Sudan University of Science and Technology

College of Graduate Studies

Measurement of Liver Dimensions for Adult Sudanese using Computed Tomography

قياس ابعاد الكبد للسودانيين البالغين باستخدام الاشعة المقطعية المحوسبة

A thesis Submitted for Partial Fulfillments of the requirements of M.Sc.

in Diagnostic Radiological Technology

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2019

الاية

قال تعالى :

"والذين جاهدوا فينا لنهدينهم سبلنا وإن الله لمع المحسنين"

سورة العنكبوت(69)

Dedication

I thank my parents for the unconditional support with my study, I'm honored to have you as my parents. Thank you for giving me a chance to prove and improve myself through all my walk of life.

I thank my family for believing in me….

Acknowledgment

-Praise is to Allah who blessed me with knowledge of which I knew not and enable me write this thesis.

-I would like to express my gratitude to **Dr. Mona Ahmed Mohammed**. For his encouraging, supervision and guidance of this research.

-Special thanks to my friends Dr. Eslam Ali for helping me too much .. also I would like to thank my best friend Dr. Maather Ahmed for supporting and inspiring me…

Abstract

This is descriptive study and was conducted in three months during the period from December 2018, To February 2019 in AL-Kuwaiti specialist Hospital. This study carried out in a sample of 100 patients (40males and 60 females) who underwent to abdominal computed tomography examination for different reason.

The objective of this study is to evaluate normal liver measurements in Sudanese using computed tomography and correlated to age.

The study showed that the mean and STD of male liver measurement for maximum craniocaudad, mid hepatic craniocaudal, mid hepatic Anterio -posterior, maximum transverse was found to be 14.1±0.50, 15.1±0.54, 18.0 ±0.61, and 14.2±0.50 cm respectively.

And female liver measurements for maximum craniocaudad, mid hepatic craniocaudal, mid hepatic Anterio-posterior, maximum transverse was found to be 14.1± 0.54, 15.2 ±0.56, 18.0 ±0.62 and 14.2 ±0.52 cm, respectively.

The study concluded were that correlation between liver and measurements (mid-hepatic craniocaudad, maximum craniocaudad, maximum transverse dimension, mid-hepatic Anterio-posterior) increased with age and this indicate that size of liver increased with age.

And also the study concluded no difference between males and females subjects at liver measurements.

The study recommended future studies should be done use Positron Emission Tomography Computed Tomography Scan.

ملخص الدراسة

قد اجريت هذه الدراسه الوصفيه خلال ثلاثه اشهر الفترة من ديسيمبر 2018 حتى فبراير 2019 في المستشفى الكويتي التخصصي ولاية الخرطوم . اجريت هذه الدراسه على عينه من 100 مريضا 60(انثى -40 ذكر)الذين خضعوا لفحص الاشعه المقطعيه لاسباب مختلفه.

الهدف من هذه الدراسه هي تقييم قياسات الكبد الطبيعيه لدى السودانيين باستخدام التصوير المقطعي وربطها بالعمر والنوع.

اهم نتائج هذه الدراسه ان المتوسط والانحراف المعياري لقياسات الكبد لعينات الذكور تشمل الحد الأقصى للكبد علوي - سفلي , متوسط الكبد علوي - سفلي ,متوسط الكبد امامي – خلفي, ,الحد الأقصى العرضي وجدت:(14.1±0.50 ، 15.1±0.54، 18.0 ±0.61، 14.2±0.50 سم) على التوالي.

اهم نتائج هذه الدراسه ان المتوسط والانحراف المعياري لقياسات الكبد لعينات الاناث تشمل(الحد الأقصى للكبد علوي - سفلي , متوسط الكبد علوي - سفلي ,متوسط الكبد امامي – خلفي, ,الحد الأقصى العرضي)وجدت (14.1± 0.54، 15.2 ±0.56، 18.0 ±0.62 و14.2 ±0.52 سم) على التوالي.

خلصت الدراسه ان قياسات الكبد التي تشمل (الحد الأقصى للكبد علوي - سفلي , متوسط الكبد علوي - سفلي ,متوسط الكبد امامي – خلفي, ,الحد الأقصى العرضي) تنخفض مع تقدم العمر وهذا يشير الى ان حجم الكبد ينخض مع تقدم العمر.

وايضا خلصت الدراسه انه لايوجد فرق بين الذكور والاناث على قياسات الكبد.

توصي الدراسه الدراسات القادمه ان تجرى باستخدام التصوير المقطعي البوزيتروني/التصوير المقطعي المحوسب.

List of Contents

List of Tables

List of Figures

List of abbreviation

CT	Computed Tomography
MPR	Multiplanner Reconstruction
HU	Hounsfield Unit
MIP	Maximum Intensity Projection
SSD	Surface Shaded Display
FLD	Fatty Liver Disease
CAT	Computed Axial Tomography
MAX CC	Maximum Creaniocudad
MHP CC	Mid Hepatic Point Creaniocudad
MHP AP	Mid Hepatic Point Anteroposterior
MAX TR	Maximum Transverse

Chapter One

Introduction

Chapter One

1.1 Introduction:

The liver is largest organ in human body. During development liver size increase with age, averaging 5 cm span at 5 year and attaining adult size by age 25, the size depend on several factors: age, sex, body size and shape as well as the particular examination technique utilized(e.g. palpation versus percussion versus radiographic).(Wolf. 1990).

Midpoint of IVC should be taken as standard reference point to measure the transverse width of CL for finding CL/RL ratio, for diagnosing conditions of liver. The study showed that the caudate lobe measurements (right to left Diameter anterio-posterior Diameter, caudate to right lobe ratio) and the right lobe diameter increased with age and this indicate that the size of liver and caudate lobe increased as the age increased**.**(Abd Elhady.2016).

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 biliary 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).

1.2 Problem of the study:

The liver size usually affected by the body including length weight age so that might lead to wrong diagnosis, there are no reference measurement value regarding liver dimension in Sudanese.

1.3 Research objectives:

1.3.1 General objectives:

To measure NORMAL liver dimensions using CT.

1.3.2 Specific objectives:

- To measure the maximum creaniocaudad diameter.
- To measure the mid hepatic point anteroposterior diameter
- To measure the maximum transverse diameter.
- To measure the mid hepatic point creaniocaudad diameter.
- To correlate the patient liver dimensions with age.
- To correlate the patient liver dimensions with gender

1.4. Thesis overview:

Chapter one contains introduction to the study and justification for why we do it, Chapter two Contains literature review for liver anatomy, physiology and CT, Chapter three Contains Material and Method for planning, designing, how to get the goals of the study, Chapter four Contains results and data analysis of the study ,Chapter five Contains discussion, conclusion and recommendations of the study, Appendix contains some images of CT scan test for patient under study.

