acquired without the danger of misregistration or double registration of anatomical details. Image could be reconstructed at any position along the patient axis and overlapping image reconstruction could be used to improve longitudinal resolution. Volume data become the very basis for applications such as CT angiograph, which has revolutionized noninvasive assessment of development of three- dimensional image processing technique such as multiplanner reconstruction (MPR), maximum- intensity projection (MIP), surface shaded display (SSD) or volume rendering technique, which has become a vital component of medical imaging today.

(.flohr, 2006).

1.2 Research problem

There are no reference measurement values regarding liver dimensions in Sudanese.

1.3 Research objectives:-

- ***General Objectives:-***
  - To measure liver dimensions using CT.
- *Specific objectives:-*
  - To measure the left hepatic boarder angle.
  - To measure the anteroposterior diameter of left lobe.
  - To measure the transverse diameter of right lobe.
  - To measure the transverse diameter of caudate lobe.
  - To correlate the patient liver dimensions with age, height and gender.

ChapterTwo

Theoretical background and Literature review

Chapter Two

Theoretical background and literature reveiw

2.1LiverAnatomy

Liver is the largest gland in the body; It is situated in the upper and right parts of the abdominal cavity, occupying almost the whole of the right hypochondria, the greater part of the epigastria, In the mal it weighs from 1.4 to 1.6 kg, in the female from 1.2 to 1.4 kg. It is relatively much larger in the fetus than in the adult, constituting, in the former, about one-eighteenth, and in the latter about on2e thirty – sixth of the entire body weight. Its consistence is that of a soft solid; it is friable, easily lacerated and highly vascular; its color is a dark reddish brown .**(Lewis, 2000)**

2.1.1 Surfaces of the liver:-

The liver possesses three surfaces, superior, inferior and posterior:-

- *the superior surface:-* comprises a part of both lobes, and, as a whole, is convex, and fits under the vault of the diaphragm which in front separates it on the right from the sixth to the tenth ribs and their. **(Lewis, 2000)**

- cartilages, and on the left from the seventh and eighth costal cartilages. Its middle part lies behind the xiphoid process, is in contact with the abdominal wall. Behind this the diaphragm separates the liver from the lower part of the lungs and pleura, the heart and pericardium. It is completely covered by peritoneum except along the line of attachment of the calceiformligament .**(Lewis, 2000)**

- *the inferior surface:-* is uneven, concave, directed downward, backward, andtotheleft,ands in relation with the stomach and duodenum, the right colic flexure, and the right kidney and suprarenal gland . **(Lewis, 2000)**

the posterior surface:- is rounded and broad behind the right lobe, but narrow on the left. Over a large part of its extent it is not covered by peritoneum; this uncovered portion is about 7.5 cm. broad at its widest. Part, and is direct contact with the diaphragm .**(Lewis, 2000)**

2.1.2 Fossa of the liver:-

The liver possesses four fosses which are:-

- *the left sagittal fossa:-* is a deep groove, which extends from the notch on the anterior margin of the liver to the upper border of the posterior surface of the organ; it separates the right and left lobes. **(Lewis, 2000)**

- *theportal or transverse fissure:-* is a short but deep fissure, about 5 cm. long, extending transversely across the under surface of the left portion of the right lobe, nearer its posterior surface than its anterior border. And separates the quadrate lobe in front from the caudate lobe and process behind. It transmits the portal vein, the hepatic artery and nerves, and the hepatic duct and lymphatics. The hepatic duct lies in front
- and to the right, the hepatic artery to the left, and the portal vein behind .and between the duct and artery. **(Lewis, 2000)**

- ***the gall-bladder fossa:-***is a shallow, oblong fossa, placed on the under surface of the right lobe, parallel withthe left sagittal fossa. It extends from the anterior free margin of the liver to the right extremity of the portal. **(Lewis, 2000)**

- ***the inferior vena cave fossa:-***is a short deep depression, occasionally a complete canal in consequence of the substance of the liver surrounding the vena cava. It extends obliquelyup ward on the posterior surface between the caudate lobe and the bare area of the liver,undines separated from the portal by caudate process. On slitting open the inferior vena cave the orifices of the hepatic veins will be seen opening into this vessel at its upper part, after perforating the floor of this fossa . **(Lewis, 2000)**

2.1.3 Lobes of the liver:-

- ***right lobe:-***is much larger than the left; the proportion between them the begging as six to one. It occupies the right hypochondrium, and is separated from the left lobe on its upper surface by the falciform ligament; on it's under and posterior surface by the left sagittal fossa; and in front by the umbilical notch. It is of a somewhat quadrilateral from, its under and posterior surfaces begin marked by three fossa : the portal and the fossa for the gall- bladder and inferior vena cave, which separate its left part into two smaller lobes; the quadrate and caudate lobes The impressions on the right lobe have already been described. **(Lewis, 2000)**

- ***quadratelobe*:-**is situated on the under surface of the right lobe, bounded in front by the anterior margin of the liver; behind by the portal; on the right, by the fossa for the gall-bladder; and on the left, by the fossaFor the umbilical vein. It is oblong in shape, its anteroom-posterior diameter begin greater than its transverse. **(Lewis, 2000)**

- ***caudate lobe:-*** is situated upon the posterior surface of the right lobe of the liver, opposite the tenth and eleventh thoracic vertebra. It is bounded, below, by the portal; on the right, by the fossa for the inferior vena cava; and, on the left, by the fossa for the ductusvenosus . **(Lewis, 2000)**

- **left lobe:-**is smaller and more flattened than the right. It is situated in the epigastria and left hypochondriac regions. Its upper surface is slightly convex and is molded on the diaphragm; it's under surface presents the gastric impression and mental tuberoses. **(Lewis, 2000)**

2.1.4 Fixation of the Liver:-

Several factors contribute to maintain the liver in place. The attachments of the liver to the diaphragm by the coronary and triangular ligaments and the intervening connective tissue of the uncovered area,

together with the intime connection of the inferior vena cave by the connective tissue and hepatic veins would hold up the posterior part of the liver. **(Lewis, 2000)**

2.1.5 Relations of the liver:-

The body is in relation, by its upper surface, with the liver; by its under surface, with the commencement of the transverse colon; and farther back usually with the upper end of the descending portion of the duodenum, but sometime with the superior portion of the duodenum or pyloric end of the stomach. The funds is completely invested by peritoneum; it is in relation, in front, with the abdominal parietals, immediately below the ninth costal cartilage; behind with the transverse colon. The neck is narrow, and curves upon itself like the letter s; at its point of connection with the cystic duct it presents a well- marked constriction. **(Lewis, 2000)**

2.1.6 Blood supply of the liver:-

The liver is supplied by two main blood vessels on its right lobe:-

The hepatic artery and the portal vein. The hepatic artery normally comes off the celiac trunk. The portal vein brings venous blood from the spleen, pancreas, and small intestine, so that the liver can process the nutrients and byproducts of food digestion. The hepatic veins drain directly into the inferior vena cava.(jcran 1969)

2.1.7 Nerve supply of the liver:-

Innervations of the liver are accomplished from the solar plexus through sympathetic trunk and the vague nerve.(Bushkovich 2000)

2.1.8 Excretoryapparatus of the Liver:-

The excretory apparatus of the liver consists of * the hepatic duct, formed by the junction of the two main ducts, which pass out of the liver at the portal; *the gall-bladder, which serves as aresavoir for the bile; * the cystic duct, or the duct of the gall-bladder; and * the common bile duct, formed by the junction of the hepatic and cyst ducts.(Lewis 2000)

2.2 Liver physiology

The liver is an organ in vertebrates, including human. It plays a major role in metabolism and has a number of functions in the body including glycogen storage, plasma protein synthesis, and drug detoxification. It also produces bile, which is important in digestion. It performs and regulates a wide variety of high-volume biochemical reaction requiring specialized tissues.(Jcran 1969)

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The bile produced in the liver is collected in bile canaliculated, which merge from bile ducts. These eventually drain into the right and left hepatic ducts, which in turn merge to form the common hepatic duct. The cystic duct (from the gallbladder) joins with the common hepatic duct to from the common bile duct. Bile can either drain directly into the duodenum via the common bile duct or be temporarily stored in the gallbladder via the cystic duct. The common bile duct and the pancreatic duct enter the duodenum together at the ampoule of Voter. The branching of the bile ducts resemble those of a tree, and indeed term “billiard tree” is commonly used in this setting. (Jcran 1969)

The liver is among the few internal human organs capable of natural regeneration of lost tissue: as little as 25% of remaining liver can regenerate into a whole liver again. (Jcran 1969)

Hepatocytes acting as unpotential stem cells. There is also some evidence of bio potential stem cells, called oval cell, which can differentiate into either hepatocytes or cholangiocytes (cells that line bile ducts).(Jcran 1969)

The various functions of the liver are carried out by liver cells or hepatocytes and the most important functions of the liver are:

