Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Caudate to Right Lobe Ratio of Liver among Sudanese Using Ultrasonography

تقويم نسبة الفص الذنبي الي الفص الايمن للكبد لدي السودانيين باستخدام التصويربالموجات فوق الصوتية

A thesis Submitted for Partial Fulfillments for the Requirement of MSc Degree in Medical Diagnostic Ultrasound

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

الآية

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ (5)

صدق الله العظيم

سورة العلق من الآية (1)الي الآية (5)

Dedication

To:-

My parent

To:-

My family

To:-

My friends

To everyone who helped me in my life

Acknowledgment

I thank God for enabling to complete this thesis. I wish thank specially my parent who encouraged me throughout this study. I sincerely thank Dr Ahamed Almustafa, the supervisor of my thesis for this continuous help, supervision and guidance.

I greatly thank all those who supported and helped me to complete this thesis. Thanks also extend to staff of Ribat university hospital.

Abstract

Caudate lobe was thoroughly investigated worldwide, and it size, appearance and relation with right lobe are popular subject to investigators and this was believed to be because it receives blood supply from both right and left portal veins and hepatic arteries.

This was descriptive study aimed to determine the ratio between the caudate lobe and right liver lobe among Sudanese. 107 subjects were enrolled in the study, the liver should look sonographically normal. All patients were scanned with Real time Siemens G60s machine was used with curve linear 3.5 MHZ transducer probe. On transverse scan, the caudate lobe and the right lobe of the liver were measured by obtaining an axial image of the liver immediately below the bifurcation of the main portal vein.

The study showed that the ratio in Sudanese ranging between 0.3 and 0.67, which was similar to the international ratio. Furthermore, there is no statistical difference between both gender measurements, and this is in term revealed that both caudate and right liver lobes were also comparable to their international measures.

Considering a widespread discrepancy regarding the ultrasound findings in cirrhotic patients, the caudate lobe right lobe ratio can be a useful tool. The study has determined the normal ratio in our environment, there is a need for another study to determine the ratio among cirrhotic patients.

الخلاصة

فحص الفص الذنبي للكبد بدقة في جميع أنحاء العالم، وحجمه، والمظهر وعلاقته مع الفص الأيمن خضع لكثير من الدراساتحيث يعتقد أنه يتلقى إمدادات الدم من كل من الأوردة البوابية اليمنى واليسرى والشرايين الكبدية.

هدفت هذه الدراسة الوصفية إلى تحديد النسبة بين الفص الذنبي وفص الكبد الأيمن لدي السودانيين. تم تسجيل 107 فرد في الدراسة، وتم التأكد من أن الكبد طبيعية في صورة الموجات فوق الصوتية. تم مسح جميع المرضى بجهازموجات صوتية (G60s) ماركة سيمنس بمسبار خطي مقوس بقوة 3.5 ميغاهيرتز. على المسح المستعرض، تم قياس الفص الذنبي والفص الأيمن للكبد من خلال الحصول على صورة محورية للكبد مباشرة تحت تشعب الوريد البابي الرئيسي.

أظهرت الدراسة أن النسبة في السودانيين تتراوح بين 0.3 و 0.67، والتي كانت مماثلة للنسبة الدولية. وعلاوة على ذلك، لا يوجد فرق إحصائي بين كل من القياسات بين الجنسين، وهذا ما كشف أن كلا من الفص الذنبي و الايمن للكبد قابل للمقارنة مع القياسات الدولية.

وبالنظر إلى تناقض واسع النطاق فيما يتعلق بنتائج الموجات فوق الصوتية في المرضى الذين يعانون من مرض تليف الكبد، فإن النسبة بين الفص الذنبي و الفص الأيمن يمكن أن تكون أداة مفيدة. وقد حددت الدراسة النسبة الطبيعية في بيئتنا، وهناك حاجة لدراسة أخرى لتحديد النسبة بين مرضى تليف الكبد.

List of abbreviations

ALT	Alanineaminotransferase
AP	Anteroposterior
AST	Asparatateaminotransferase
C\R	Caudate-Right lobe
CD	Color Doppler
CLD	Chronic liver disease
C\R-R	Caudate-right ratio
GIT	Gastrointestinal tract
IVC	Inferior vena cava
MHz	Mega hertz
PV	Portal vein
SPSS	Special Purpose Statistical System
U\S	Ultrasound

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Chapter one

Introduction

1.1 Introduction:

Liver diseases attained great concerns because they constitutes a bulk of work for both clinicians and sonologist, and in our country the incidence of liver diseases is so great because of many reasons which include poverty ,poor sanitation , Crownless ,lack of health facilities and war which result in many refuges in whom such diseases are prevalent ,for the above reasons liver was extensively studied by researchers and they set many criteria determining it ultrasound characteristics, appearance and measurement that help in diagnostic diseases that affect it(Lefkowitch, 2017).

Diseases processes affect the liver in many ways, some of them alter its echogenicity, and others alter its contour, while other affect its size and some affect it in combined way. Many parameters are used to assess the size of the liver as whole or its lobes separately and averages of normal measures were set and used worldwide in assessing liver disease. Hepatitis and cirrhosis are by far the most common disease processes that affect the liver resulting in various changes to the liver depending on the stage of the disease and the stage ranges from minimal echogenicity changes to shrinkage and total contour disrupture(Bedossa, 2017).

Changes in echogenicity, contour disrupture, nodularity, change in size and many other secondary changes were used to diagnose liver cirrhosis. The ratio under study is very well stated criterion for assessing the liver for cirrhotic changes and may be first clue to draw attention for presence of cirrhosis and because of this ratio used to be a popular topic for researcher (Wang et al., 2017).

Caudate lobe was thoroughly investigated worldwide, and it size, appearance and relation with right lobe are popular subject to investigators and this was believed to be because it receives blood supply from both right and left portal veins and hepatic arteries, its assumed as separate segment, which is sometimes spared from some disease processes that affect the liver specially cirrhosis, in which case the ratio of it with the right lobe is distorted. Many studies investigate this area and concluded different ratio due to the geographical difference and this ratio is target of my study in Sudanese population(Abdalla et al., 2002).

The aim of my study is to assess the ratio under study in Sudanese populations so as to set our normal ratio and compare it with international ones.

1.2 Problem of the study:

Various abnormal ultrasound patterns, assigned to cirrhosis of the liver, have always been controversial; this necessitates a quantitative measurement of hepatic dimensions and assessment of various ratios. One of these important ratios is the caudate lobe to right lobe ratio.

1.3 Objectives of the study:

1.3.1 General objective:

To evaluate of caudate to right lobe ratio of liver in Sudanese population.

1.3.2 Specific objectives:

- To measure the caudate lobe of the liver among Sudanese population
- To measure the Right lobe of the liver among Sudanese population
- To establish the ratio of caudate lobe to right liver lobe in Sudanese population

1.4 Overview of the study:

This study consists of five chapters. Chapter one contains introduction, objectives and overview of study. Chapter two deals with the literature review which includes anatomy, physiology and pathology of the liver, symptoms and signs of liver diseases, investigation of liver diseases\S assessment of caudate RT liver lobe ratio, international study of caudate RT lobe ratio and previous study. Chapter three contains methodology of study; chapter four contains the results of study. Chapter five contains discussion of the results; conclusions and recommendations. Finally, there are list references, appendices which include U\S images and data collection sheet.

Chapter two

Literature review

2.1 Anatomy of liver

2.1.1 Hepatic surface:

The liver is usually described as having superior, anterior, right, posterior and inferior surfaces, and has a distinct inferior border. However, superior, anterior and right surfaces are continuous and no definable borders separate them. It would be more appropriate to group them as the diaphragmatic surface, which is mostly separated from the inferior or visceral surface, by a narrow inferior border. The border is rounded between the right and inferior surfaces. The inferior border follows the right costal margin lateral to the fundus of the gallbladder. To the left of the ligamentum teres, the inferior border ascends below the medial end of the right costal margin. At the infra sternal angle the inferior border is related to the anterior abdominal wall(Ortale and Borges Keiralla, 2004).