Chapter Two

Theoretical Background and Literature Review

Chapter Two

Theoretical Background and Literature Review

2.1 Theoretical background:

2.1.1 Liver Anatomy:

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)

2.1.1.1 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 calceifornligament . (Lewis, 2000) the inferior surface:- is uneven, concave, directed downward, backward, and to the left, and 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)

2.1.1.2 Lobes and segment 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)

Quadrate lobe:-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)

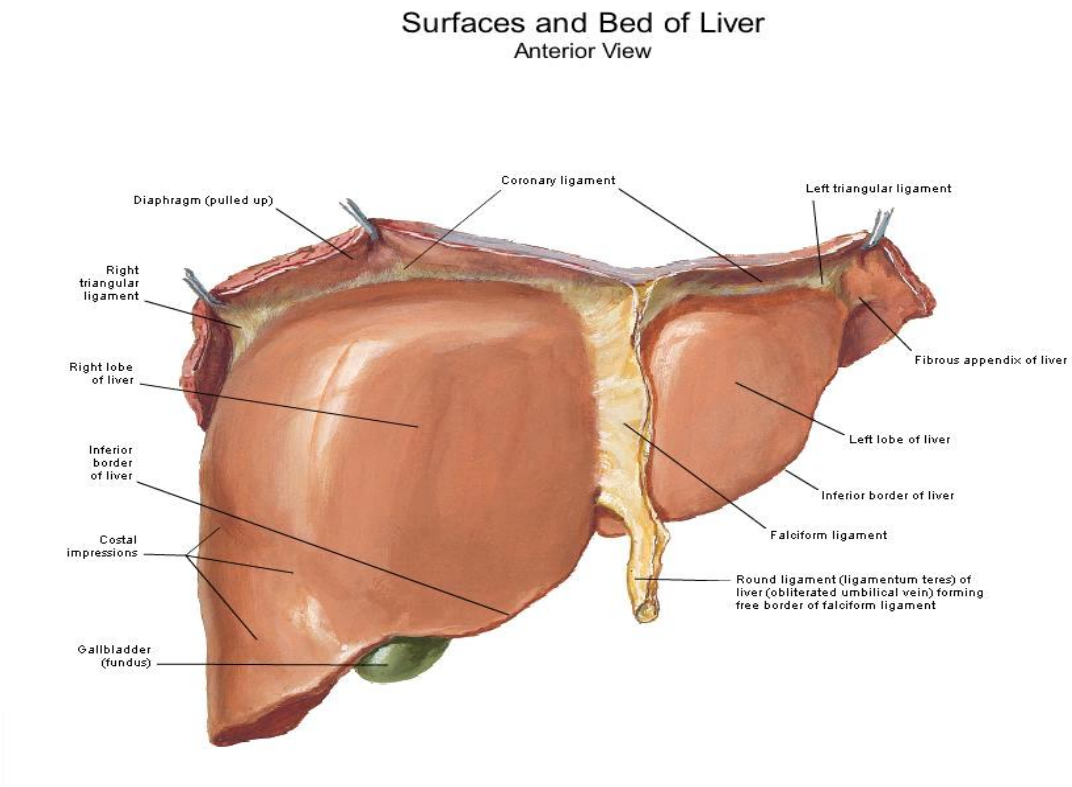


Figure 2.1: Shows liver Surfaces (pubmed.com)

2.1.1.3 Segment of the liver:

Couinaud classification: The Couinaud classification of liver anatomy divides the liver into eight functionally independent segments.

Each segment has its own vascular inflow (hepatic artery & portal vein), outflow (hepatic vein) and biliary drainage.

Right hepatic vein divides the right lobe into anterior and posterior segments (segment 6& 7 usually not visulaized at the frontal view).

Middle hepatic vein divides the liver into right and left lobes (or right and left hemiliver). This plane runs from the inferior vena cava to the gallbladder fossa (Cantlie's line), Left hepatic vein divides the left lobe into a medial and lateral part, Portal vein divides the liver into upper & lower segments,

Couinaud's numbering system:

Caudate Lobe (posteriorly): Left Superior Lateral segment, Left Inferior Lateral segment: a-Left Superior Medial segment, b-Left Inferior Medial

segment, Right Inferior Anterior segment, Right Inferior Posterior segment, Right Superior Posterior segment8-Right Superior Anterior segment

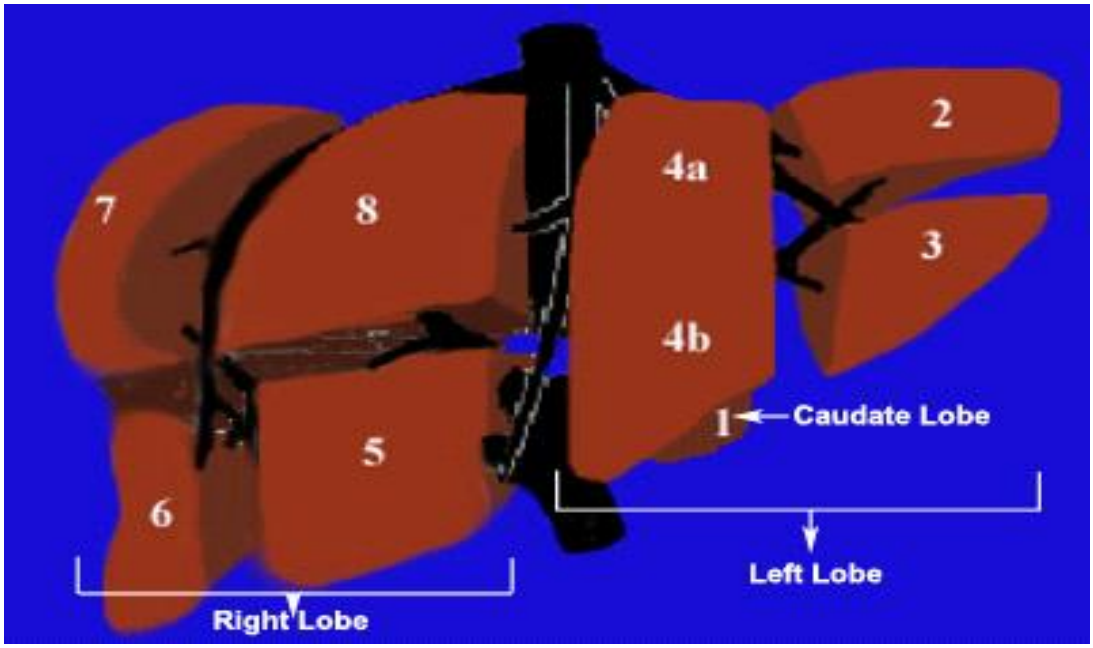


Figure 2.2: Shows liver Segments (pubmed.com)

2.1.1.4 Excretory apparatus 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 are savoir 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)

2.1.2 Liver physiology:

The various functions of the liver are carried out by the liver cells or hepatocytes. The liver is thought to be responsible for up to 500 separate functions, usually in combination with other systems and organs. Currently, there is no artificial organ or device capable of reproducing all the functions of the liver. Some functions can be carried out by liver dialysis, an experimental treatment for liver failure. (Benjamin -2008).

The liver synthesizes and stores approximately 100g of glycogen via glycogenesis, the formation of glycogen from glucose. When needed, the liver releases glucose into the blood by performing glycogenolysis, the breakdown of glycogen into glucose. (Benjamin -2008).

The liver is also responsible forgluconeogenesis, which is the synthesis of glucose from certain amino acids, lactate or glycerol. Adipose and liver cells produce glycerol by breakdown of fat, which the liver uses for gluconeogenesis. The liver plays a role in the production of clotting factors as well as red blood cell production. Some of the proteins synthesized by the liver include coagulation factors I (fibrinogen), II(prothrombin), protein S and antithrombin. In the first trimester fetus, the liver is the main site of red blood cell production. By the 32nd week of gestation, the bone marrow has almost completely taken over that task. The liver is a major site of production for thrombopoietin, a glycoprotein hormone that regulates the production of platelets by the bone marrow. (Benjamin- 2008)

The liver plays several roles in lipid metabolism: it performs cholesterol synthesis, lipogenesis, the production of triglycerides, and a bulk of the body's lipoproteins are synthesized in the liver.(Jelkmann-2001)

The liver plays a key role in digestion, as it produces and excretes bile (a yellowish liquid) required for emulsifying fats and help the absorption of vitamin K from the diet. Some of the bile drains directly into the duodenum, and some is stored in the gallbladder. (Jelkmann-2001)

The liver also produces insulin-like growth factor 1 (IGF-1), a polypeptide protein hormone that plays an important role in childhood growth and continues to have anabolic effectsin adults. (Jelkmann- 2001)

The liver is responsible for the breakdown of insulin and other hormones, and breaks down bilirubin via glucuronidation, facilitating its excretion into bile and excretion of many waste products. It plays a key role in

breaking down or modifying toxic substances (e.g., methylation) and most medicinal products in a process called drug metabolism. The liver breaks down ammonia into urea as part of the urea cycle, and the urea is excreted in the urine. (Jelkmann-2001)

2.1.2.1 function of the liver are:

The liver stores a multitude of substances, including glucose (in the form of glycogen), vitamin A (1–2 years supply), vitamin D (1–4 months' supply), vitamin B12(3–5 years supply), vitamin K, iron, and copper. (Benjamin- 2008).