- the liver produces and excretes bile requires for dissolving fats. Some of the bile drains directly into the duodenum, and some is stored in the gallbladder.
- the liver performs several roles in carbohydrate metabolism and the most. important are:-
    - gluconeogensis (the formation of glucose from certain amino acids, lactate or glycerol)
    - glycogenolysis (the formation of glucose from glycogen)
    - glycogeneisic (the formation of glycogen from glucose)
    - the breakdown of insulin and other hormones
    - the liver is responsible for the mainstay of protein metabolism.
    - the liver also performs several roles in lipid metabolism:
    - cholesterol synthesis
    - the production of triglycerides (fats)
- the liver produces coagulation factors I (fibrinogen), II (prothrombin), V, VII, IX, X and XI, as well as protein C,Protein S and ant thrombin. (Jcran 1969)
- the liver breaks down hemoglobin, creating metabolites that are added to bile as pigment.(Jcran 1969)
- the liver breaks down toxic substance and most medicinal in a process called drug metabolism. This sometimes results in oxidation, when the metabolite is more toxic than its precursor. (Jcran 1969)
- the liver converts ammonia to urea. (Jcran 1969)

- the liver stores a multitude of substances, including glucose in the form of glycogen, vitamin B12, iron, and copper.(Jcran 1969)
- In the first trimester fetus, the liver is the main site of red blood cell production. By the 32nd weeks of gestation, the marrow has almost completely taken over that task.(Jcran 1969)

2.3 Liver pathology

2.3.1 Jaundice:-

Jaundice is one of the commonest presenting singe of liver disease. It is means simply a yellow discoloration of the skin and sclera and is caused by increase the amount of bilirubine circulating in serum (normal range = 5 to 17 micro m1/lit).(Thompson 1983)

Bilirubine is the main waist product of the breakdown of the them component of heamgolbine and the other ham proteins and is therefore mainly derived from red blood cells which are sequestered by the reticuloendothelial system at the end of their life span and the most important types of jaundice are:).(Thompson 1983)

- ***hemolytic jaundice:-***
- the least common form of jaundice is that duo to increase red cell destruction, which increases the bilirubine serum levels (i.e.68 micro mo1/lit).).(Thompson 1983)
- ***hepatocellular jaundice:-***
  - the liver cells damage by infections, toxins, immune processes or tumor may cause jaundice by interrupting the transport, conjugation or excretion of bilirubine by hepatocyte.).(Thompson 1983)
  - ***obstructive jaundice:-***
    - Jaundice may occur as part of the process of cholestasis which means literally stagnation of bile. This is caused by obstruction to the flow of bile at any stage between the bile canailles and the entry of the bile duct into the duodenum at the ampoule of voter. The causes are Multiple and the condition is classified into extra hepatic billiard obstruction, intrahepatic mechanical obstruction and intrahepatic cholestasis without mechanical obstruction. ***extra hepatic billiard obstruction,** the major causes are

gallstones and tumors. Gallstones may lodge in the common bile duct lead to jaundice. Carcinoma of the pancreatic head, stomach, bile duct itself may lead to obstructive jaundice. ***intrahepatic mechanical obstruction,** widespread intrahepatic duct obstruction is required to produce jaundice in this way. In cystic fibrosis plugging bile ducts by inspissated mucus may occur. Sclerosing cholangitis may be intrahepatic and may cause obstructive jaundice. ***intrahepatic cholestasis without mechanical obstruction,** pure cholestasis without a mechanical block is un common but may occur with certain drugs and is will recognized in pregnancy and a being recurrent cholestasts in which there repeated self –limiting episodes of jaundice and fever without demonstrable disease of the liver parenchyma.).(Thompson 1983)

2.3.1.1 Diagnosis of obstructive jaundice:-

Obstructive jaundice is suggested by the association of dark urine and plea stool because of diversion of pigment from the gut to the blood stream and hence to urine. The accurate diagnosis is by imaging technology, ultrasound, and computed tomography.).(Thompson 1983)

2.3.2 Liver cirrhosis:-

2.3.2.1 Definition:-

It is diffuse, chronic, progressive liver disease characterized by Fibrosis regenerating nodules, and loss of lobular pattern.).(Thompson 1983)

2.3.2.2Additional features:-

Severe necrosis and inflammation occur in progressive (decompensate) cirrhosis, while compensated cirrhosis contains no necrosis with less inflammation.(Kowalczyk 1999)

2.3.2.3 Classification:-

- micro nodular: nodular size between 3-5 mm with fine fibrous tissue bands separating nodules.
- micro nodular: nodular size between 5 mm with thick fibrous bands (scar) separating nodules.
- mixed: starts as micro nodular and some become macro nodular→

Mixed.(Kowalczyk 1999)

2.3.2.3.1 Etiological classification

- viral: most common cause in our region.
- alcoholic: most common cause in western countries.
- biliary: either primary or secondary.
- hemochromatosis (iron overload).
- wilson's disease (copper accumulation).
- alpha 1 antitrypsin deficiency: enzyme is retained in hepatocyte and become deficient in serum.
- cryptogenic cirrhosis . (Kowalczyk 1999)

2.3.2.4 Complications of cirrhosis:-

- liver failure.
- portal hypertension: due to:
  - capillarization of sinusoid.
  - regenerating nodules which compress blood vessels.

- fibrosis.
- formation of Porto-systemic shunt inside the liver itself.(Kowalczyk 1999)

- hepatocellular carcinoma:-

Necrosis stimulates viable cells regeneration (compensation) that may causes hyperplasia and finally neoplasia. (Kowalczyk 1999)

2.3.2.5 Clinical presentation of cirrhosis:

All forms of cirrhosis are silent (asymptomatic). If symptomatic, it lead to non- specific symptoms **including:**

- anorexia.
- weight loss.
- weakness.
- frank debilitation in advanced cases. (Kowalczyk 1999)

2.3.3 Hepatitis:-

Hepatitis is relatively common liver condition, with an estimated 70,000 cases reported annually. A virus causes acute inflammation of the liver and interface with the liver's impaired ability to excrete bilirubine, the orange or yellowish pigment in bile. Evidence of the disease is seen by nausea, vomiting, discomfort, and tenderness over the liver area, and laboratory results indicate a disturbance in liver function. Jaundice may be developed within 1 or 2 weeks because disturbance of billirubine excretion. If the liver inflammation lasts 6 months or more, the condition is classified as chronic. Different viruses give rise to three types of a viral hepatitis, with their names describing the usual method of transmission and they are. (Kowalczyk 1999)

2.3.3.1 Hepatitis A: infectious hepatitis is excreted in the GI tract in fecal material and is plead by contact with an infected individual, normally through ingestion of contaminated food or water. It is the most common from and highly contagious. The incubation period of the disease is relatively short (15 to 50 days), and its course is usually mild. (Kowalczyk 1999)

2.3.3.2 Hepatitis B:-serum hepatitis, it transmitted parent rally in infected serum or blood products, its incubation period is much longer (50 to 160 days) and its effects more severe than those of hepatitis A. hepatitis type B can result in an asymptomatic carrier state, acute hepatitis, chronic hepatitis, cirrhosis, and Hepatocellular carcinoma. (Kowalczyk 1999)

2.3.3.3 Hepatitis C:- is non – A, non – B, and is caused by a parent rally transmitted RNA virus, type C account for 90% of the cases of hepatitis that develop after blood transfusions. Recently, a routine test for anti-hepatitis C antibody has been developed, so transmission via transfused blood has been significantly decreased. Hepatitis C can cause either acute or chronic hepatitis, with 10% to 20% of these patients eventually developing cirrhosis of the liver.(Kowalczyk 1999)

- the diagnosis of viral hepatitis is usually made through laboratory teeing because the disease is carried in the bloodstream during the acute phase. Evidence of hepatitis may be seen radio graphically on a plain film of the abdomen that demonstrate hepatomegaly, although this non specific finding. Cellular necrosis can be confirmed through nuclear medicine scanning of the liver, CT, or liver biopsy US is useful in distinguishing the characteristics of the liver. (Kowalczyk 1999)
- viral hepatitis is usually mild; the majority of patients recover without complications, treatment generally consists of bed rest and medication to fight nausea and vomiting, in healthy individual, the liver regenerates

after hepatitis damage, and complete recovery is gained. Approximately 10% of patients with type B and 60% of type C progress into chronic hepatitis. In some, the disease may become progressive and lead to liver failure. (Kowalczyk 1999)

2.3.4 Hepatic failure:-

2.3.4.1Definition:-

It is failure of liver to perform its function when 80-90% of liver capacity is lost as a result of acute or chronic liver damage, with 70-95% mortality rate. (Montaser 2003)

2.3.4.2 predisposing factors:-

- (GIT) hemorrhage, due to portal hypertension **leading to:-**
  - Absorption of toxic substance to liver from intestine.
  - Post- hemorrhagic anemia.
- systemic infection.(Montaser 2003)
- (CHF) (chronic heart failure).(Montaser 2003)
- electrolyte imbalance.(Montaser 2003)
- stress (e.g. major surgery, heart failure).(Montaser 2003)

- massive, and sometimes sub-massive, hepatic necrosis due to drugs or viral hepatitis (hepatortropic and non-hepatotropic viruses which lead to fulminate hepatitis).(Montaser 2003)
- chronic liver diseases as cirrhosis, and chronic hepatitis. However, chronic liver diseases are considered as the most common route to hepatic failure. (Montaser 2003)
- no apparent liver necrosis as Reye syndrome, acute fatty liver of pregnancy, and tetracycline toxicity in which, there is micro vesicular

fatty change with no necrosis leading to biochemical hepatic dysfunction. (Montaser 2003)