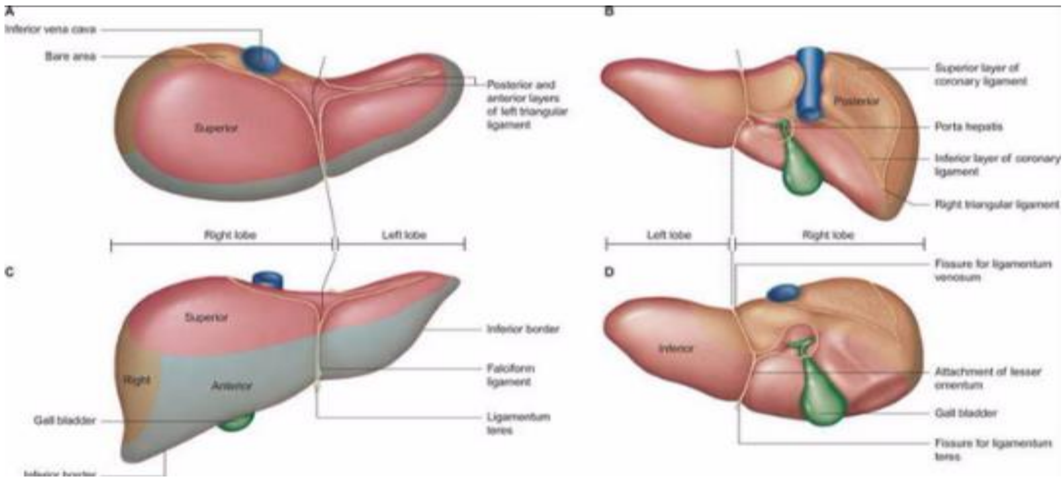

Figure (2.1) the surfaces and external features of the liver. Top left, superior view; top right, posterior view; bottom left, anterior view; bottom right, inferior vein (Ortale and Borges Keiralla, 2004)

2.1.2 Superior surface:

The superior surface is the largest surface and lies immediately below the diaphragm, separated from it by peritoneum except for a small triangular area where the two layers of the falciform ligament diverge. The majority of the superior surface lies beneath the right dome. The left side of the superior surface lies beneath part of the left dome of the diaphragm. The superior surface blends imperceptibly with the anterior, right and posterior surfaces over the 'dome' of the liver. It is related to the right diaphragmatic pleura and base of the right lung, to the pericardium and ventricular part of the heart, and to part of the left diaphragmatic pleura and base of the left lung(Boybeyi et al., 2015).

2.1.3 Anterior surface

The anterior surface, which is approximately triangular and convex, is covered by peritoneum except at the attachment of the falciform ligament. Much of it is in contact with the anterior attachment of the diaphragm. On the right the diaphragm separates it from the pleura and sixth to tenth ribs and cartilages, and on the left from the seventh and eighth costal cartilages. The median area of the anterior surface lies behind the xiphoid process and the anterior abdominal wall in the infracostal angle(Boybeyi et al., 2015).

2.1.4 The right surface:

The right surface is covered by peritoneum and lies adjacent to the right dome of the diaphragm which separates it from the right lung and pleura and the seventh to eleventh ribs. The diaphragm, the costodiaphragmatic recess lined by pleura, and the ninth and tenth ribs all lie lateral to the middle third of the right surface. Lateral to the lower third, the diaphragm and thoracic wall are in direct contact. (Boybeyi et al., 2015)

2.1.5 The posterior surface

The posterior surface is convex, wide on the right, but narrow on the left. A deep median concavity corresponds to the forward convexity of the vertebral column close to the attachment of the ligamentum venosum. Much of the posterior surface is attached to the diaphragm by loose connective tissue, which forms the so-called 'bare area'. The 'bare area' is triangular in shape. To the left of the caval groove the posterior surface of the liver is formed by the caudate lobe, which is covered by a layer of peritoneum. The caudate lobe is related to the diaphragmatic crura above the aortic opening and the right inferior phrenic artery. It is separated by these structures from the descending thoracic aorta.

The fissure for the ligamentum venosum separates the posterior aspect of the caudate from the main part of the left lobe. The fissure cuts deeply in front of the caudate lobe and contains the two layers of the lesser omentum. Below, it curves laterally to the left end of the portahepatis. At the upper end of the caudate lobe it joins the left hepatic vein near its entry into the inferior vena cava, or sometimes the vena cava itself. (Boybeyi et al., 2015)

2.1.6 Inferior surface:

The inferior surface of the left lobe is related inferiorly to the fundus of the stomach and the upper lesser omentum. The quadrate lobe lies adjacent to the pylorus. The inferior surface is bounded by the inferior edge of the liver. It blends with the posterior surface in the region of the origin of the lesser omentum, the portahepatis and the lower layer of the coronary ligament. It is marked near the midline by a sharp fissure which contains the ligamentum teres. Posteriorly the inferior surface is related to the ligamentum venosum and the gallbladder. Duodenum and the lower part of the lesser omentum. To the right of the gallbladder, the inferior surface is related to the hepatic flexure of the colon, the right suprarenal gland and right kidney, and the first part of the duodenum. (Boybeyi et al., 2015)

2.1.7 The portahepatis

The portahepatis is the area of the inferior surface through which all the neurovascular and biliary structures, except the hepatic veins, enter and leave the liver. It is situated between the quadrate lobe in front and the caudate process behind. The portahepatis is actually a deep fissure into which the portal vein, hepatic artery and hepatic nervous plexus ascend into the parenchyma of the liver. The right and left hepatic bile ducts and some lymph vessels emerge from it. At the portahepatis, the hepatic ducts lie anterior to the portal vein and its branches, and the hepatic artery with its branches lies between the two. The dense aggregation of vessels, supporting connective tissue, and liver parenchyma just above the portahepatis is often referred to as the 'hilar plate' of the liver. (Boybeyi et al., 2015)

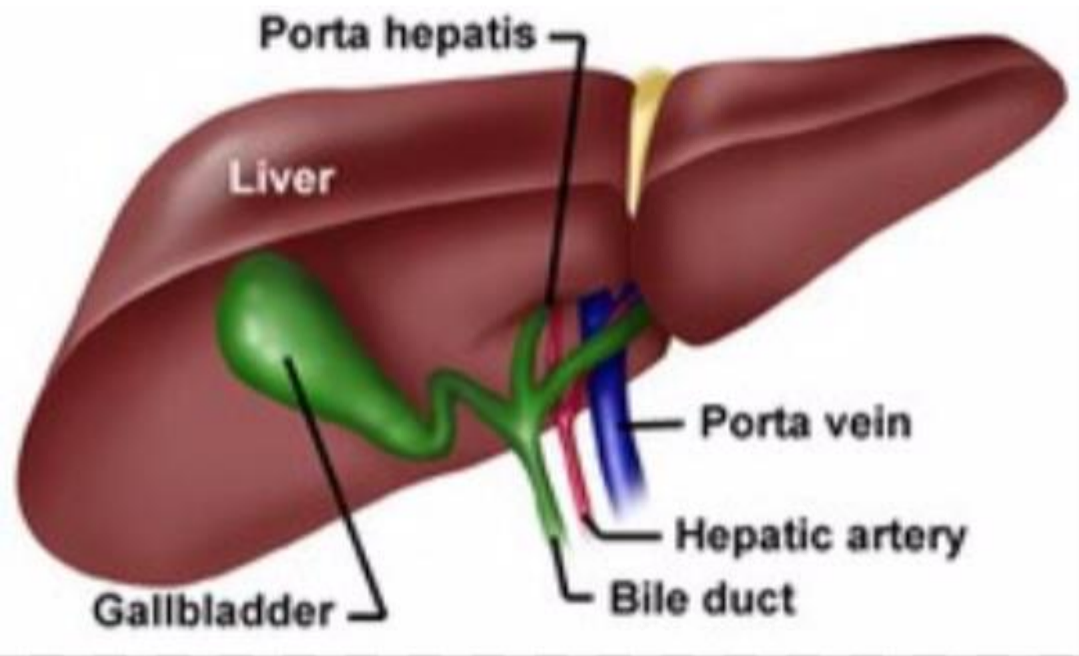

Figure (2.2):- The portahepatis of the liver (Boybeyi et al., 2015)

2.1.8 Lobation and segmentation

The liver has four lobes or eight segments, depending on whether it is defined by its gross anatomical appearance or by its internal architecture. Classification of the liver by internal architecture divides it into lobes, segments or sectors. The biliary, hepatic arterial and portal venous supply of the liver tends to follow very similar distributions used to define the hepatic segments. The surface of the liver is often marked by indentations or accessory fissures which do not relate directly to the lobes or segments. They occur most often over the superior, right, and anterior surfaces. (Boybeyi et al., 2015)

Historically the gross anatomical appearance of the liver has been divided into right, left, caudate and quadrate lobes by the surface peritoneal and ligamentous attachments. The falciform ligament superiorly and the ligamentum venosum inferiorly, mark the division between right and left lobes. On the inferior surface, to the right of the groove formed by the ligamentum venosum, there are two prominences separated by the portahepatis. The quadrate lobe lays interiorly, the caudate lobe posteriorly. (Boybeyi et al., 2015)

The right lobe is the largest in volume and contributes to all surfaces. It is demarcated by the line of attachment of the falciform ligament superiorly. Inferiorly the fissure for the ligamentum teres, the groove for the ligamentum venosum, and the attachment of the lesser omentum, mark its border. (Boybeyi et al., 2015)

The inferior border of the right lobe, to the right of the gallbladder, often demonstrates a bulge of tissue, which when pronounced, is referred to as Riedel's lobe. Although the right inferior border of the liver is not usually palpable, the presence of a Riedel's lobe may be clinically detectable and may give rise to confusion as an apparent pathological right upper quadrant mass.