The liver is responsible for immunological effects-the mononuclear phagocyte system of the liver contains many immunologically active cells, acting as a (sieve) for antigens carried to it via the portal system. (Benjamin -2008).

The liver produces albumin, the most abundant protein in blood serum. It is essential in the maintenance of oncotic pressure, and acts as a transport for fatty acids andsteroid hormones. (Benjamin -2008).

The liver synthesizes angiotensinogen, a hormone that is responsible for raising the blood pressure when activated by renin, an enzyme that is released when the kidneysenses low blood pressure. (Benjamin -2008).

2.1.3 Liver pathology:

2.1.3.1 Cirrhosis:

Is a slowly progressing disease in which healthy liver tissue is replaced with scar tissue, eventually preventing the liver from functioning properly. The scar tissue blocks the flow of blood through the liver and slows the processing of nutrients, hormones, drugs, and naturally produced toxins (en.m.wikipedia.org).

2.1.3.2 Glycogen storage disease:

The liver cannot control the use of glycogen and glucose because certain enzymes are missing that control the change of sugar (glucose) into its

storage form (glycogen) or release of glucose from glycogen (en.m.wikipedia.org).

2.1.3.3 Fatty liver:

Also known as fatty liver disease (FLD), is a reversible condition wherein large vacuoles of triglyceride fat accumulate in liver cells via the process of steatosis (en.m.wikipedia.org).

2.1.3.4 Cyst:

Fluid-filled cavities in the liver usually cause no signs or symptoms and need no treatment (en.m.wikipedia.org).

2.1.3.5 Abscess:

Is a pus-filled mass inside the liver, Common causes are abdominal infections such as appendicitis or diverticulitis due to haematogenous spread through the portal vein (en.m.wikipedia.org).

2.1.3.6 Tumors:

2.1.3.6.1 Benign:

If you are told your tumor is “benign,” that means it is not cancerous. It is similar to cancer because the growth is a result of abnormal cells. However, unlike cancer, it is unable to spread to other areas of the body (such as the brain or lungs) and it does not affect nearby tissue. It is a contained mass that stays where it grows (Cooper 1992).

On its own, a benign tumor is not dangerous. However, the location of the tumor is what poses the threat. If the mass puts pressure on a primary nerve, a main artery, or compresses brain matter, even a benign tumor can cause serious problems. Some suspected causes of benign tumors include a traumatic injury at the tumor location, chronic inflammation (or long-term stress that leads to inflammation), an undetected infection, or diet (Cooper 1992).

Most common benign tumors are , adenomas (epithelial tissue that covers the organs and glands), meningiomas (brain and spinal cord), fibromas or

fibroids (connective tissue of any organ – most commonly found in the uterus), papillomas (skin, breast, cervix, and mucus membranes), lipomas (fat cells), nevi (moles), myomas (muscle tissue), hemangiomas (blood vessels and skin), neuromas (nerves), osteochondromas (bones) (Cooper 1992). Depending on the location and size of a benign tumor, treatment might not be necessary. Doctors will monitor it, track patient symptoms and do tests at specific intervals (Cooper 1992).

Benign tumors are often surrounded by a protective "sac" a mechanism performed by your immune system – that segregates it from the rest of your body and enables it to be easily removed (Cooper 1992).

If you are diagnosed with a benign tumor, altering your diet to an anti-cancer regimen is sound advice. Some benign tumors can become malignant but it's rare. Even when they are removed, your doctor will schedule regular tests periodically to ensure no additional tumors form (also a rare occurrence). Overall, benign tumors respond well to treatment and the prognosis is usually favorable (Cooper 1992).

2.1.3.6.2 Malignant:

If your doctor determines that you have a malignant tumor, that means the mass is cancerous. The word malignant is Latin for "badly born." This type of tumor has the ability to multiply uncontrollably, to metastasize (spread) to various parts of the body and invade surrounding tissue (Cooper 1992).

Malignant tumors are formed from abnormal cells that are highly unstable and travel via the blood stream, circulatory system and lymphatic system. Malignant cells do not have chemical adhesion molecules to anchor them to the original growth site that benign tumors possess (Cooper 1992).

There are many suspected causes of cancer – some are widely accepted by the medical community while others are not. Obesity, smoking, alcohol consumption, poor diet, environmental pollution, heavy metal

exposure and household toxins are a few culprits that may lead to cancer in your body (Cooper 1992).

Most Common malignant tumors are, Sarcomas (connective tissues such as muscle, tendon, fat, and cartilage) and carcinomas (organs and gland tissue such as the breast, cervix, prostate, lung, and thyroid) (Cooper 1992).

Malignant tumors may not have symptoms initially and the first indication that something isn't right may be the detection of a painless lump. These types of tumors are "elastic," which enables them to grow fairly large before they are detected (Cooper 1992).

As they grow and begin to press against organs, blood vessels and nerves, pain and general soreness at the site may occur (Cooper 1992).

2.1.3.6.3 Metastases:

Occurs when cancer spreads from its original location (primary tumor) to a new part of the body (en.m.wikipedia.org).

2.1.4 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:

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. (Jiang,2009)

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)

2.1.5 CT physics:

As the x-ray beam passes through the patient it is attenuated to some degree. To create an x-ray image we must collect information regarding the degree to which each anatomic structure attenuated the beam. In CT, detectors used to collect the information. The detector array comprises detector elements situated in an arc or a ring, each of which measures the intensity of transmitted x-ray radiation along a beam projected from the x-ray source to that particular detector element. Detectors can be made from different substances, each with their own advantages and disadvantages. All new scanners possess detectors of the solid- state crystal variety. Detectors made from xenon gas have been manufactured but have largely become obsolete as their design prevents them from use in MDCT systems. **(**Lois, 2011)

2.2 Previous Studies:

Benjamin Effiong Udoh 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.

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.

Mohammed saad Eldin, 2012 studies CT measurement of the dimension of the liver the aim of study were the measurement Sudanese dimension of the normal liver and take the 50 patients' 25 male and 25 female in the Jarash international 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 AL vela right equal to 0.14 ± 0.53.

Chapter Three

Materials and Methods

Chapter Three

Materials and Methods

3.1 Materials:

3.1.1 Patients:

The entire populations of this study were 100 patients, 40 patients were males and 60 patients were females; those patients had a variety of ages, ranged from 20 and greater than 70 years old, patients had been reported having a normal liver tomograms their referred to CT department for abdominal ct.

3.1.2 Machines:

- Optima 64 slice.
- Power injector, Madrid, sealant, dual piston.