2.3.4.2.3 Benign Liver Lesions:-

Benign lesions of the liver may present clinically with symptoms due to mass effect or to vascular complications, or may be discovered incidentally during surgical exploration or imaging evaluation for other clinical indications. Given the increased access to midcap care, the latter instance, namely discovery of incidental focal lesions of the liver at imaging techniques, the most important types are. (Bartolozzi 2003)

2.3.4.2.4 liver Cyst:-

Simple hepatic or congenital cysts are benign developmental lesions that do not communicate with the biliary tree. They seem to originate from hamartomatous tissue. Hepatic cysts are a common finding, being found in 1%-3% of routine liver examination. They are more often discovered in women and are usually asymptomatic; rarely may they cause pain, and symptoms disappear after percutaneous aspiration. Simple hepatic cysts can be solitary or multiple. Their size is very variable, although they are frequently less than 5 cm. they tend to increase in number and size with age. Usually they have a serious content, rarely they may present as “complicated” cysts due to the presence of hemorrhage or inflammation.(Bartolozzi 2003)

On non-enhanced CT scans a hepatic cyst appears as a round or ovoid weal-defined lesion, with no evident wall. It has ashomogeneouse and hypo attenuating content with attenuation valises similar to water (< 20 HU). After contrast media injection, both the wall and its content do not show any enhancement. Higher attenuation values (< 20 HU) are present in cyst with hemorrhage or inflammation inside; in these cases".(Bartolozzi 2003)

Complicated "cysts are difficult to differentiate from metastases arising from cystic carcinomas (as pancreatic or ovarian ones).(Bartolozzi 2003)

2.3.4.2.5 Liver Hemangioms:-

Hemangioma is the most common benign hepatic tumor. The prevalence of hemangioma in the general population ranges from 1% - 2% to 20%. The female – to male ratio varies from 2:1 to 5:1. They occur at all ages. The vast majority of hemangiomas remain clinically silent. Few patients are symptomatic due to a mass lesion, complication or compression of adjacent structures. Most of these symptoms are observed in large hemangiomas. The natural history of hemangiomas is variable: most of them remain stable, some may grow or involutes. The role of sex hormones in causing enlargement during pregnancy or recurrence is deputed. (Bartolozzi 2003)

Hemangiomas are usually solitary, less than 5 cm in size and appear as well-delineated lesions of red color that partially color that partially collapse on sectioning. A few are pedunculated. Giant hemangiomas (often defined as 10 cm or larger) are heterogeneous and show varying degrees of fibrosis and calcification. Some Hemangiomas may become entirely fibrous.(Bartolozzi 2003)

Microscopically, hemangiomas are composed of blood –filled spaces of variable size and shape and are lined by a single layer of flat endothelium.(Bartolozzi 2003)

The septa between the spaces are often incomplete. Blood vessels and arteriovenous shunting may be seen in large septa.(Bartolozzi 2003)

Strict criteria for the diagnosis of hemangioma were described before the most recent technical advances in CT. These criteria were:

- Low attenuation on non-contrast CT

- Peripheral enhancement of the lesion followed by a central

Enhancement was observed in 43% - 54% hemangiomas and 4% - 14% of malignant tumors; globular enhancement in 46% - 49% and 0% - 2% respectively. So, small hemangiomas frequently show atypical appearances at CT resulting in a decrease in sensitivity compared to larger hemangiomas but specificity remains high.(Bartolozzi 2003)

2.3.6 Malignancies of the liver:-

2.3.6.1hepatocellular carcinoma:-

Hepatocellular carcinoma (HCC) is a major health problem worldwide due to its high incidence (approximately 600, 000 new cases in 2000), and severe natural history. Indeed, the incidence and mortality rates associated with this disease significantly overlap worldwide. The identification of chronic liver disease as the relevant risk factor for this tumor has made surveillance aimed at early detection of HCC possible and surveillance is now universally recognized to be the practical approach for improving the treatment of HCC patients. (Bartolozzi 2003)

2.3.6.1.1Diagnosis and Staging of Hepatocellular:-

Carcinoma:-

Diagnostic confirmation and careful staging of the patient with hepatocellular carcinoma (HCC) are key aspects for establishing the patient's prognosis and planning an appropriate treatment. (Bartolozzi 2003)

For years, the diagnosis of HCC was based mainly on percutaneous biopsy and accurate tumor staging required invasive procedures, such as angiography or angiographic ally assisted techniques. Currently, owing to the advances in imaging modalities, a reliable diagnostic assessment can be based in most instances on noninvasive examinations in combination with clinical and laboratory findings ultrasound (US) is widely accepted.(Bartolozzi 2003)

2.3.6.1.2 Hepatic Metastases:-

Metastatic disease in the liver represents one of the most common problems in oncology. The liver provides a fertile soil for metastases, especially due to its dual blood supply from the systemic and splanchnic system. The liver is second only to regional lymph nodes as a site of metastatic disease. Metastatic disease is unknown, because most figures are based on autopsy. (Bartolozzi 2003)

The early detection of liver metastases is of paramount importance in paramount importance in patients suffering from liver malignancies. In most malignancies, the presence of liver metastases indicates non-respectability of the primary tumor for oncologic reasons. In these patients, chemotherapy may be sought. On the other hand colorectal cancer is the prototype of malignant disease, in which the presence of limited metastatic disease does not preclude surgery. Exact knowledge of number, localization and size of metastases is crucial to evaluate the liver must achieve accurate depiction and characterization of both focal and diffuse processes. Additionally, they should provide information on segmental and vascular anatomy to facilitate treatment planning. (Bartolozzi 2003)

2.4 CT Machine

Computed tomography (CT), sometimes called "computerized tomography" or "computed axial tomography" (CAT), is a noninvasive medical examination or procedure that uses specialized X-ray equipment to produce cross-sectional images of the body. Each cross-sectional image represents a “slice” of the person being imaged, like the slices in a loaf of bread. These cross-sectional images are used for a variety of diagnostic and therapeutic purposes.

CT scans can be performed on every region of the body for a variety of reasons (e.g., diagnostic, treatment planning, interventional, or screening). Most CT scans are performed as outpatient procedures (Jiang,2009)

- A motorized table moves the patient through a circular opening in the CT imaging system.
- While the patient is inside the opening, an X-ray source and a detector assembly within the system rotate around the patient. A single rotation typically takes a second or less. During rotation the X-ray source produces a narrow, fan-shaped beam of X-rays that passes through a section of the patient's body.
- Detectors in rows opposite the X-ray source register the X-rays that pass through the patient's body as a snapshot in the process of creating an image. Many different "snapshots" (at many angles through the patient) are collected during one complete rotation.
- For each rotation of the X-ray source and detector assembly, the image data are sent to a computer to reconstruct all of the individual "snapshots" into one or multiple cross-sectional images (slices) of the internal organs and tissues (Buzug,2008)

2.5 Liver Technique

2.5.1 Liver Tri –phase

Dynamic CT is an established method for the differentiation of focal liver lesions by monitoring the contrast enhancement. It is especially restricted in the assessment of small and multiple lesions due to respiratory organ movements. Spiral-CT allows the examination of large volumes in the breath hold technique. Spiral-CT with controlled i.v. contrast media administration can be used for the assessment of the entire liver in distinct phases of perfusion. We describe the use of this new technique in a patient with multifocal nodular hyperplasia (FNH), for whom assessment with dynamic CT was not suitable. The lesions were first located with a conventional contrast-enhanced CT-scan. The impossibility to assess all the lesions with dynamic CT led to the decision to perform a three-phase spiral-CT with three sequential scans (native, arterial, and portal perfusion phase). The entire liver was scanned after power injector-controlled i.v. administration of contrast media with the following parameters. (Subburaj , 2011)

* arterial phase: 70 ml contrast media, 2 ml/s, start delay 18 s; 2) portal phase: 80 ml contrast media, 2 ml/s, start delay 60 s; slice 8 mm, table feed 8 mm, increment 4 mm; 24 s of breath hold data acquisition.(Marchal,2005)

2.2 previous study

2.2.1 Benjamin EffiongUdoh et al, 2011 had studied zoographic Assessment of Liver Size in Healthy South East Nigerians The aim of this study was to determine the normal liver size of a large selected population and to establish a possible reference values for the selected population, Two thousand six hundred and two (2062) apparently healthy subjects were enlisted in the study. There were 1061 males (age range, 27-80 years mean age 40.1+14.0 years) and 1001 females (age range \, 20-62 years, mean age, 31.6 +11.3years). Liver sizes of the subjects were measured zoographically in the mid clavicles line to determine the AP and longitudinal diameters.

> The mean AP diameter of the liver in the entire population was 14.2 ± 2.62 cm.when correlated with physical data sex, body mass index, height and weight had a positive and significant correlation with liver size. Males had larger liver sizes than Females (14.70 versus 13.10cm,p<o.001)
>
> The result demonstrates that liver sizes increase with age up to about 50 years when decrease in the sizes of the liver is noticed progressively. The results also show that males had larger liver sizes then females.

2.2.2 Sachit K. Verma et al, 2010 had studied Simple linear measurements of the normal liver Inter observer agreement and correlation with hepatic volume on MRI.