The quadrate lobe is only visible from the inferior surface. It is bounded by the gallbladder fossa to the right, a short portion of the inferior border interiorly, the fissure for the ligamentum teres to the left, and the portahepatis posteriorly. In gross anatomical descriptions it is said to be a lobe arising from the right lobe; however, it is functionally related to the left lobe. (Boybeyi et al., 2015)

The caudate lobe is visible on the posterior surface. It is bounded on the left by the fissure for the ligamentum venosum, below by the portahepatis, and on the right by the groove for the inferior vena cava. Above, it continues into the superior surface on the right of the upper end of the fissure for the ligamentum venosum. Below and to the right, it is connected to the right lobe by a narrow caudate process, which is immediately behind the portahepatis and above the epiploic foramen. Depending on the depth of the fissure for the ligamentum venosum, the caudate lobe often has an anterior surface, which forms the posterior wall of the fissure and is in contact with the hepatic part of the lesser omentum. In gross anatomical descriptions this lobe is said to arise from the right lobe, but it is functionally separate. (Boybeyi et al., 2015)

The left lobe is the smaller of the two 'main' lobes. It lies to the left of the falciform ligament, has no subdivisions, and ends in a thin apex pointing into the left upper quadrant. Since it is substantially thinner than the right lobe it is more flexible. It is nearly as large as the right lobe in young children, possibly due to a more even distribution in portal and hepatic arterial supply, which may progressively come to favour growth of the right lobe during development of the body cavity. A fibrous band may be present at the left end of the adult left lobe: it represents an atrophied remnant of the more extensive left lobe found in children. If present, it contains atrophied bile ducts called the hepatic vasa aberrantia. (Boybeyi et al., 2015)

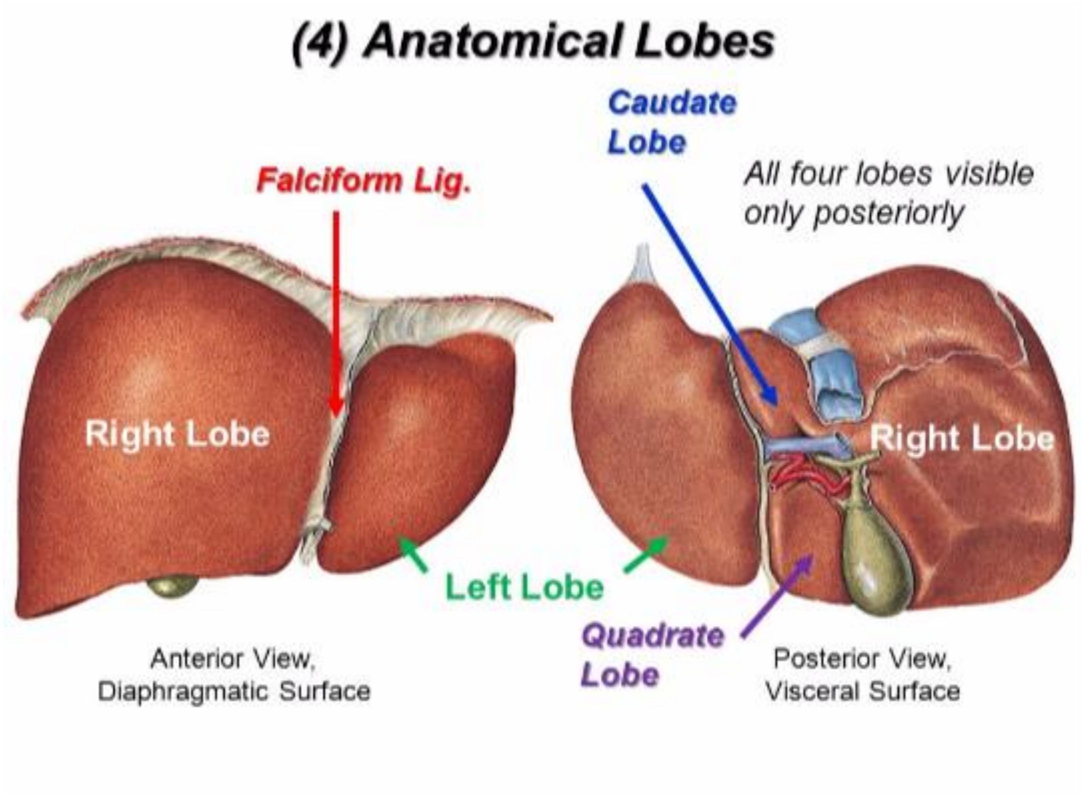

Figure (2.3) the anatomical lobes of liver (Boybeyi et al., 2015)

Although a variety of definitions have been used to describe the anatomy of the liver segments, the most widely accepted clinical nomenclature is that described by Couinaud (1957), and Healey and Schroy (1953). The internal architecture of the liver is divided into segments, commonly referred to as Couinaud's segments. Couinaud based his work on the distribution of the portal and hepatic veins whilst Healey and Schroy studied the arterial and biliary anatomy. (Boybeyi et al., 2015)

The liver is divided by the 'principal plane' into two halves of approximately equal size. The principal plane is defined by an imaginary parasagittal line from the gallbladder anteriorly to the inferior vena cava posteriorly. The usual functional division of the liver into right and left lobes lies along this plane. The liver is further subdivided into segments, each supplied by a principal branch of the hepatic artery, portal vein and bile duct. Segments I, II, III and IV make up the functional left lobe, and segments V, VI, VII and VIII make up the functional right lobe. The right lobe can be further divided into a posterior and anterior section or sector. The right posterior section is made up of segments VI and VII, and the right anterior section is made up of segments V and VIII. The left lobe can also be divided into sections: segment IV is referred to as the left medial section, and segments II and III as the left lateral section. The hepatic veins lie in liver parenchyma between the sections. Segment I corresponds to the gross anatomical caudate lobe and segment IV to the quadrate lobe (Boybeyi et al., 2015)

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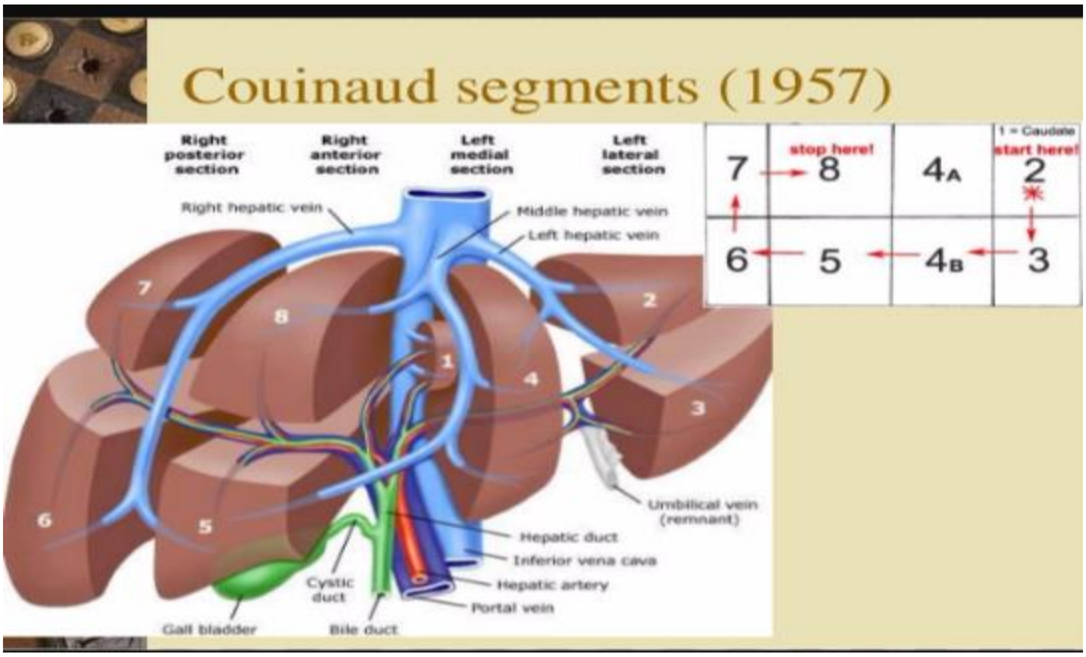

Boybeyi et al., 2015)

2.1.9 Hepatic ligaments:-

The liver is attached to the anterior abdominal wall, diaphragm and other viscera by several ligaments; the liver is attached in front to the anterior abdominal wall by the falciform ligament. The two layers of this ligament descend from the posterior surface of the anterior abdominal wall and diaphragm and turn onto the anterior and superior surfaces of the liver. On the dome of the superior surface, the right leaf runs laterally and is continuous with the upper layer of the coronary ligament. The left layer of the falciform ligament turns medially and is continuous with the anterior layer of the left triangular ligament. The ligamentum teres it runs in the lower free border of the falciform ligament. (Boybeyi et al., 2015).