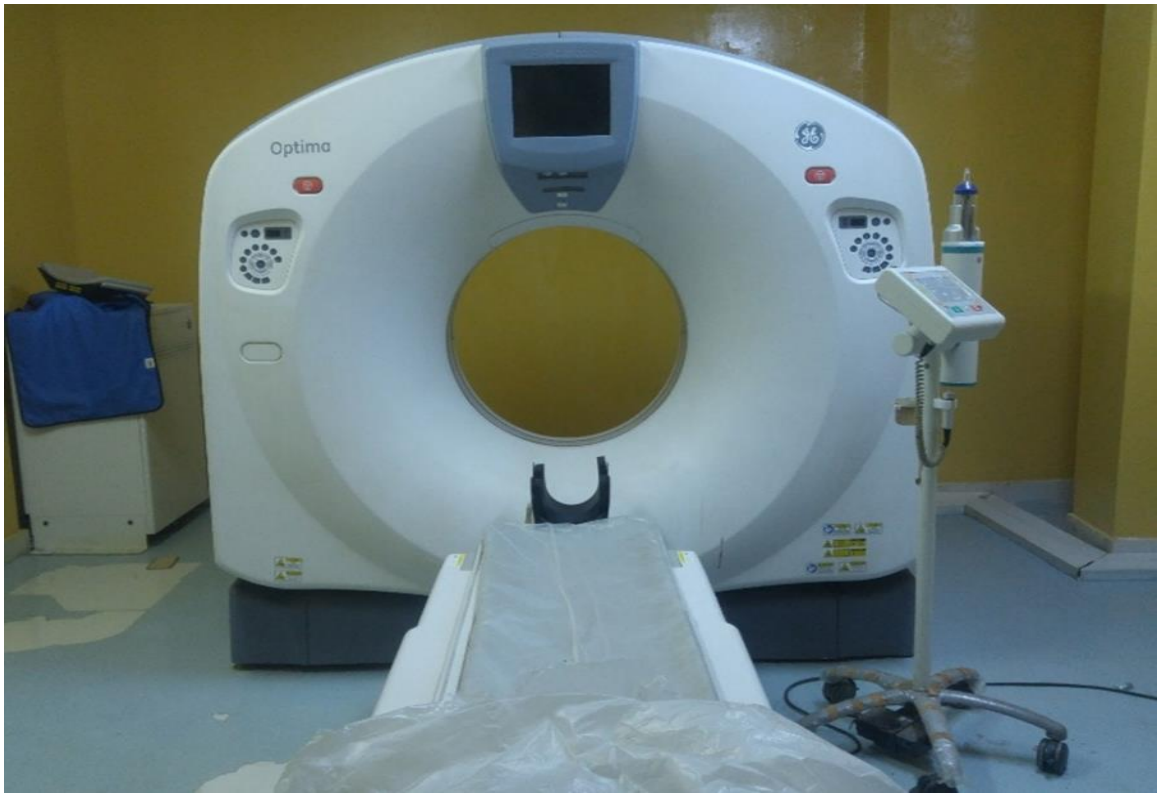


Figure 3.1: Optima 64 slice

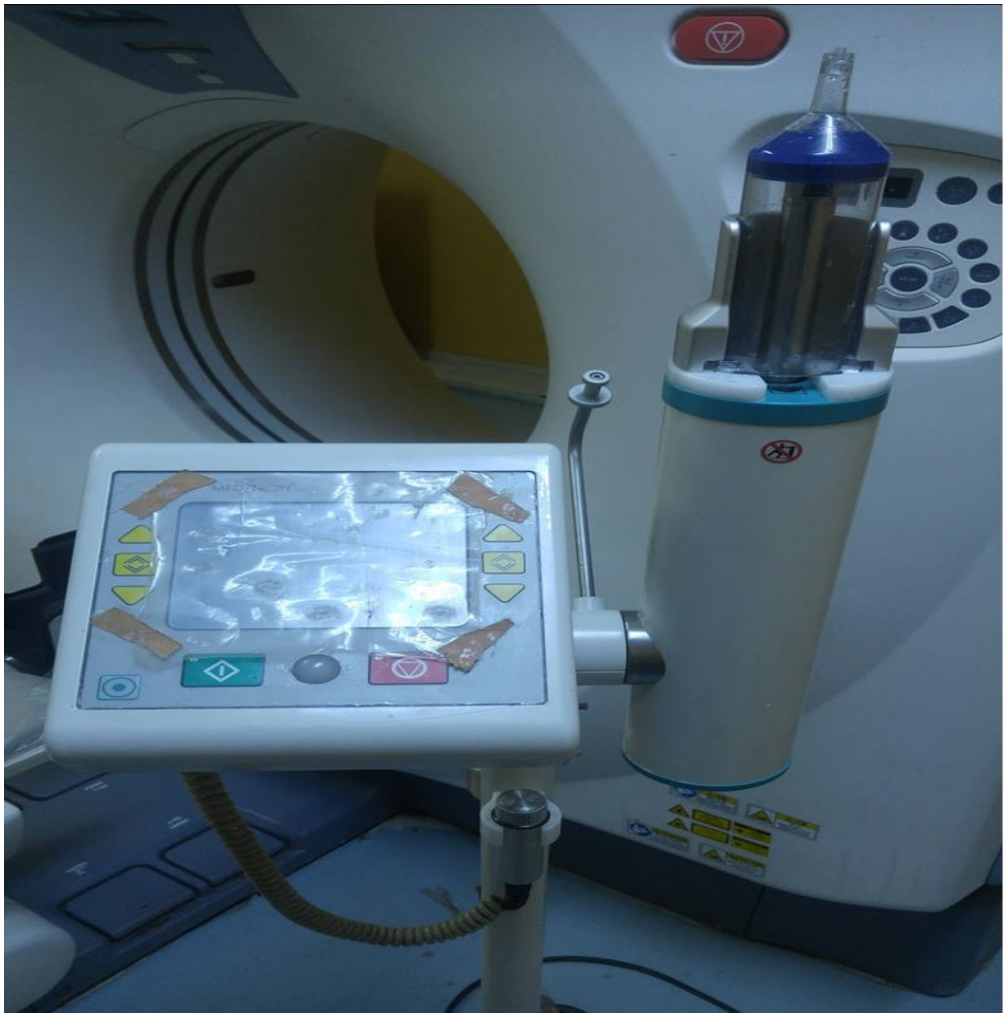


Figure 3.2 Power injector, Madrid, sealant, dual piston

3.2 Methods:

3.2.1 Method of Hepatic measurements:-

The following measurements of the liver were performed independently :

Mid hepatic point craniocaudad (MHP CC): Perpendicular measurement on the coronal images from the hepatic dome to the inferior margin of the liver passing through the mid-hepaticpoint.

Maximum CC to liver tip (Max CC): Greatest obtainable craniocaudad dimension of the liver from the hepatic dome to the liver tip on coronal or sagittal reconstructed images.

Maximum transverse dimension: The maximum measurement from the right to left marginsof the liver at the level of the portal vein.

MHP AP measurement: The MHP was defined as half way between the mid vertebra and right lateral margin of the liver at the level of main portal vein on a transverse section. This measurement taken at the levelof the midhepatic point from anterior to posterior margin of the liver.

3.2.2 Inclusion criteria

Normal patients

3.2.3 Exclusion criteria

Disease patients

3.2.4 Computed tomography Protocol (technique):

The patient undergoes an abdominal CT. with contrast, the departmental protocol states 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 222the 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.

Phases:

Arterial: After 35 sec from contrast injection. Porto venous: After 50 sec from contrast injection. Venous: After 75 sec from contrast injection. Delay: After 5 min contrast injection.

3.2.5 Data collection and analysis:

Using a data collection sheet in addition to patient gender and age. The data analysis statistically using SPSS

3.2.6 Area of the study:

The study had been done in Khartoum state; the patients were randomly selected at Al Kuwaiti Specialized Hospital December 2018 to march l 2019.

3.2.7 Ethical Consideration:

There is no patient identification or individual patient details will be published. Also confidentiality will be ensured by making the collected data accessible only to the researcher and consultant radiologist and the head of radiology department. all data collected during the study will be stored on computer protected by password, all paper format data will be stored in locked cabinet.

Chapter Four

Results

Chapter Four

Results

The following tables and figures represent data obtained from randomly selected sample of patients (44 males and 56 females) who underwent CT abdomen for different indications.

Table 4.1: The distribution of sample according to gender.