> All patients had normal liver function. The final study group consisted of 116 patients (40 men, 76 women; age range 16-89, mean; 55.5 years)
>
> Study was concluded that linear hepatic dimensions (expressed as mean ± standard **deviations):**

Product of MHP CC with MHP AP dimensions ranged from 79.70 to 312.87 cm^2 (mean 183.13 cm^2± 47.07 cm^2) and of Max CC with MHP AP dimensions ranged from 98.03 to 467.99cm^2 (mean 265.58 ± 68.26 cm^2). 113 (96%) patients had MHP CC dimension of 16 cm or less (mean 12.2 cm; 7.1-16 cm). 33 (28%) patients has Max CC dimension of 16 cm

2.2.3 Emad S .Tarawneh et al, 2007 had studied Ultrasounds Measurement of liver Span in Jordanian Adults.

The study were to establish a normal figure of liver span for adults in Jordan.population sample of 242 male and 275 female adults with age range of 18-76 years. Statistical analyses including correlation, regression were performed on the data to test the statistical significance of the various relationships between liver span as represented by midclavicle line longitudinal diameter on one side, and several anthropometric factors including age, gender, Wight, height, body mass index and body surface area.

2.2.4 Moammed saad Eldin, 2012 studies CT measurement of the dimension of the liver the aim of study were the measurment sudanese dimension of the normal liver and take the 50 patients's 25 male and 25 femal in the Jarash interanational Hospital in khartoum.He found dimensions following the measurement of the human liver , the anterior posterior dimension of the left hepatic lobe equals 1.216.09 ± cm. Transverse dimension of the right lobe equals 1.38.21 ± cm left hepatic angle the liver limit equal to 10.39 ± 46.33 ± degree transverse dimension of the caudate lobe equals 1.12 4.32 ± cm while the researcher found that the ratio between the prefrontal lobe Alvela right equal to 0.14 ± 0.53.

ChapterThree

Material and Methods

Chapter Three

Material and Methods

3.1 Material:-

3.1.1 Patients:-

The entire populations of this study were 50 patients, 31 patients were males and 19 patients were females; those patients had a variety of ages, ranged from 32 and greater than 65years old, patients had been reported having a normal liver tomograms as well as the attenuation coefficients in normal ranges.

❖ Dependent variables:

- Anterioposterior diameter of left lobe.
- Transverse diameter of right lobe.
- Transverse diameter of caudate lobe.
- Left hepatic boarder angle.

❖ Independent variables:

- Patient age.
- Patient gender.
- Patient height.
- Ct finding

3.1.2 Machines:-

- TOSHIBA,Aqulion cx 64 slice.
- Power injector, Madrid, sealant, dual piston.

3.2 Method:-

.

3.2.1 Method of Hepatic measurements:-

The following measurements of the liver were performed independently :

- Left hepatic boarder angle.
- Anteroposterior diameter of left lobe.
- Transerse diameter of right lobe.
- Transerse diameter of caudate lobe.

3.2.2 Computed tomography Protocol (technique) :-

The patient undergoes an abdominal CT. with contrast, the departmental protocol states the the –volume of the Omnipaque (Iohexl 300mg I/m1) is 100 m1, injected using a power injector with a flow rate of 4.5 m1/ second.

The patient is ordered to be fasting for at least 4 hours before the exam, at the department the patient is instruced to drink an oral contrast (Ominpaque 300 mg I/m1) of a volume of 2 liters over a period of 2 hours.

3.2.3 Data collection and analysis:-

Using a metric tab the patient height per centimete is recorded on a data collection sheet in addition to patient gender and age.

CT data sets were transferred to a dedicated 3D workstation (Vitrea 2), the plane of the horizontal component of the main portal vein was identifed which correlate to second lumber vertebrae and used as a reference point for measurements.

The data were tabulated on Statistical Package for Social Sciences (SPSS) spreadsheets version 18 and Microsoft excel 2010, which in addition to liver size data included the age, gender, and height of the study population

3.2.4 Area of the study:-

The study had been done in Khartoum state; the patients were randomly selected at Al Zaitona International Specicalized Hospital April 2016 to October 2016.

Chapter Four

Results

Chapter Four

Results

Table 4.1 show statistical parameters of all patients:

	Mean	Median	STD	Min	Max
Age	47.54	48	9.78	31	65
Body weight	74.02	76	5.95	64	87
Body high	173	175.5	7.85	154	188
Lt hepatic Angle	45.22	45	0.86	43	46
AP diameter H.L	5.28	5	0.54	5	6
CL	4.44	4	0.54	3	5
RL	6.72	7	0.45	6	7

Table 4.2 show statistical parameters of Male patients:

	Mean	Median	STD	Min	Max
Age	47.68	45	10.38	32	65
Body weight	75.26	76	5.62	65	86
Body high	174.52	176	6.87	164	188
Lt hepatic Angle	45.71	46	0.46	45	46
AP diameter H.L	5.45	5	0.50	5	6
CL	4.74	5	0.44	4	5
RL	6.87	7	0.34	6	7

Table 4.3 show statistical parameters of Female patients:

	Mean	Median	STD	Min	Max
Age	47.32	48	8.97	31	60
Body weight	72	70	6.06	64	87
Body high	170	169	6.06	64	87
Lt hepatic Angle	44.42	44	0.76	43	46
AP diameter H.L	5	5	0.00	5	5
CL	3.95	4	0.229	3	4
RL	6.47	6	0.51	6	7

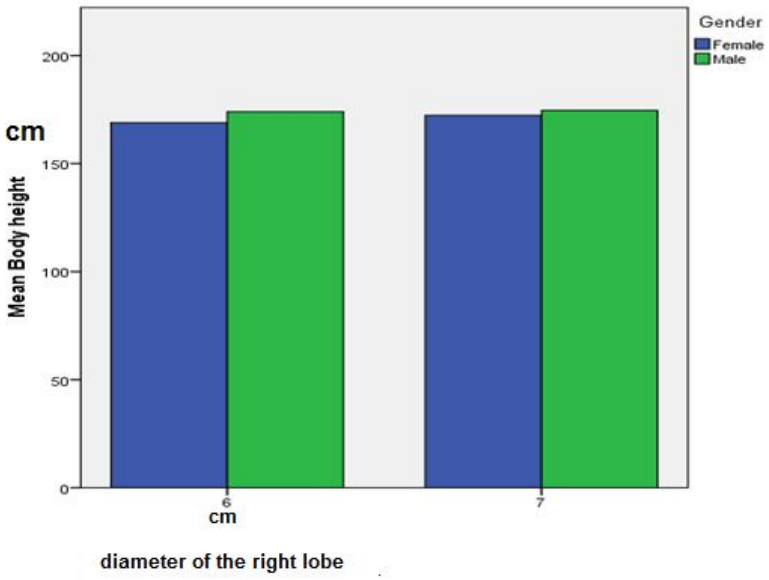

Figure 4.1 show Correlations between length of the Right lobe and Body high according to gender

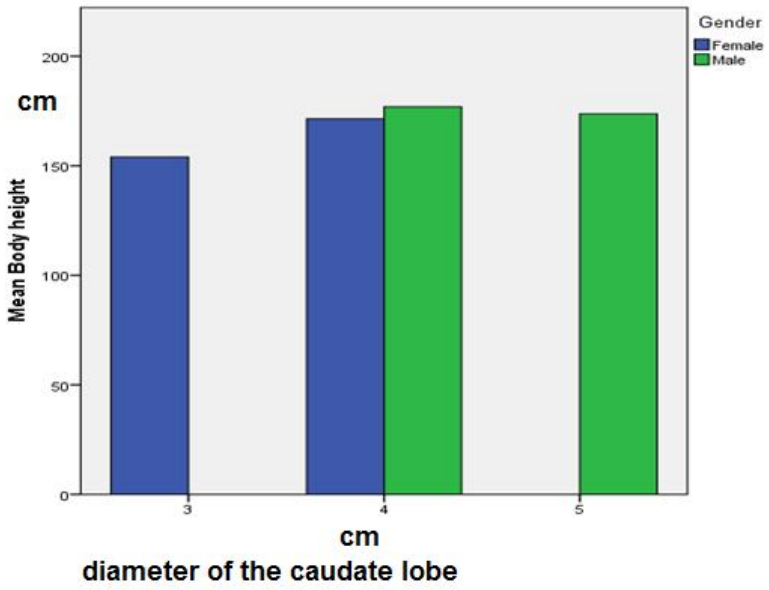

Figure 4.2show Correlations between length of the Caudate lobe and Body high according to gender:

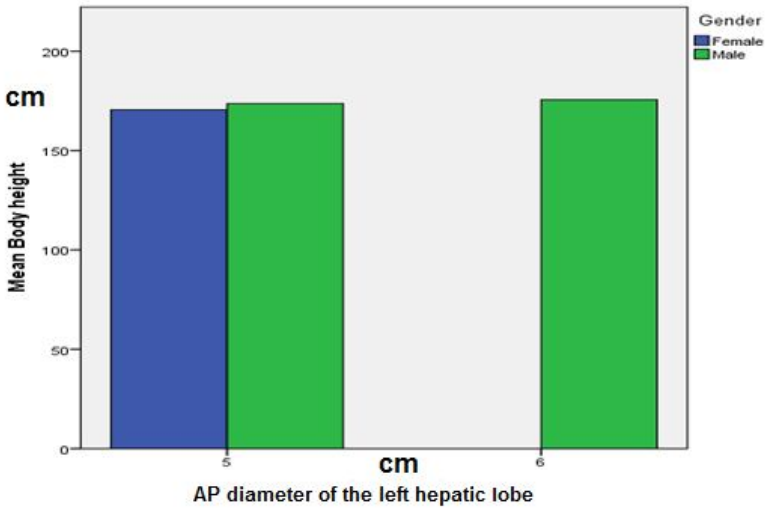

Figure 4.3 show Correlations between AP diameter hepatic lobe and Body high according to gender:

:

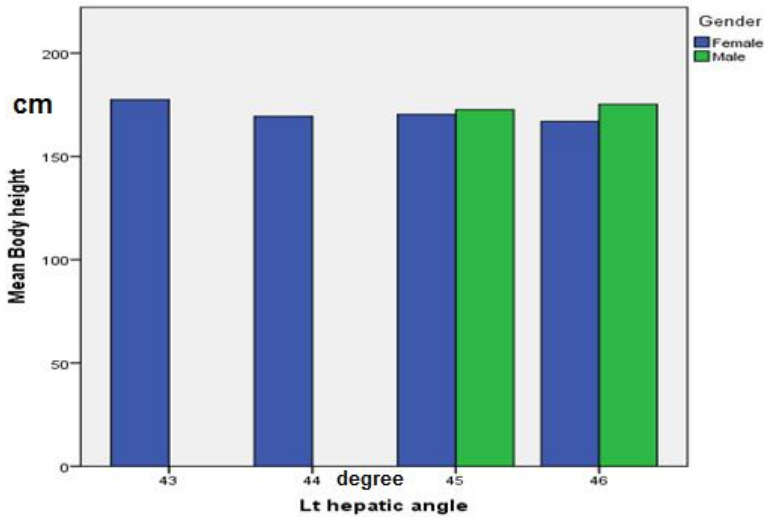

Figure 4.4 show Correlations between Left hepatic angle and Body height according to gender

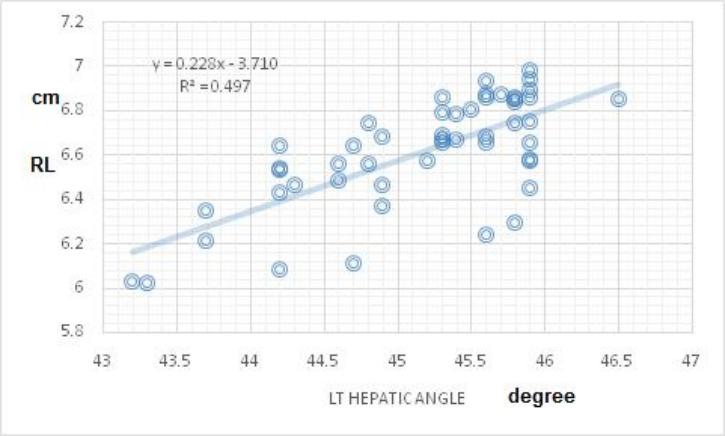

Figure4.5 show correlation between Left hepatic Angle with diameter of the Right lobe

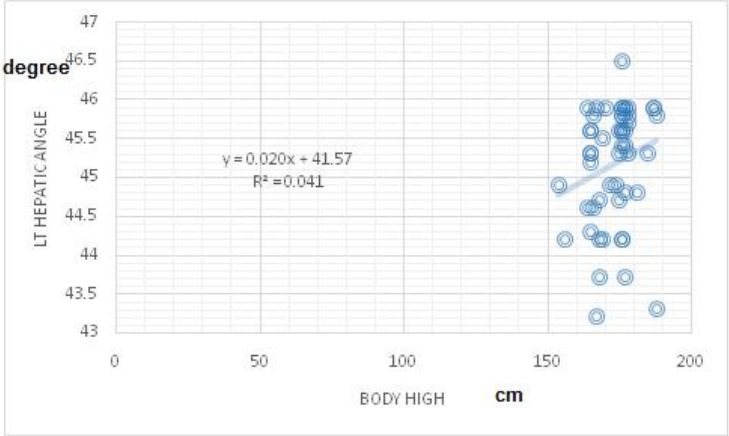

Figure 4.6 show correlation between Left hepatic Angle with body height

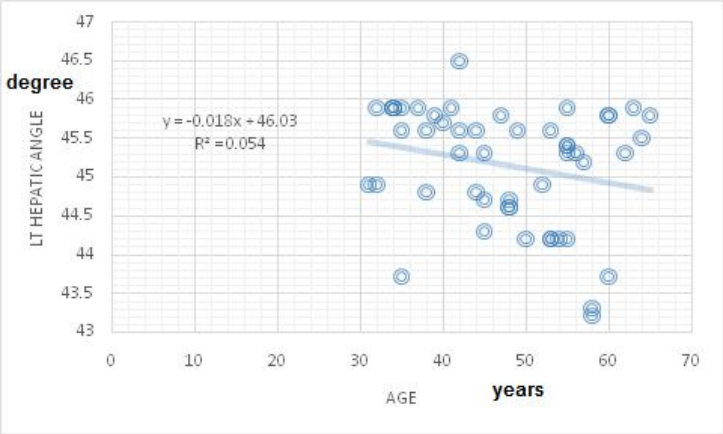

Figure 4.7 show correlation between Lt hepatic Angle with Age

Chapter Five

Discussion, Conclusion and Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5.1 Discussion

This study showed parameters for all patient using mean, median,SD,Min, Max and for age the mean ± SD was (47.54 ± 9.78) and for body weightwas (74.02kg ± 5.95kg) , body height was (173 cm ± 7.85cm) ,left hepatic Angle was($45.22^0 \pm 0.86^0$), AP diameter of the left hepatic lobe was (5.28 cm± 0.54 cm), diameter of the caudate lobe was(4.44 cm ±0.54 cm) and diameter of the right lobe was(6.72cm ± 0.54 cm) in (table 4.1) , showed just for male patient using mean, median, SD , Min , Max was body weight (75.26kgm ± 5.62kgm), body height is(174.52 cm ± 6.87 cm) , left hepatic angle was ($45.71^0 \pm 0.46^0$) , AP diameter of the left hepatic lobe was(5.45 cm ± 0.50 cm) , diameter of the caudate lobe was (4.74 cm ± 0.44 cm) and diameter of the right lobe was (6.87 cm ±0.34 cm) in (table 4.2) ,showed parameters of female patient using Mean, median, SD, Min, Max was body weight was (72kgm ± 6.06kgm) , body height was (170cm ± 6.06 cm) , left hepatic angle was ($44.42^0 \pm 0.76^0$) , AP diameter of the left hepatic lobe was (5 cm ± 0 cm) , diameter of the caudate lobe was (3.95 cm ± 0.229 cm) and diameter of the right lobe was (6.47 cm± 0.51 cm) in (table 4.3) , showed correlation between length of the right lobe and body height with the gender were the value appearance way 6cm and 7cm was high in male than female and 7 cm was almost equal for both gander that mean males had larger liver size than females that also found researcher Benjamin effiongudoh(2011) (figure 4.1) , showed correlation between length of the caudate lobe and

body height with gender were the range of length 3– 5cm were in 3 cm was a female just , and for 4 cm was for both and 5cm for just male. that mean when increased the height patient increased the liver dimension and males had larger liver size than females that also found researcher Benjamin effiongudoh(2011) (figure 4.2) , showed correlation between AP diameter hepatic lobe and body height according to gender were 5cm to both female and male and 6 cm just for male that mean when increased the height patient increased the liver dimension and males had larger liver size than females that also found researcher Benjamineffiongudoh(2011) (figure 4.3) , showed correlation between left hepatic angle and body height according to gender were the angle 43^{o} for female and 44^{o} also for female and 45^{o} for both female and male and 66^{o} also for both female and male that mean when increased the height patient increased the liver dimension and males had larger liver size than females that also found researcher Benjamin effiongudoh(2011) (figure 4.4) , showed correlation between it hepatic angle with RL were the value of relation (R^2=0.497) which mean, there is moderate relation between left hepatic angle and right lobe which mean moderate relation in (figure 4.5) , showed correlation between Lt Hepatic angle with height were the value of relation (R^2=0.41) which mean them is weak relation in (Figure 4.6) and showed correlation between left hepatic angle with Age were value of relation (R^2 = 0.054) which mean there is weak relation in (Figure 4.7)

5.2 Conclusion:-

By the end of the study, the researcher suggested that the Sudanese patient is characterized by the dimensions of the liver largest for what is mentiond in the references compared to the dimension of the anterior posterior lobe right and the ratio of the hepatic angle and males had larger liver size than females.

5.3 Recommendations:-

According to the study :

- we recommend further measure liver dimension for Sudanese by different devices (ultrasound and magnetic resonance imaging) after this research by computed tomography.

- we recommend dimensional measurements of the other organs of the Sudanese proportion of the difference we found in the liver dimension with references.

- the need conduct such research because it increase the knowledge of the exact anatomy of the Sudanese and its importance in the correct diagnosis of various diseases.