The coronary ligament is formed by the reflection of the peritoneum from the diaphragm onto the posterior surfaces of the right lobe of the liver. Between the two layers of this ligament there is a large triangular area of liver devoid of peritoneal covering called the 'bare area' of the liver. The coronary ligament is continuous on the right with the right triangular ligament. On the left, it becomes closely applied, and forms the left triangular ligament. The upper layer of the coronary ligament is reflected superiorly onto the inferior surface of the diaphragm and inferiorly onto the right and superior surface of the liver. The lower layer of the coronary ligament reflects inferiorly over the right suprarenal gland and right kidney, and superiorly onto the inferior surface of the liver. (Boybeyi et al., 2015)

The left triangular ligament is a double layer of peritoneum which extends to a variable length over the superior border of the left lobe of the liver. Medially the anterior leaf is continuous with the left layer of the falciform ligament. The posterior layer is continuous with the left layer of the lesser omentum. The left triangular ligament lies in front of the abdominal part of the oesophagus, the upper end of the lesser omentum and part of the fundus of the stomach. Boybeyi et al., 2015)

Division of the left triangular ligament allows the left lobe of the liver to be mobilized for exposure of the abdominal oesophagus and crura of the diaphragm. The right triangular ligament is a short structure which lies at the apex of the 'bare area' of the liver and is continuous with the layers of the coronary ligament. The lesser omentum is a fold of peritoneum which extends from the lesser curve of the stomach and proximal duodenum to the inferior surface of the liver. The attachment to the inferior surface of the liver is L-shaped. The vertical component follows the line of the fissure for the ligamentum venosum - the fibrous remnant of the ductus venosus. More inferiorly the attachment runs horizontally to complete the L in the portahepatis. At its upper end, the superior layer of lesser omentum is continuous on the left with the posterior layer of the left triangular ligament, and the inferior layer is continuous on the right with the coronary ligament as it encloses the inferior vena cava. At its lower end, the two layers diverge to surround the structures of the portahepatis. A thin fibrous condensation of fascia usually runs from the medial end of the portahepatis into the fissure in the inferior surface which contains the ligamentum teres. This fascia is continuous with the lower border of the falciform ligament when the ligamentum teres re-emerges at the inferior border of the liver (Boybeyi et al., 2015)

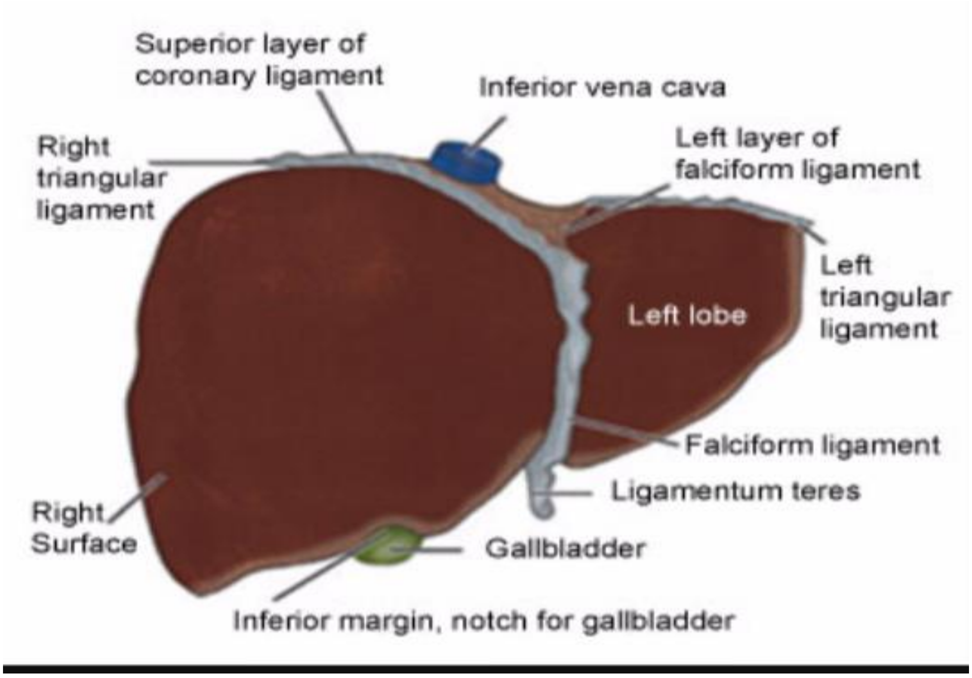

Figure (2.5) the ligaments of liver (Boybeyi et al., 2015)

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2.1.10 Fixation of liver

Several factors contribute to maintain the liver in place. The attachment of the liver to the diaphragm by coronary ligaments and intervening connective tissue of uncovered area, together with the intimate connection of inferior vena cava by connective tissue and hepatic vein would hold up the posterior part of the liver. Some support is derived from the pressure of abdominal viscera which completely fill the abdomen whose muscular wall are always in estate of tonic contraction. The superior surface of the liver is perfectly fitted to the under surface of diaphragm so that atmospheric pressure alone would be enough to hold it against the diaphragm. The latter is turn is hold up by negative pressure in the thorax. The lax falciform ligament certainly gives no support though it probably limits lateral displacement.

2.1.11Development of liver:

The liver arises from the distal end of foregut as solid bud of entodermal cell. The site of origin lies at the apex of the loop of developing duodenum and corresponds to appoint half away along the second part of the fully formed duodenum.

The hepatic bud grows interiorly into the mass of splanchnic mesoderm called the septum transversum. The end of bud now divided into right and left branches. The paired vitelline veins and umbilical veins that course through the septum transversum become broken up by the invading columns of liver cells and form the liver sinusoids. The columns of entodermal cells form the liver cords. The connective tissue of liver is formed from mesenchyme of the septum transversum.

The main hepatic bud and its right and left terminal branches now become canalized to form the common hepatic duct and right and left hepatic ducts, the right lobe becomes much larger than the left lobe.

2.1.12 Important relation:

Anteriorly; Diaphragm, right and left costal margins, right and left pleura and lower margins of lung,xiphoid process and interior abdominal wall in sub costal angle.Posteriorly; Diaphram,right kidney, hepatic flexure of colon, duodenum, gall bladder,IVC,esophagus and fundus of stomach.

2.1.13 Anatomic variants of liver:

Riedel lobe can be described as a tongue like extension of right hepatic lobe. This anatomic variant is more often seen in women.Riedel lobe may extend inferiorly as far as the iliac crest. An additional variant of the liver is papillary process of caudate lobe. This inferior extension of the caudate lobe can resemble amass .if papillary process is suspected care to evaluate the caudate lobe in both transverse and sigittal scan planes is warranted other anomalies of liver include situs in versus, agenesis of lobe and vascular variations.

2.1.14 Normal structure of liver:

The liver is made up of lobules which are composed of following structure:

Central vein (hepatic vein), Draining sinusoids, Columns of the liver cells between sinusoid arranged in regular and radiate manner and Portal tracts at the periphery, each of it contains branch of hepatic artery, portal vein and intrahepatic bile ducts. The bile ducts drain the numerous of intralobular bile canaliculi which lie between liver cells.

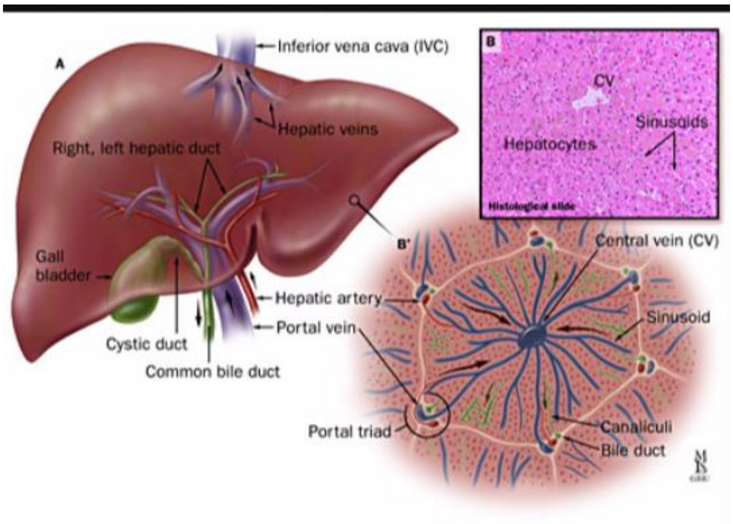

Figure (2.6) the structure of liver

2.1.15 Blood supply:

The hepatic, a branch of celiac artery, divides into right and left terminals branches that enter the portal hepatis. The portal vein divides into the right and left terminal branches that enter the portahepatis behind the arteries .the hepatic veins (three or more) emerge from the posterior surface of the liver and drain into the inferior vena cava. The blood vessels conveying bloods to the liver are the hepatic artery (30%) and portal vein (70%). The hepatic artery brings oxygenated blood to the liver, and portal vein brings venous blood rich in products of digestion.   The arterial and venous blood in conducted to the central vein of each liver lobule by the liver sinusoids. The central veins drains into right and left hepatic veins and these leave the posterior surface of liver and open directly into inferior vena cava(Ortale and Borges Keiralla, 2004).

2.1.16 Lymphatic Drainage:

The liver produces a large amount of lymph about one third to one half all body lymph. The lymph vessels leave the liver and enter several lymph nodes in portal hepatis. The efferent vessels pass to the celiac nodes .a few vessels pass from the bare area of liver through the diaphragm to the posterior mediastinal lymph nodes(Ortale and Borges Keiralla, 2004).