Gender	Frequency	Percentage %
Male	44	44%
Female	56	56%
Total	100	100%

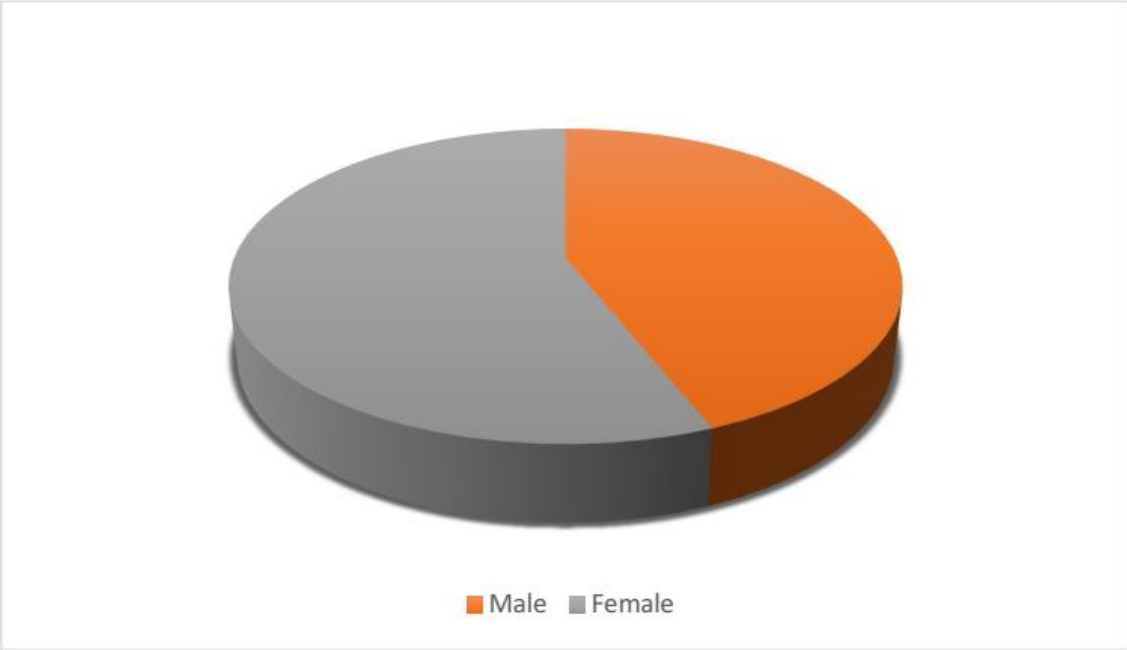
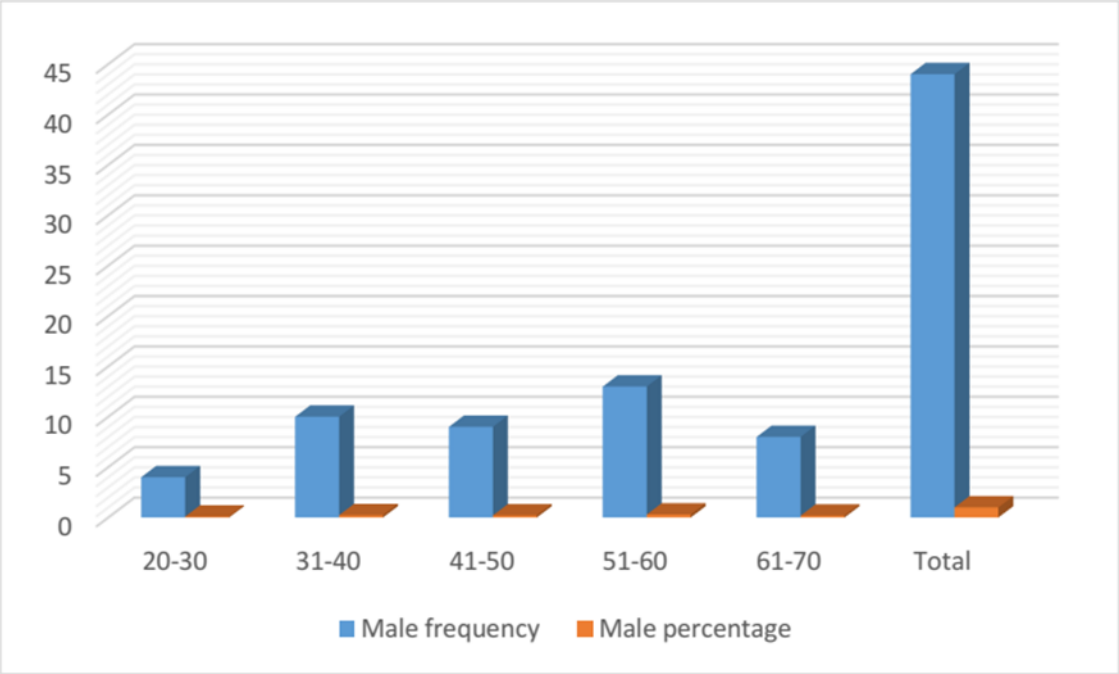


Figure 4.1:The distribution of sample according to gender.

Table 4.2: The distribution of Male in the study group age.

Age class	Male frequency	Male percentage%
20-30	4	9.09%
31-40	10	22.7%
41-50	9	20.5%
51-60	13	29.5%
61-70	8	18.2%
Total	44	100%



Figures 4.2: Show the distribution of male in the study group age.

Table 4.3:The distribution of female in the study group age.

Age class	Female frequency	Female percentage%
20-30	10	17.9%
31-40	5	8.9%
41-50	16	28.6%
51-60	16	28.6%
61-70	9	16%
Total	56	100%

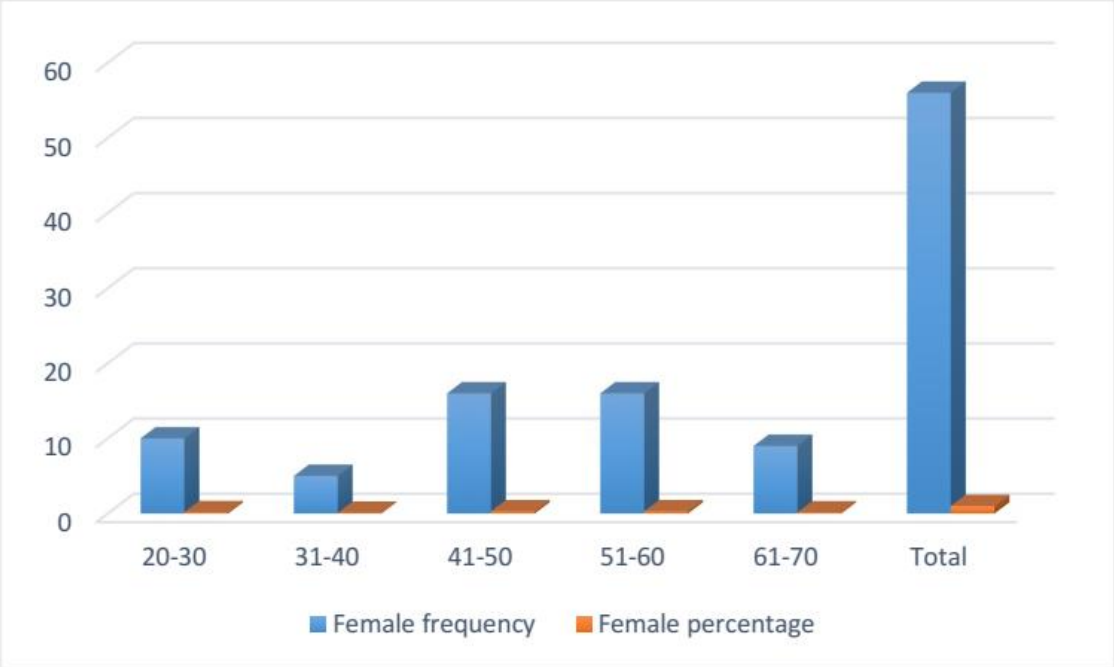


Figure 4.3: The distribution of female in the study group age.

Table4.4: Mean of study group age.

Gender	Mean
Male	47
Female	46

Table 4.5:Male liver measurements (minimum, maximum, mean, standard deviation).