References

References:

1. **Albert A. Moss et al**, 1992, computed tomography of the body with magnetic resonance imaging, 2nd edition, sunders company, Philadelphia, USA.
2. **G.Marchal et al**, 2005, Multidetector Raw Computed Tomography Scanning and Contrast Protocols, 1st edition Springer Milan Berlin Heidelberg,New York.
3. **Hsieh, Jiang**.2009. Computed tomography: principles, design, artifacts, and recent advances, 2nd edition, Bellingham, Washington.
4. **Jerrold T. Bushberg et al**, 2002, the essential physics of medical imaging, 2nd edition, Philadelphia, USA.
5. **K. Subburaj**, 2011, CT scanning technique and application, 1st Edition, JanezaTrdine,Rijeka, Croatia.
6. **R.bruening et al**,2006, protocols for multislice CT, , 2nd edition, springer, verlag berlin hiedelberg, Germany.
7. **Ramsay Vallance et al**, 1999, an atlas of Diagnostic radiology in gastroenterology,1st edition, oxford,united kingdom.
8. **Thorsten M. buzug**,2008, Computed Tomography from Photon Statistics to Modern Cone-Beam CT,1st edition, Springer- Verlag Berlin Heidelberg, Germany.
9. **William R. Hendee et al**, 2002, medical imaging phsics, Fourth Edition, Wiley-Liss, Inc., New York.
10. **Henry Grey, Warren H Lewis**, 2000, Grey Anatomy of the Human Body, Twentieth Edition, Philadelphia: Lea&Febiger 1918; New York: Bartleby.com
11. **Jain E Gillespie, T.J. Thompson**, 1983 ,Gastroentrology, An integrated course,thirdedition,Churchilllivingstone.
12. **JamescD.mace, Nina Kowalczyk** 2001,Radiographic phathology for technologists
13. **Dr. Adel Montaser,** 2003 , Diseases of Liver, Biliry system Pancreas
14. M. prives, N. Iysenkov, V. bushkovich, 1985, Human Anatomy volume one, MIR publishers , Moscow.
15. Provophys(C) Whiteknight(C) RiRi82 (C) jcran69 ,HUMAN PHYSYOLOGY by Wikibooks contributors.

Appendices

Appendices:-

Appendices A

Data sheet collecting

Age	Gender	Body height	Body weight	LT hepatic angle	AP diameter hepatic lobe	CL	RL

Appendices B

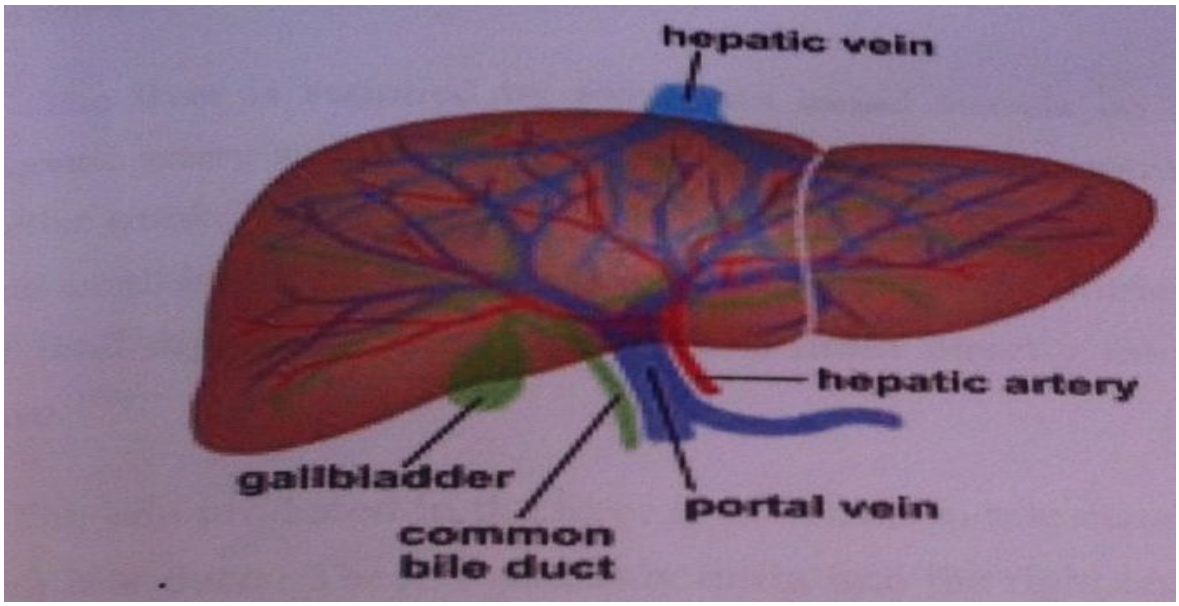

Fig AP LIVERNetwork of branching and retrenching blood vessels in the liver.

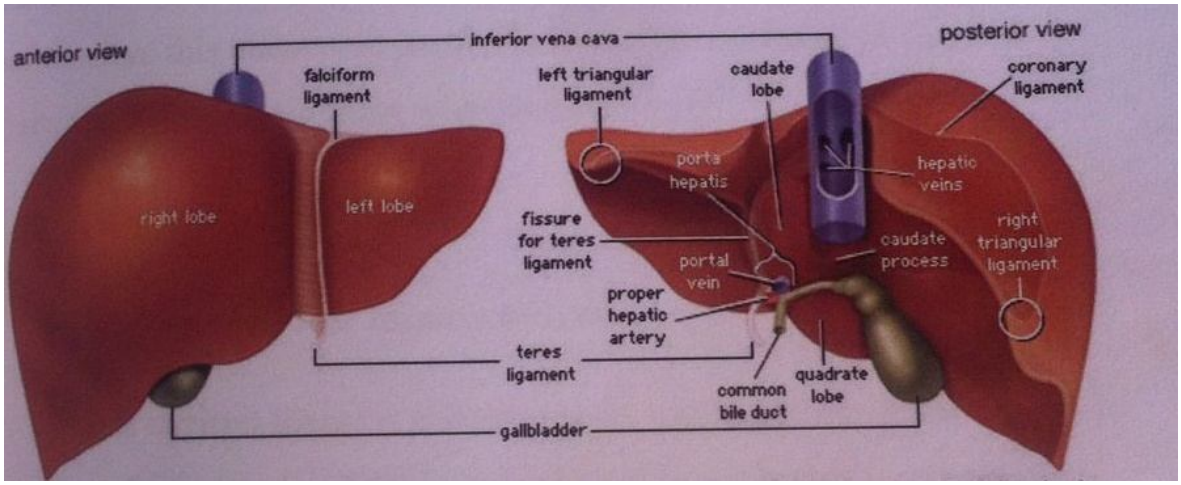

Fig Anterior and posterior views of the liver

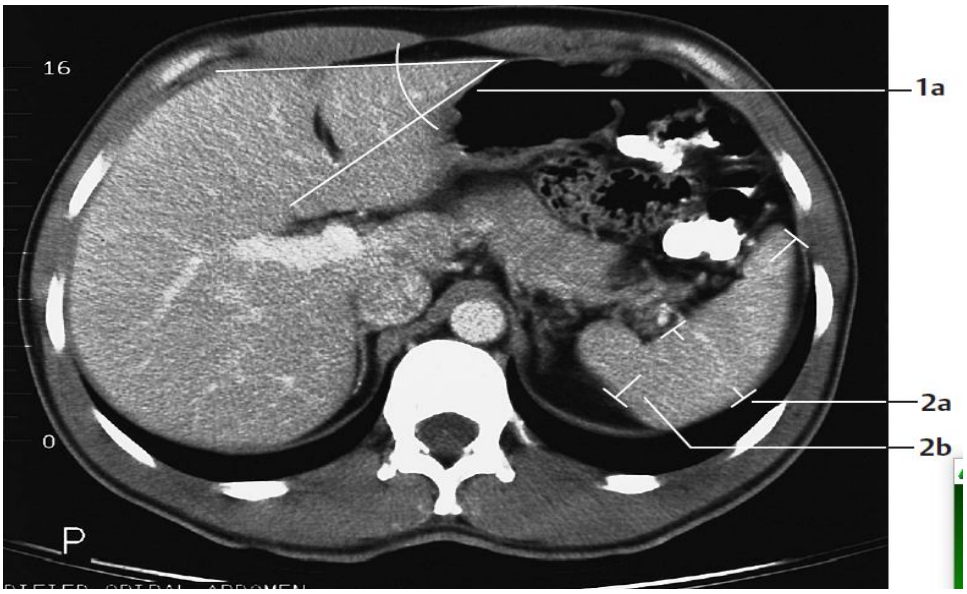

Fig CT liver axial venous phase (1a) Left hepatic angle

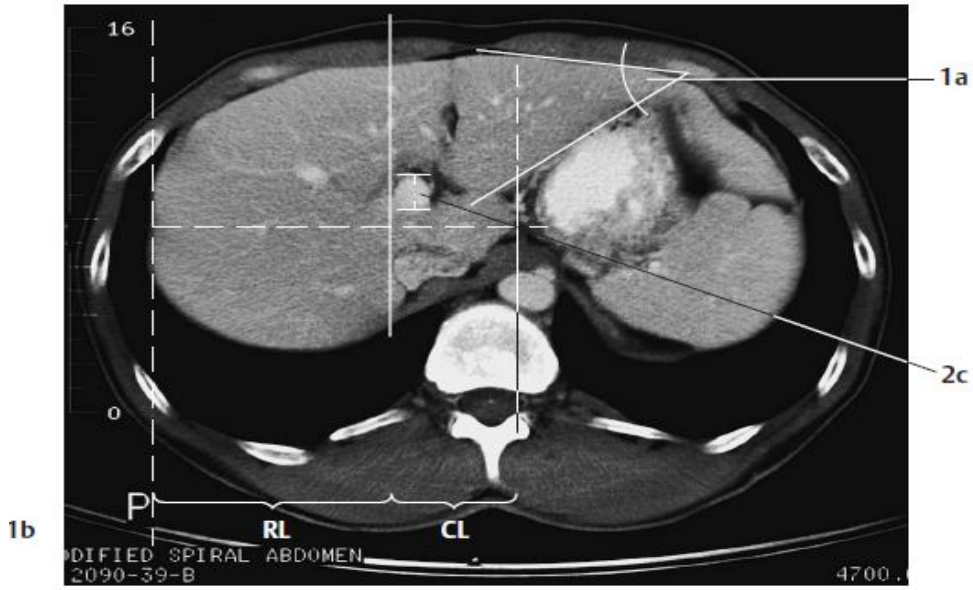

Fig CT liver axial venous phase (1a) LT hepatic angle –AP diameter of the left hepatic lobe,diameter the caudate lobe & diameter the right lobe