2.2 Physiology of liver:-

Bile a fluid that contains bile salts, cholesterol and small amounts of bilirubin –a waste product from destruction of red blood cells [RBC]. The iron in the heme stored in the liver, the golobin is broken down into amino acids and reused and the pigment part of hemewill be excreted by the liver as part of bile.Bilirubin obtained from the breakdown of RBCs by the spleen is called indirect uniconjugated of fat soluble. It is taken to the liver where, longs with liver unconjugated bilirubin,it is converted to direct, conjugated of water solubleform. Bilirubin must be in the water soluble form to work with the bile salts and enable absorption of fats (Fernandez-Rojo and Ramm, 2016).

The liver manufactures albumin which is large molecule found in the blood. Its role to remain within the capillary and attract back into the vessel the same amount of fluid that left the vessel. Albumin will attract into the vessel the correct amount of interstitial fluid to replenish the plasma lost. Albumin plays a significant role in maintaining the body fluid balance (Fernandez-Rojo and Ramm, 2016).

Many of liver functions are achieved through enzymes, which it also manufactures .enzymes called transaminases are stored in the liver and are used by the liver to move amino groups around from protein to protein as different amino acid are made.Aspartate aminotransferase [AST] and alanine aminotransferase [ALT] are two important enzymes that will back up into blood steam whenever ACUTE hepatic cell damage or death is. Therefore marked elevation of these transaminases in the serum are indicators of an acute hepatic disorder (Hikspoors et al., 2017).

Ammonia is formed from the breakdown of protein. The liver removes this from the blood and it then becomes a principal part of urea. The pancreatic hormones insulin and glucagon work in conjunction with glucose regulation by the liver. The liver removes fatty acids from the blood and changes them into lipoproteins which are more readily used by the body (Poisson et al., 2017).

The liver stores glycogen, fats, amino acids, iron and several vitamins [A, D, B complex and K].the liver utilizes vitamin K to form prothrombin. The liver detoxifies alcohol, drugs and steroid hormones therefore prolonged abuse of alcohol and certain drugs can eventually destroy the hepatic cells. The sex hormones are inactive and metabolized by the liver (Poisson et al., 2017).

Since the liver contains phagocytic cells [called kuffer cells] it can be classified as the part of reticuloendothelial system; these cells remove foreign materials and also remove worn out red blood cells. The iron is stored and pigments, which are a waste, will be excreted as bilirubin protein of bile. These cells also remove the technetium sulfur colloid from the blood(Maratos-Flier, 2017).

2.3 Investigation of liver diseases:

2.3.1 Ultrasound:-

This is noninvasive, safe and relatively cheap technique. It involves the analysis of reflected of U\S beam detected by probe moved across the abdomen .the normal liver appear as relatively homogenous structure .the gall bladder, common bile duct, pancreas, portal vein and other structure in the abdomen can be visualized Other abdominal masses can be delineated and biopsies obtained under U\S guidance(Muller and Tuma, 2015).

2.3.2 Endoscopy:-

The endoscopy can help in the following situations:

- Diagnosis and treatment of varieces.

- Portal hypertensive gastropathy.
- Associated peptic ulcer.
- Colonoscopy may show portal hypertensive colopathy.

2.3.3 Endoscopic U\S.

Endoscopic retrograde chalangiopancreatography (ERCP), Used to outline biliary tree and pancreatic duct, removal of bile duct stent, draining of obstructed biliary system stent and branchy therapy for changiocarcinoma.

2.3.4 Computed tomography (CT scan)

It visualizes pancreas, spleen, lymph nodes and lesion in portahepatis. It also allows assessing shape, size, and a density of liver and characterizes focal lesions. It can also help guiding biopsy. But it expensive and not available in many areas (Poisson et al., 2017).

2.3.5 Magnetic resonance imaging (MRI):

More sensitive investigating focal liver diseases, STIR modes is sensitive for haemangioma, contract agent such as gadolinium characterized lesion further and provide angiography and venography of splanchemic circulation. Magnetic resonance colangio pancreatography (MRCP), Good for visualized bile duct and pancreatic duct (Poisson et al., 2017).

2.4 Sonographic assessment of caudate lobe –RT liver lobe ratio

Only gray scale 2 mode was used to measure caudocranial diameter of both caudate and RT liver lobe. To measure caudocranial diameter of both caudate and RT liver lobe and make ratio between them. Siemens is machine used. Curved array transducer with frequency 3.5MHZ.System setup for abdominal U\S evaluation (Govender et al., 2013).

Usually at mid-clavicular line but partially at axillary line is better to measuring full liver, right kidney is recommended in the view, where as we have normal for this measurement ranging from 14cm to16.5 cm,aline is drawing straight from the lowest most corner of left lobe and another line is drawn from middle of dome which touch the first(Kelly et al., 2017).

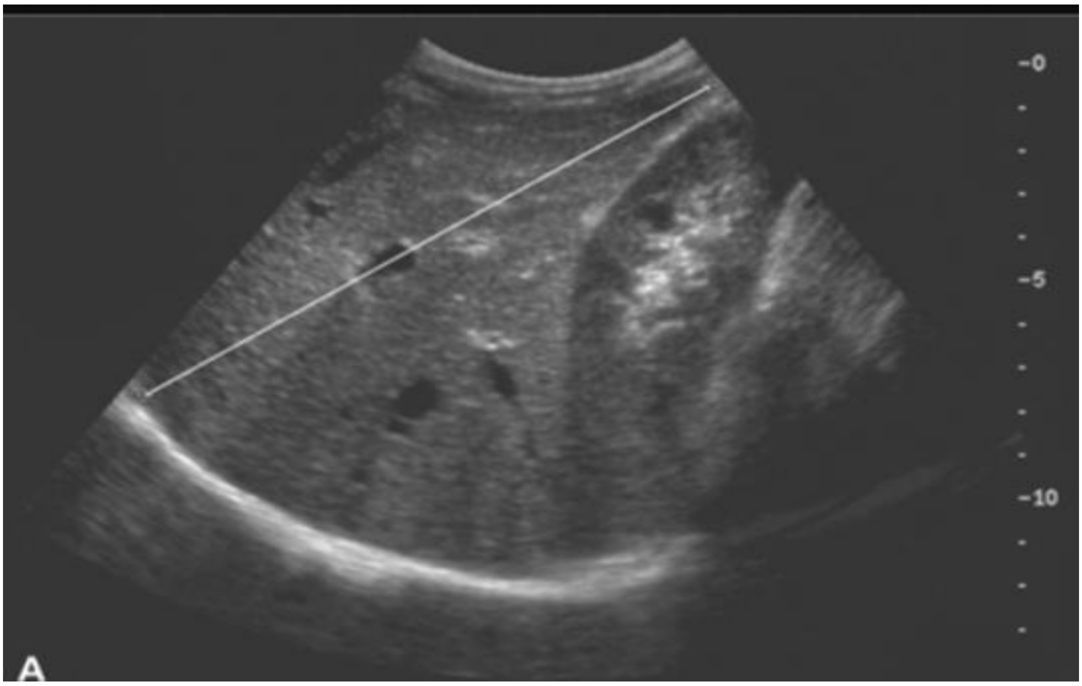

Figure (2.7) showing measurement of liver by caudio-cranial technique.

2.5 Previous studies

A study conducted by Khalid Abdallah to determine the ratio between caudate lobe and right liver lobe ratio, the study survey 102 patients; 63were females and 39were males in alzaiem Alazhary University ultrasound clinic and military hospital. The study found the ratio in Sudanese ranging between0.3 and.69 and there is no statically difference between the ratio obtained and international ratio.

Another study conducted by Alhadi Abdallah Mustafa to evaluation of caudate lobe to right of liver ratio, the study survey 90 patients; 45were females and 45were males in alzaiem Alazhary University ultrasound clinic and Omdurman teaching hospital. The study found the ratio in Sudanese ranging between0.3 and 0.6 the study found that there were siginfant correlation between age and caudate to right lobe ratio and there is no statically difference between the ratio obtained and international ratio.

Another study conducted by Musab Ezz Edin Ali to characterization of normal caudate lobe of liver in adult Sudanese population, the study survey 50patients; 30were females and 20were males in Abu jubaiyah education hospital and alrayan medical center. The study found the ratio in Sudanese ranging between0.3 and 0.6 and there is no statically difference between the ratio obtained and international ratio

Chapter three

Materials and Method

3.1 Materials:

3.1.1 Subjects:

One hundred and seven person selected by non-probability method using convenience sampling, the liver should look sonographically normal. All patients were referred to ultrasound examination in Ribat National University hospital. Verbal consent was obtained from the patients.

3.1.2 Machine Used:

Real time Siemens G60s machine was used with curve linear 3.5 MHZ transducer probe.

3.2 Method

3.2.1 Type of study

Non interventional descriptive cross sectional study.

3.2.2 Area and duration of the study:

The study conducted in Khartoum state, over period from august 2017 to November 2017.

3.2.3 Technique used:

Liver dimensions were obtained with the aid ultrasound Machine using a 3.5MHz curve-linear transducer. The subjects were placed in the supine position on an examination couch and ultrasound gel was applied over the right upper quadrant of the abdomen. We adapted the measurement method outlined below as described by (Harbin et al., 1980),for caudate lobe to right lobe ratio. On transverse scan, the caudate lobe and the right lobe of the liver were measured by obtaining an axial image of the liver immediately below the bifurcation of the main portal vein (Figure 3.1). A para sagittal line (line 1) was drawn through the right lateral border of the portal vein. Another parasagittal line (line 2) was drawn through the left lateral border of the caudate lobe. Two lines orthogonal to lines 1 and 2 midway between the portal vein and the IVC extended to the right liver edge were drawn. The Right Lobe measurement was done along-line 3, from right liver edge to line 1.The caudate lobe was measured along line3, between line 1 and line 2. The caudate-right lobe ratio: C/RL was calculated.