	N	Minimum	Maximum	Mean	Std. Deviation
Mid-hepatic craniocaudad	44	13.1	14.9	14.141	.4938
Maximum craniocaudad	44	14.1	16.0	15.175	.5657
Maximum transverse	44	16.8	18.8	18.016	.6235
Mid hepatic anteroposterior	44	13.5	14.9	14.261	.5217

Table 4.6: Female liver measurements (minimum, maximum, mean, standard deviation).

	N	Minimum	Maximum	Mean	Std. Deviation
Mid-hepatic craniocaudad	56	13.2	14.9	14.138	.5158
Maximum craniocaudad	56	14.1	16.0	15.209	.5435
Maximum transverse	56	16.8	18.9	18.066	.6094
Midhepatic anteroposterior	56	13.2	15.1	14.320	.5043

Table4.7:show correlation between age and mid hepatic raniocaudad.

		Age	Mid hepatic point craniocaudad
Age	Pearson Correlation	1	-.803**
	Sig. (2-tailed)		.000
	N	100	100
Mid hepatic poincraniocaudad	Pearson Correlation	-.803**	1
	Sig. (2-tailed)	.000	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

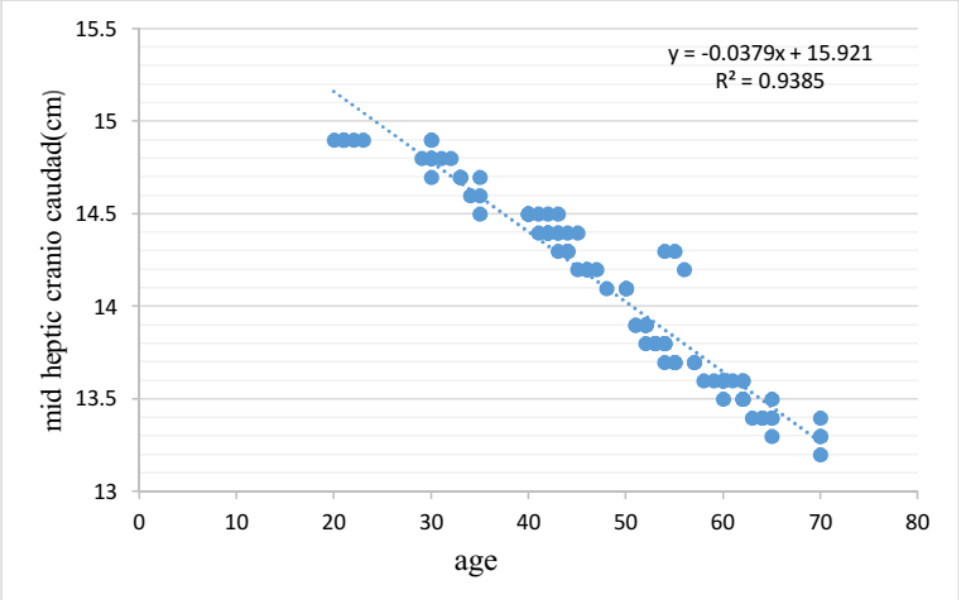


Figure 4.4: Scatter plot diagram shows the linear relation between the age and mid-hepatic pointcranio-caudad, as age increased the mid-hepatic cranio-caudad decreased by 0.03.

Table 4.8: show correlation between age and maximum craniocaudad.

		Age	Maximum craniocaudad
Age	Pearson	1	-.671**
	Sig. (2-tailed)		.000
	N	100	100
Maximum craniocaudad	Pearson	-.671**	1
	Sig. (2-tailed)	.000	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

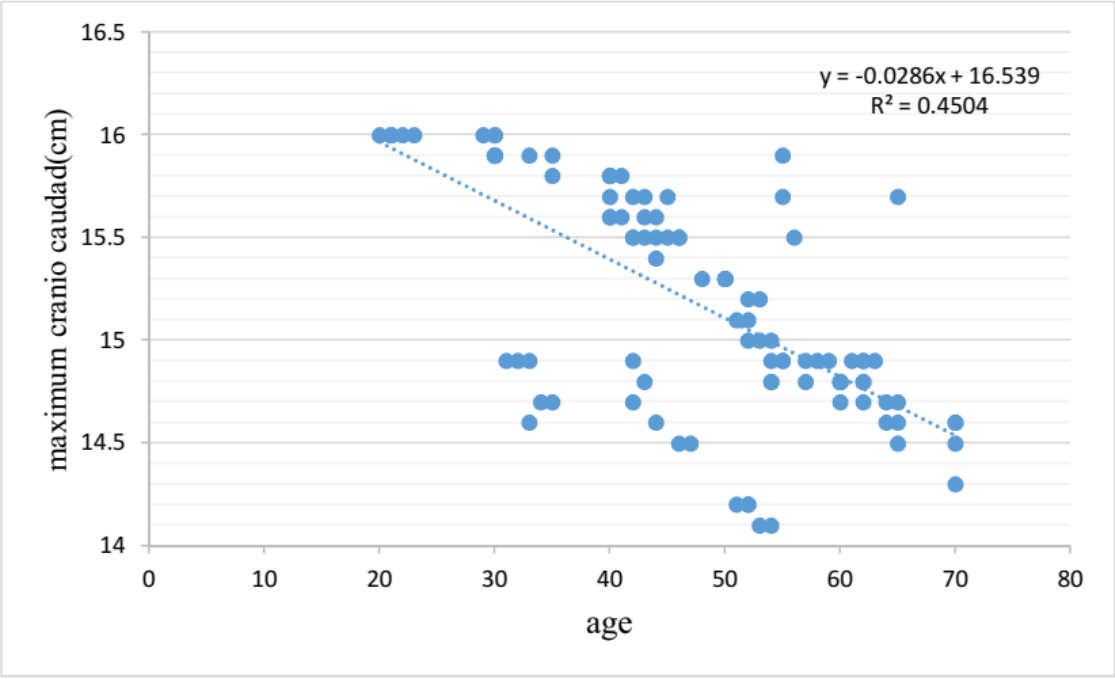


Figure 4.5: Scatter plot diagram shows the linear relation between the age and maximum craniocaudad, as age increase the maximum craniocaudad decreased by 0.02.

Table 4.9: show correlation between age and maximum transverse dimension.

		Age	Maximum transverse dimension
Age	Pearson	1	-.920**
	Sig. (2-tailed)		.000
	N	100	100
Maximum transverse dimension	Pearson	-.920**	1
	Sig. (2-tailed)	.000	
	N	100	100

**. Correlation is significant at the 0.01 level (2-tailed).

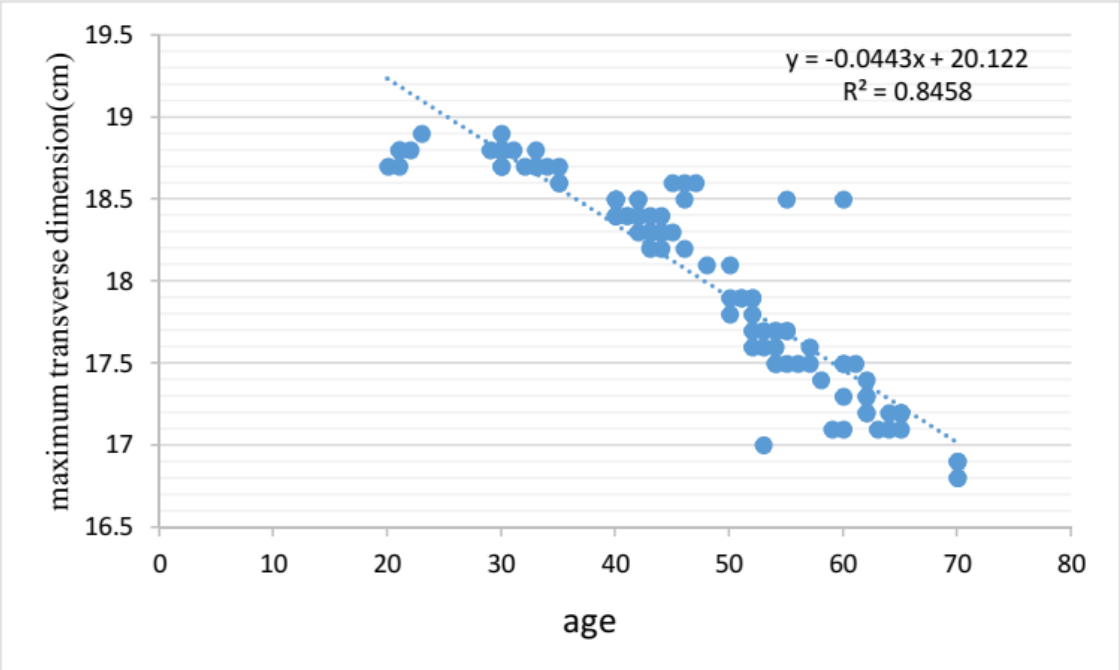


Figure 4.6: Scatter plot diagram shows the linear relation between the age and maximum transverse, as age increased the maximum transverse dimension decreased by 0.04.