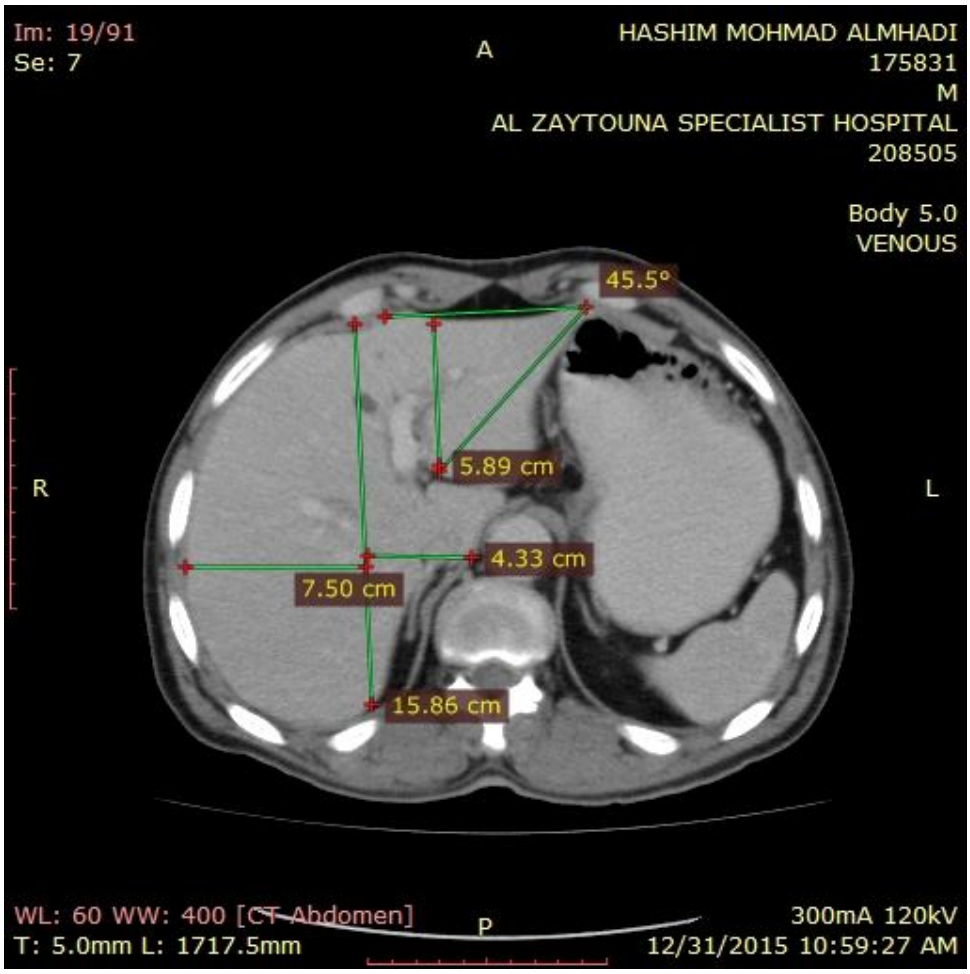

Fig CT liver axial venous phasethe left hepatic angle-45.5^{o} AP diameter of the left hepatic lobe L-5.89 cm diameter of the right lobe-7.50 cm diameter of the caudate lobe-4.33 cm

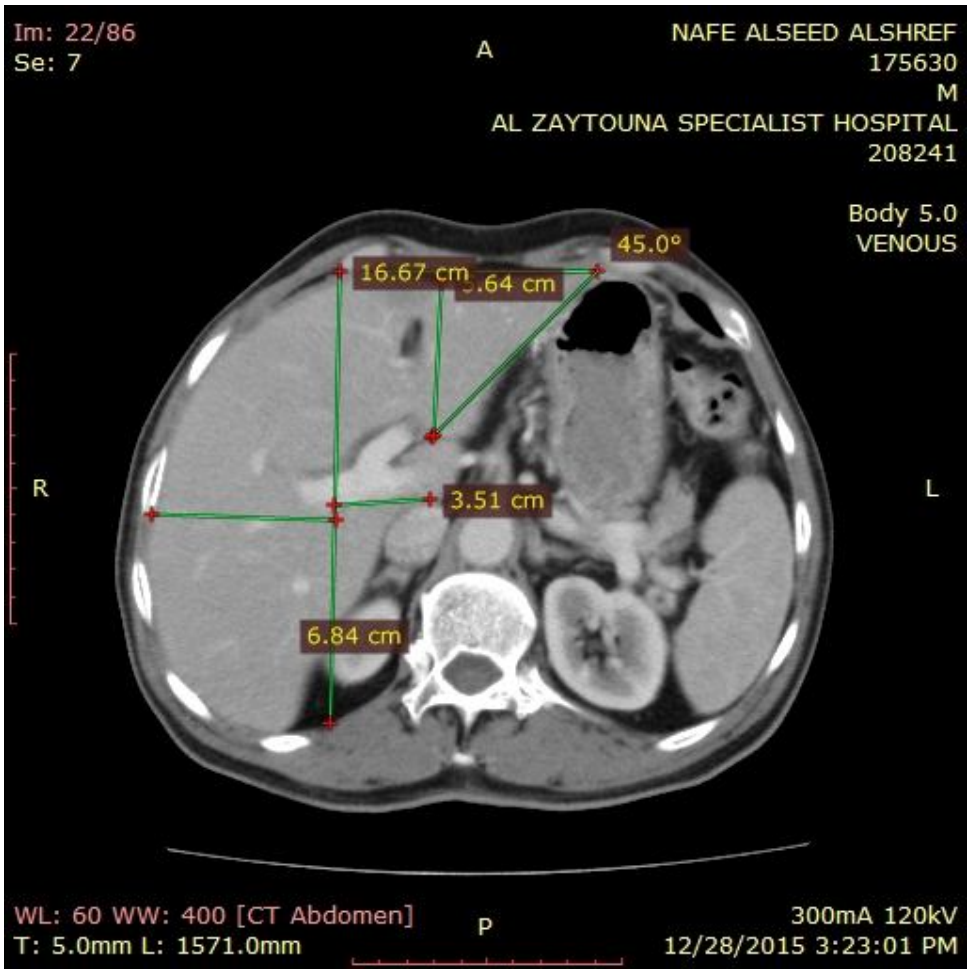

Fig CT liver axial venous phase the lefthepatic angle-45.0^{o} AP diameter of the left hepatic lobe -5.64 cm diameter of the right lobe -6.84 cm diameter of the caudate lobe-3.51 cm

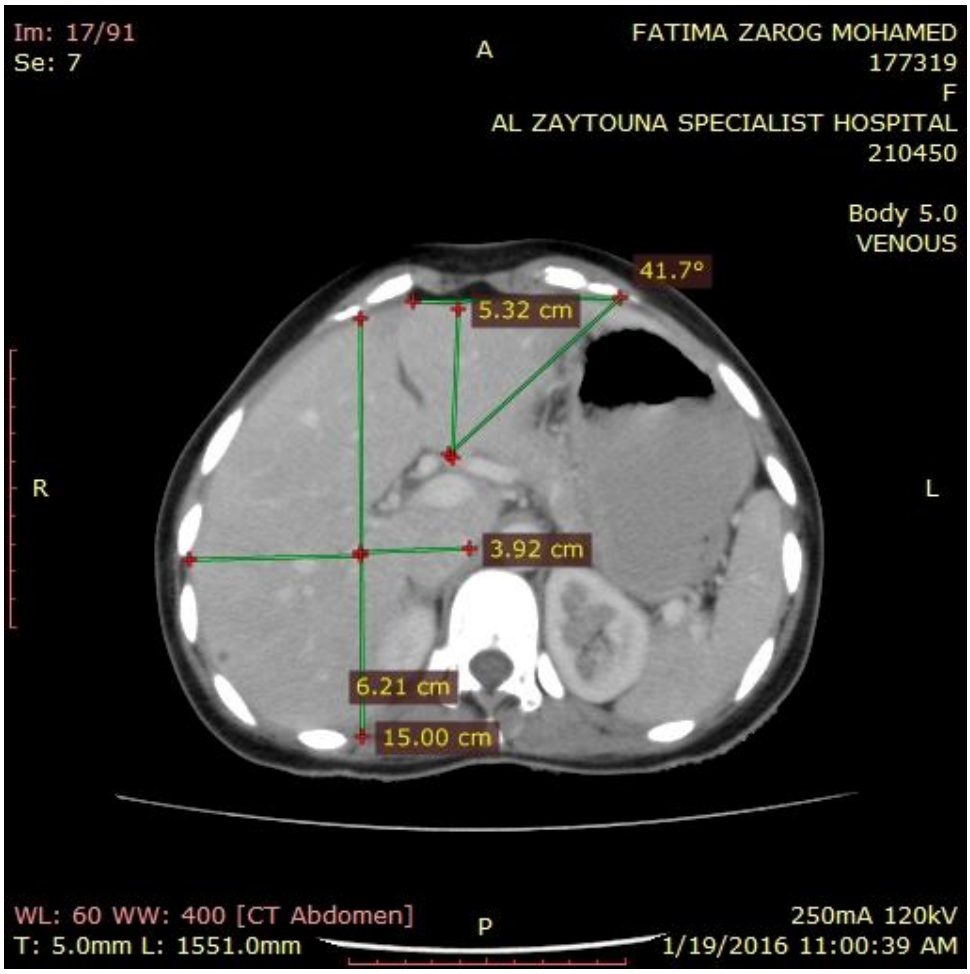

Fig CT liver axial venous phasethe left hepatic angle -41.7^{o} AP diameter of the left hepatic lobe 5.32 cm diameter of the right lobe -6.21 cm diameter of the caudate lobe -3.92 cm