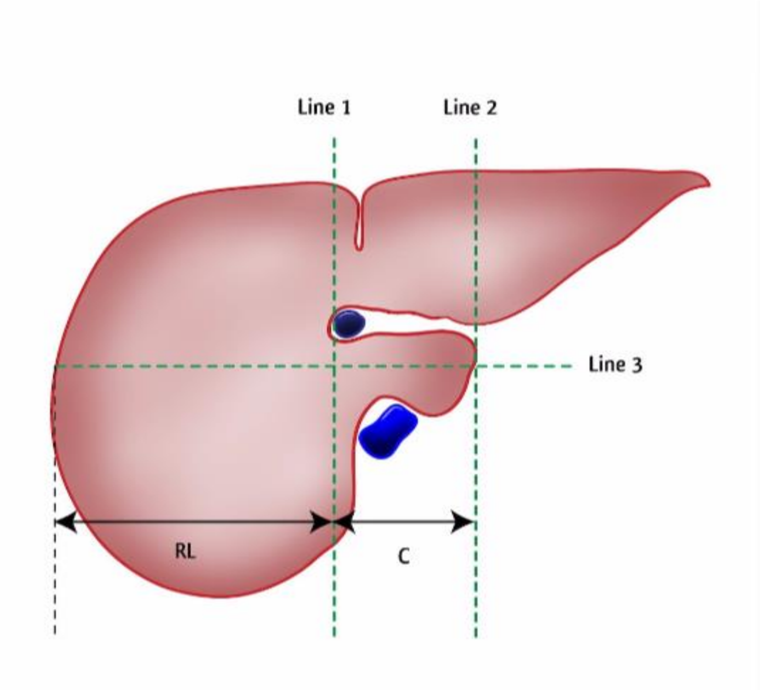

Figure (3.1) showed caudate lobe and right lobe measurement

3.2.4 Image Interpretation

-C\RL<0.6=normal (does exclude cirrhosis).

-C\RL 0.6-0.65=border line.

-C\RL>0.65=96%likely to be cirrhosis.

-C\RL>0.73=99%likely to be cirrhosis.

3.2.5 Data collection and analysis:

The data was collected and calculated where necessary. It was entered into computer for statistical analysis using SPSS for Windows Version 19. The data obtained were presented in tables and figures.

Chapter four

Result

4.1 Results:

Table(4.1) the mean and standard deviation of personal data

	N	Minimum	Maximum	Mean	Std. Deviation
Age	107	3	88	35.26	21.386
Height	107	67	184	156.32	24.060
Weight	107	12	190	64.41	29.952

Table(4.2) the mean and standard deviation of liver measurement

	N	Minimum	Maximum	Mean	Std. Deviation
Right Lobe Size	107	61	147	105.31	18.820
Caudate lobe Size	107	23	90	47.14	10.955
CL\RL Ratio	107	.30	.67	.4483	.07316

Table(4.3) gender distribution

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	50	46.7	46.7	46.7
Female	57	53.3	53.3	100.0
Total	107	100.0	100.0	

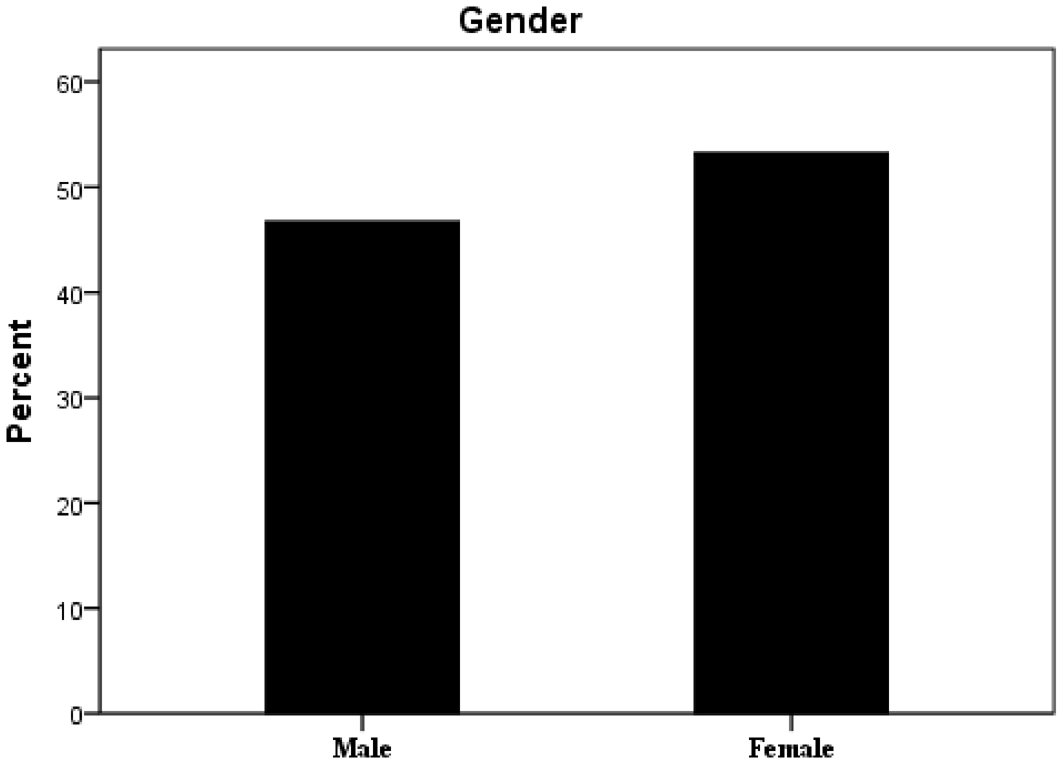

Figure (4.1) gender distribution

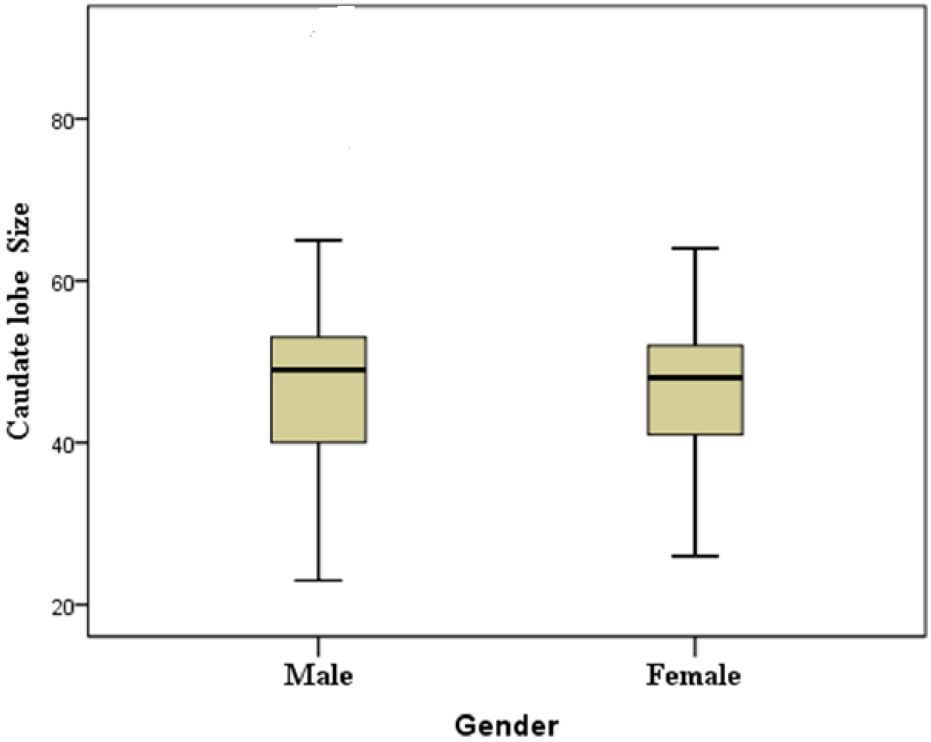

Figure (4.2) caudate lobe in male and female

Table (4.4) distribution of caudate and RT lobe size by gender

	Gender	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
Caudate lobe Size	Male	50	48.06	13.064	1.848	0.640
	Female	57	46.33	8.741	1.158	0.419
Right Lobe Size	Male	50	106.24	21.427	3.030	0.431
	Female	57	104.49	16.347	2.165	0.634

Table (4.5) distribution of ratio by gender

Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
RL/CL Ratio	Male	50	.4514	.07759	.01097
	Female	57	.4456	.06962	.00922

Table (4.6) age group

Age	**Frequency**	**Percent**
1-20	24	22.4%
21-40	45	42.1%
41-60	20	18.7%
61-80	17	15.9%
>80	1	0.9%
Total	**107**	**100.0%**