Table 4.10:show correlation between age and mid hepatic antero-posterior.

		Age	Mid hepatic anteroposterior
Age	Pearson Correlation	1	-.796**
	Sig. (2-tailed)		.000
	N	10	100
Mid hepatic anteroposterior	Pearson Correlation	-	1
	Sig. (2-tailed)	.00	
	N	10	100

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 4.7: Scatter plot diagram shows the linear relation between the age and Mid-hepatic antero-posterior, as age increased the mid-hepatic antero-posterior decreased by 0.03.

Chapter Five

Discussion, Conclusion and Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5.1 Discussion:

This study is aimed to evaluate normal liver measurement in Sudanese using CT to find new index for Sudanese. The study took into consideration the normal liver measurements correlated that with age and gender.

The study showed that the mean and STD of male liver measurement for mid hepatic craniocaudad, maximum craniocaudad, maximum transverse and mid hepatic antero-posterior was found 14.1± 0.54938 cm, 15.2 ±0.5657cm, 18.0 ±0.6235 cm and 14.2 ±0.5217 cm respectively.

And female liver measurements for mid hepatic craniocaudad, maximum craniocaudad, maximum transverse dimension ,mid hepatic antero-posterior was found 14.1± 0.5158 cm,15.2 ±0.5435 cm , 18.1 ±0.6094 cm, 14.3 ±0.5043 cm respectively. This study showed no difference in liver measurements between males and females subjects as in tables (4.5, 4.6).

This study showed mean and STD of mid-hepatic craniocaudad 14.1±0.502 cm for all sample as in table (4.7), these measurements compare to study done by Verma.2010 found mean of mid hepatic craniocaudad was 12.4±2.3 cm which was decreased by 1.7 cm.

The correlation between age and mid-hepatic point of this study showed that there was significant correlation at (P_value0.01) and mid-hepatic craniocaudad decreased by factor 0.03with age as in figure 4.5.

This study showed mean and STD of maximum craniocaudad 15.1±0.547 cm for all sample as in table (4.7), these measurements compare to study done by Verma.2010 found mean and STD of maximum craniocaudad was 17.8±2.3 cm which was increased by 2.7cm.

The correlation between age and maximum craniocoudad of this study showed that there was significant correlation at (P_value0.01) and maximum craniocaudad decreased by factor 0.02with age as in figure 4.6.

This study showed mean and STD of maximum transverse dimension 18.0±0.619 cm for all sample as in table (4.7), these measurements compare to study done by Verma.2010 found mean of maximum transverse dimension was 18.4±2.6cm which was increased by 0.4cm.

The correlation between age and maximum transverse dimension of this study showed that was significant correlation at (P_value0.01) and maximum transverse dimension decreased by factor 0.04with age as in figure 4.7.

This study showed mean and STD of mid-hepatic point anteroposterior 14.3±0.508 cm for all sample as in table (4.7), these measurements compare to study done by Verma.2010 found mean of mid-hepatic point anteroposterior was 14.8±2.7cm which was increased by 0.5cm.

The correlation between age and mid-hepatic point anteroposterior of this study showed that was significant correlation at(P_vaule 0.01) and mid hepatic point decreased by factor 0.03with age as in figure 4.8.

5.2 Conclusion:

By the end of the study the researcher found liver measurements (mid hepatic craniocaudad, maximum craniocaudad, maximum transverse dimension and mid hepatic anteroposterior) of Sudanese decreased with age and this indicate liver size decreased with age.

Also there were no different between measurements of male and female.

5.3 Recommendations:

Recommended further measure liver dimension for Sudanese by different device (US, MRI) compared with CT.

Availability of different diagnostic imaging machine in all Sudan cities.

Future studies in evolution of liver measurement should be done with larger sample of population for more accurate results.

-Future studies should be done with several body characteristic in correlation with liver measurements. -Future studies should be done use PET/ CT scan. Future studiesshould be done evolution of liver measurements in child.

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Appendices

Appendix 1

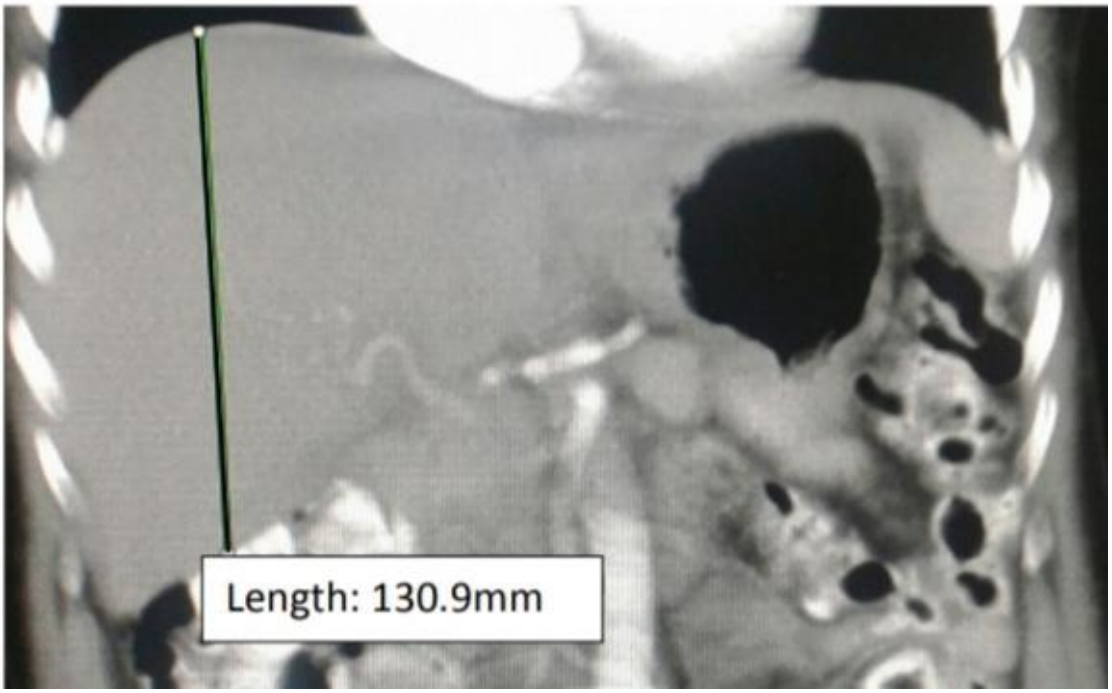

Figure 1: Coronal CT image for female (65years) show measurements of midhepatic craniocaudad.