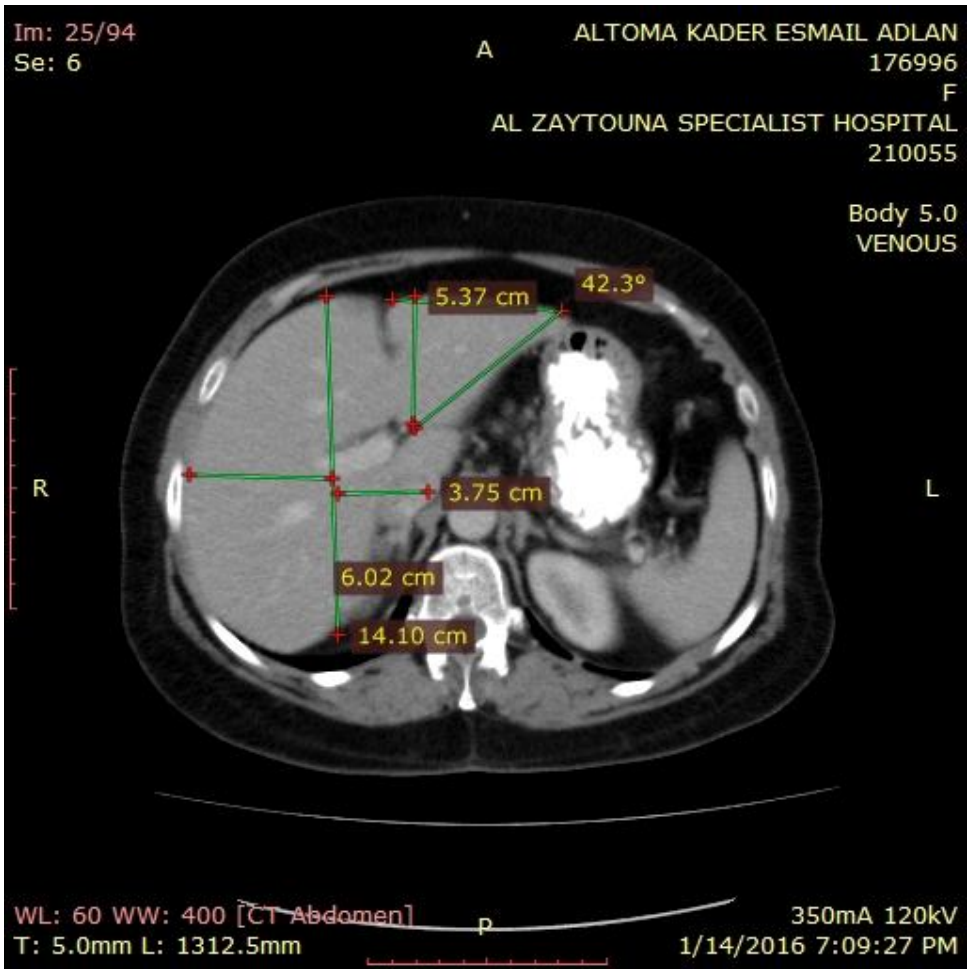

Fig CT liveraxialvenousphasethe left hepatic angle-42.3^{o} AP diameter of the left hepatic lobe 5.37 cm diameter of the right lobe -6.02 cm diameter of the caudate lobe-3.75 cm

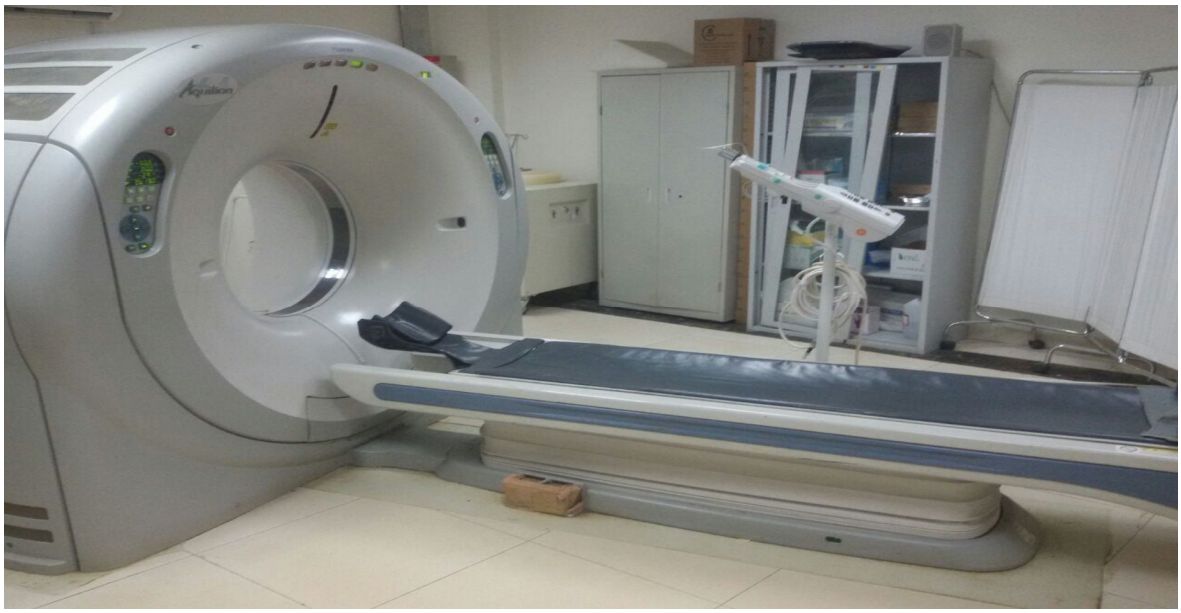

Fig CT Scan Machine

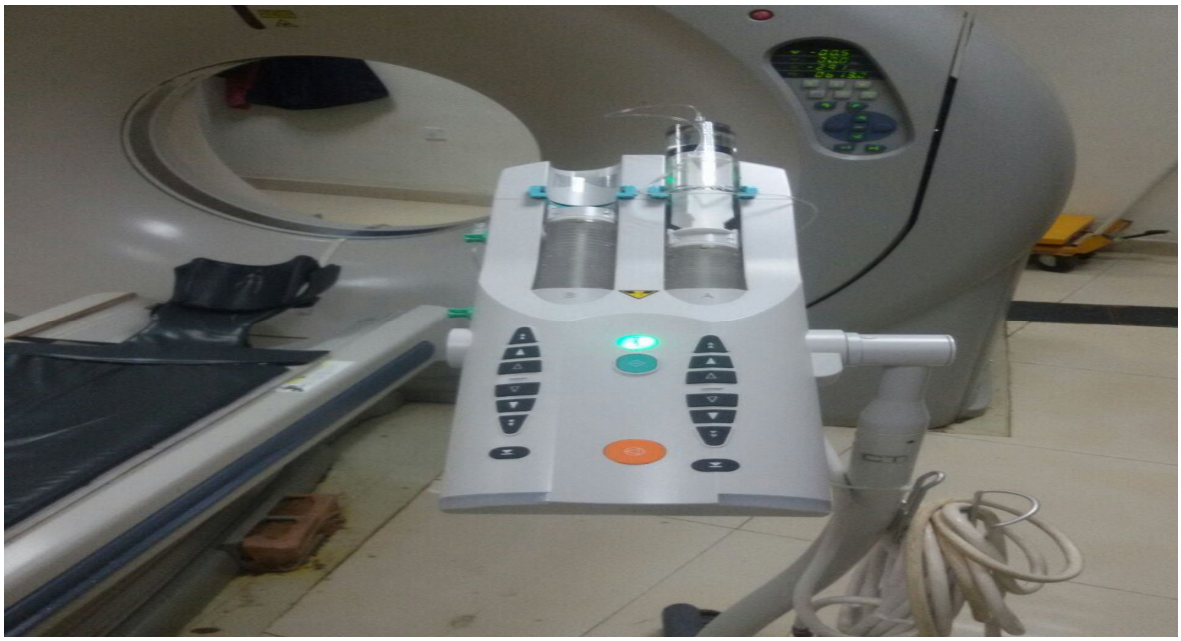

Fig Automatic Injector