Table (4.7) distribution of cases by normal and abnormal ratio

Ratio	Frequency	Percent
Normal	104	97.2%
Abnormal	3	2.8%
Mean±SD	0.45±0.07	
Total	**107**	**100.0%**

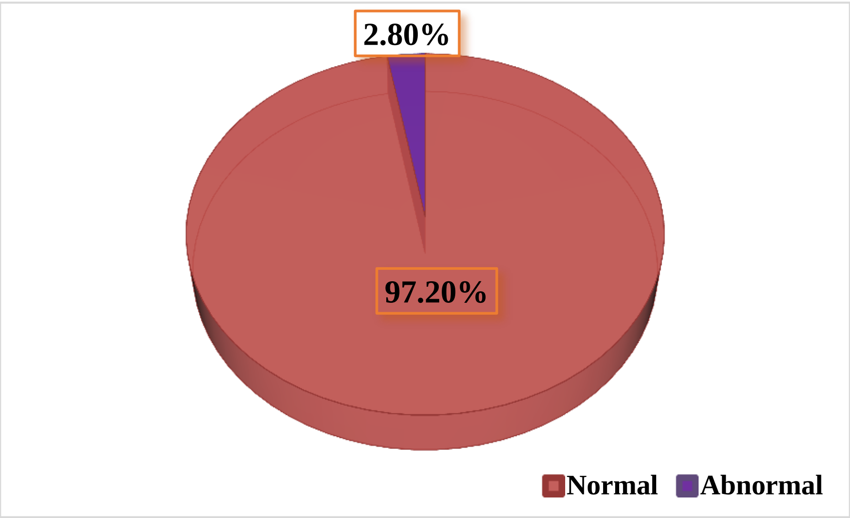

Figure (4.3) distribution of cases by normal and abnormal ratio

Table (4.8) height distribution

Height	Frequency	Percent
65-85	1	0.9%
86-105	7	6.5%
106-125	10	9.3%
126-155	8	7.5%
156-175	67	62.6%
176-195	14	13.1%
Mean±SD	156.32±24.06	
Total	**107**	**100.0%**

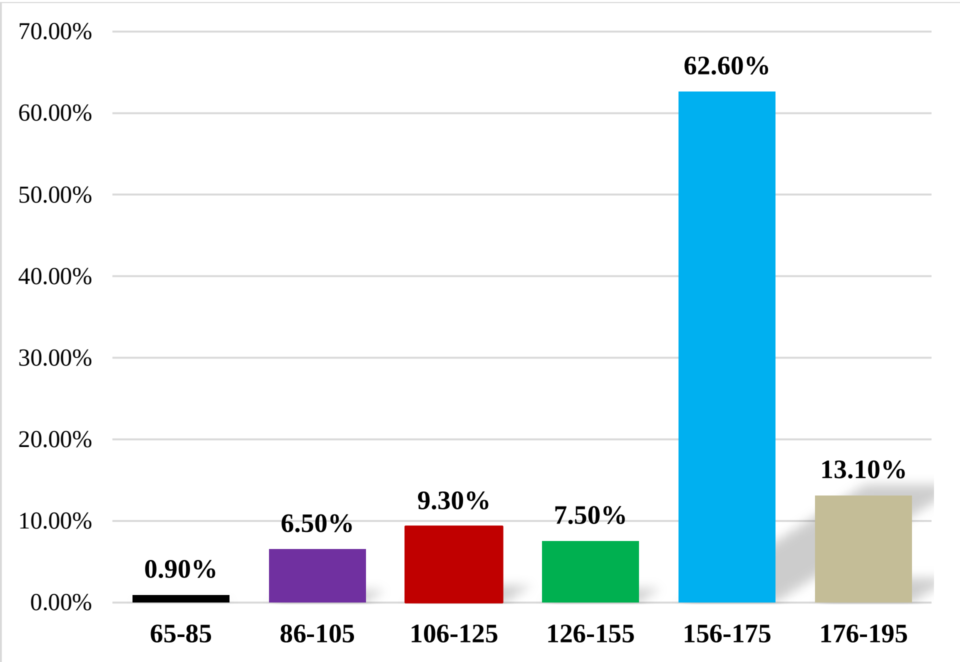

Figure (4.4) height distribution

Table (4.9) weight distribution

Weight	Frequency	Percent
10-40	19	17.8%
41-70	46	43.0%
71-100	37	34.6%
101-130	3	2.8%
161-190	2	1.9%
Mean±SD	64.41±29.95	
Total	**107**	**100.0%**

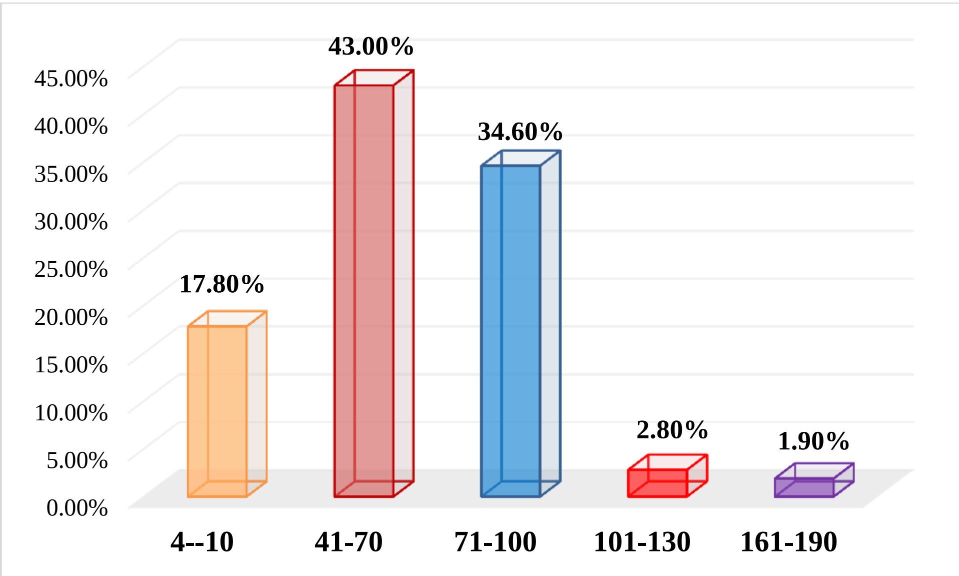

Figure (4.5) weight distribution

Table (4.10) distribution caudate lobe measurement

Caudate	Frequency	Percent
22-<42	29	27.1%
42-<62	67	62.6%
62-<82	10	9.3%
82-102	1	0.9%
Mean±SD	47.14±11.02	
Total	**107**	**100.0%**

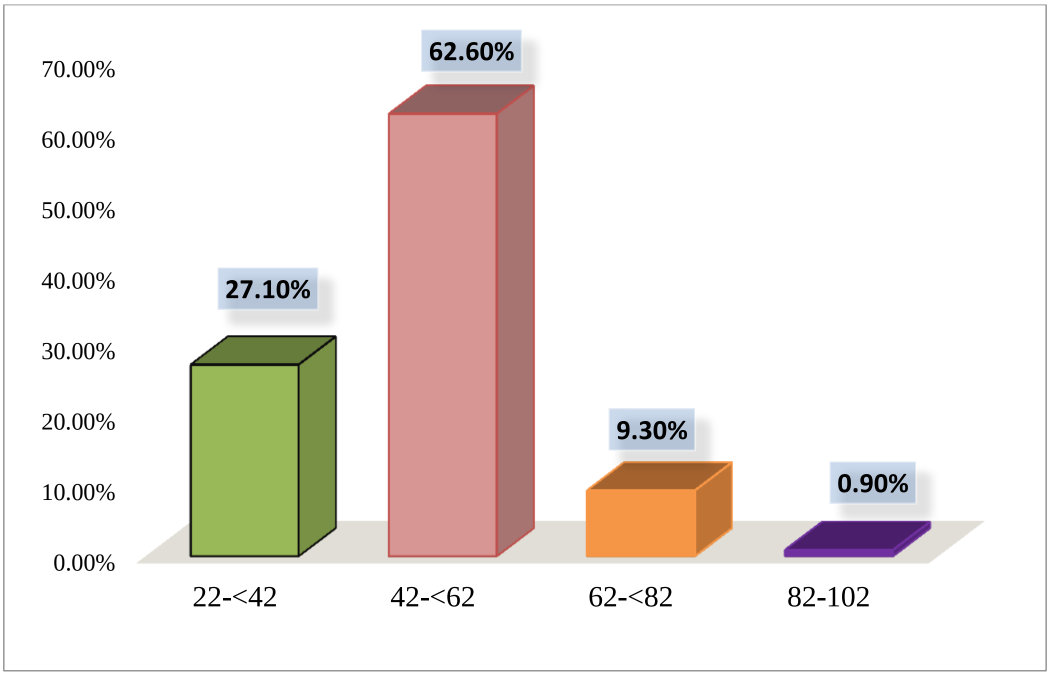

Figure (4.6) caudate lobe measurement distribution

Table (4.11) distribution of right liver lobe measurement

Size of Right Lobe	Frequency	Percent
60-<87	14	13.1%
80-<107	22	20.6%
107-<127	47	43.9%
127-147	24	22.4%
Mean±SD	105.30±18.82	
Total	**107**	**100.0%**