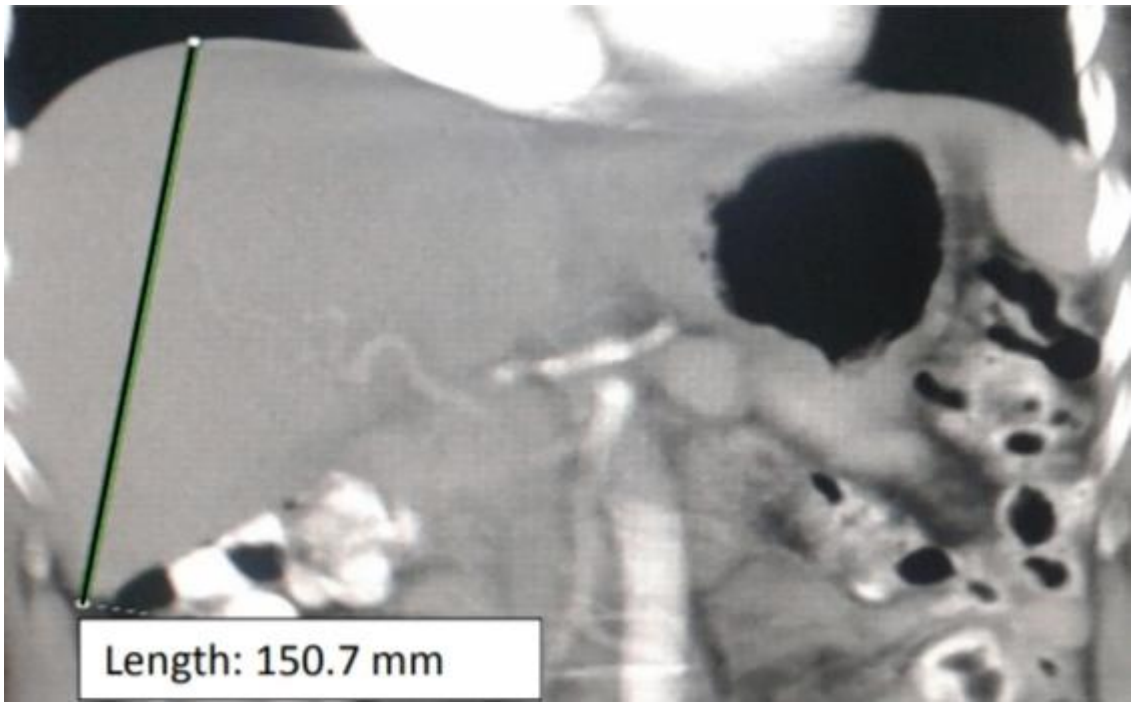

Figure 2: Coronal CT image for female (65 years) show measurements of maximum craniocaudad.

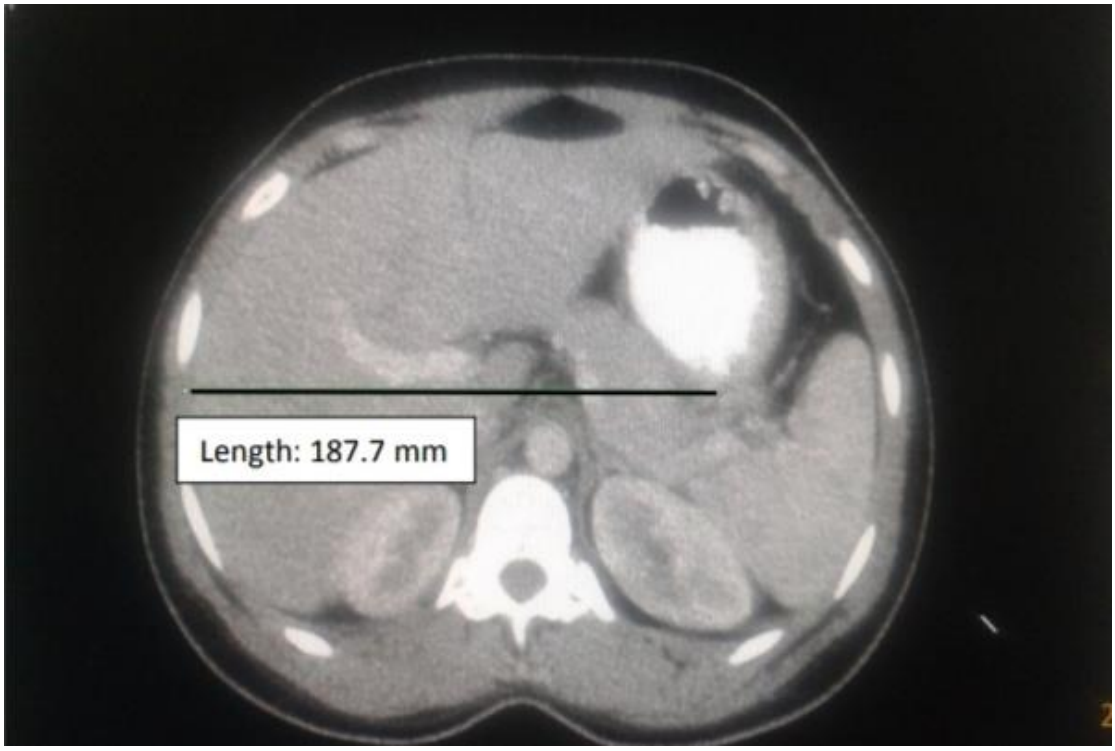

Figure 3: Axial CT image for male (29 years) show measurements of maximum transverse dimension.

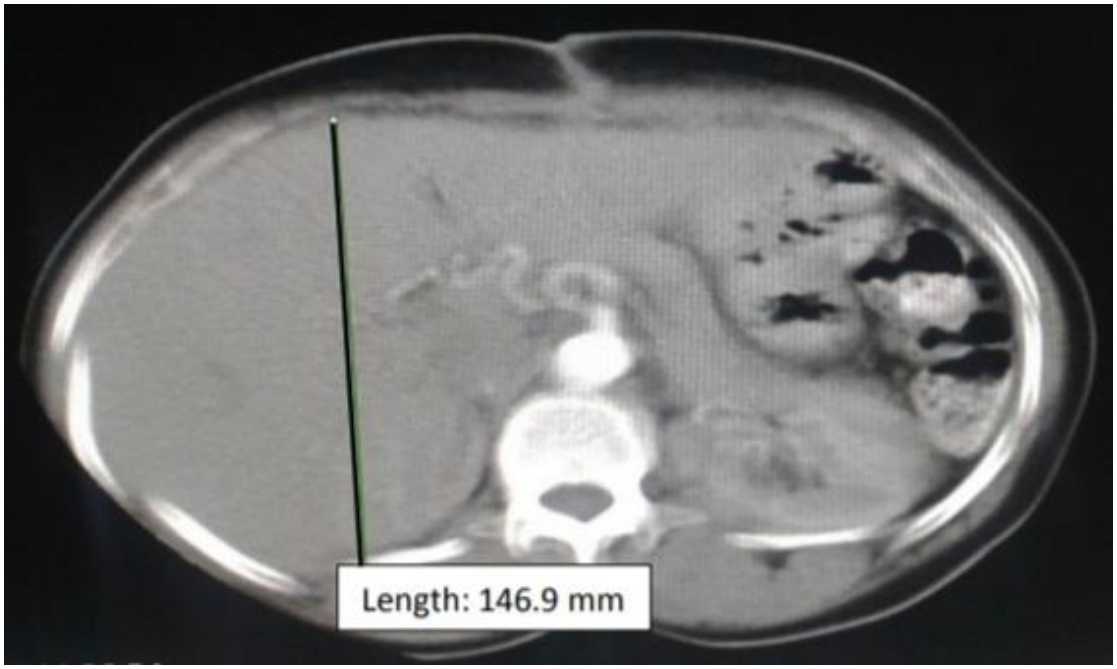

Figure 4: Axial CT image for male (65 years) show measurements of mid hepticantero posterior.

Appendix 2

Sudan University of Science and Technology Collage of Graduate

Study Measurement of liver among Sudanese adult by using Computed tomography

Data collection sheet

NO	Gender	Age	Midhepticcraniocaudad	Maximum craniocaudad	Maximum transverse	Midheptic anteriorposterior