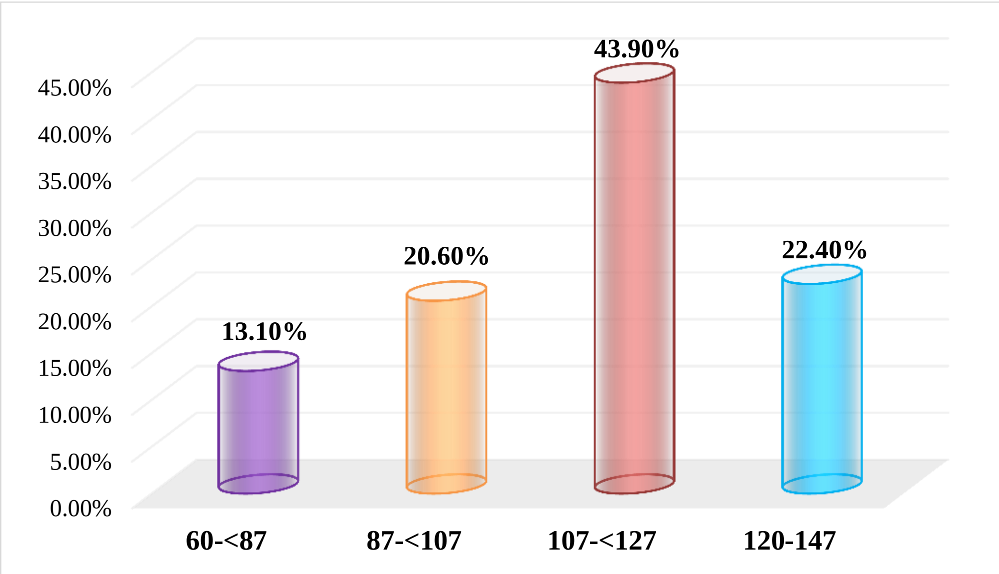

Figure (4.7) distribution of cases by right lobe measurement

Table (4.12) correlation between the C\R ratio and personal data

Correlations					
		AGE	HEIGHT	WEIGHT	RL/CL Ratio
AGE	Pearson Correlation	1	.592**	.392**	.203*
	Sig. (2-tailed)		.000	.000	.036
	N	107	107	107	107
HEIGHT	Pearson Correlation	.592**	1	.420**	.195*
	Sig. (2-tailed)	.000		.000	.045
	N	107	107	107	107
WEIGHT	Pearson Correlation	.392**	.420**	1	.137
	Sig. (2-tailed)	.000	.000		.158
	N	107	107	107	107
RL/CL Ratio	Pearson Correlation	.203*	.195*	.137	1
	Sig. (2-tailed)	.036	.045	.158	
	N	107	107	107	107
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

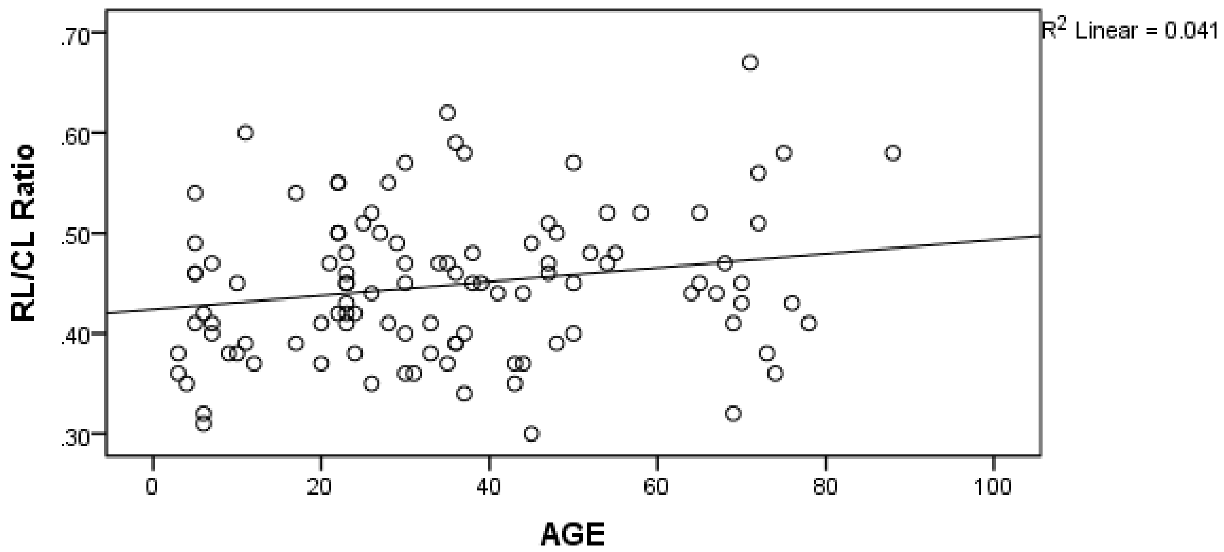

Figure (4.8) scatter plot for patient show the linear association between the CL\RT lobe ratio and age

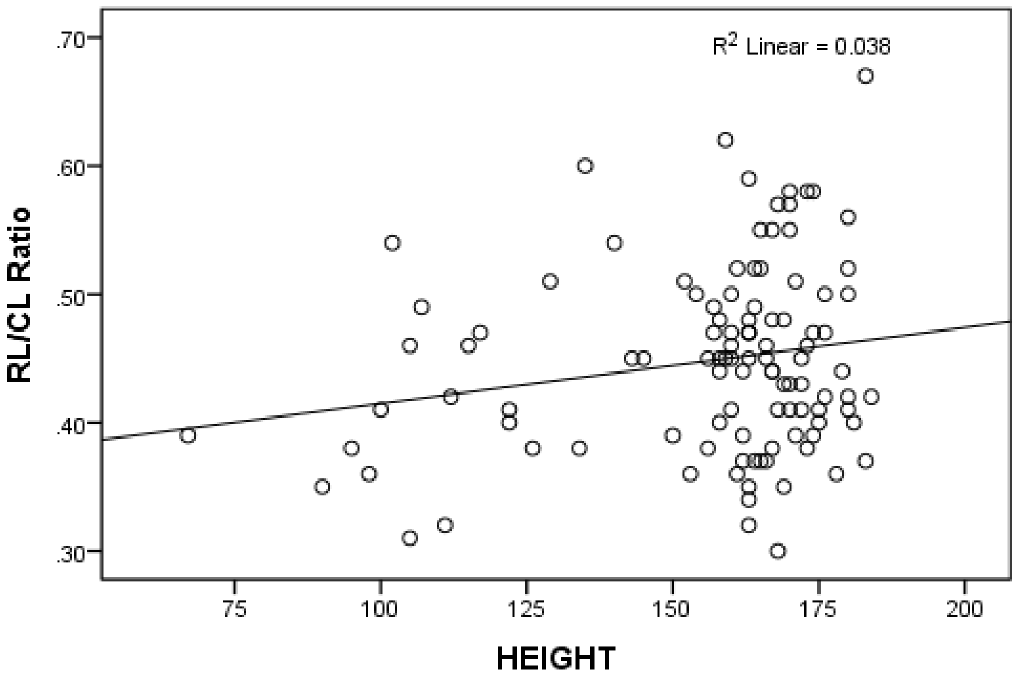

Figure (4.9) scatter plot shows the linear association between C\RT ratio and height

Table (4.13) mean and range value of the anthropometric and measurement parameters.

Items	**Mean±SD**	**Min**	**Max**
Age	35.26±21.39	3.00	88.00
Height	156.32±24.06	67.00	184.00
Weight	64.41±29.95	12.00	190.00
Right Lobe of Liver	105.30±18.82	60.60	146.70
QUADATE	47.14±11.02	22.70	90.40
Ratio	0.45±0.07	0.30	0.67

Chapter five

Discussion, Conclusion and Recommendations

5.1 Discussion

The present study examined 107 subjects (50 were males and 57 were females) with two inclusion criteria which are absence of past history of jaundice and the liver looks sonographicaly normal, their age ranged from 3 years to 88 years.

The caudate (spigelian) lobe is located posteriorly between the inferior vena cava on the right, fissure for the ligamentum venosum on the left and portahepatis anterior. Anatomically, the caudate lobe is classified as part of the right lobe, but functionally it belongs to the left lobe since it receives blood from the left branches of the hepatic artery and portal vein and drain bile to the left hepatic duct(Anatomy, 2005).

Determination of pathological changes in the caudate lobe of the liver and that of the right lobe necessitates knowing the normal ratios of the various parts of the liver in healthy adult subjects. One of these ratios is the caudate lobe to right lobe ratio. It is a useful measurement in assessing chronic liver diseases because of its high sensitivity and specificity in cirrhosis. The information would serve as a source of valuable reference to the radiologists and clinicians attending to patients in our society(Ahidjo et al., 2007).

The study found the caudocranial length of caudate lobe was between 2.3cm and 9cm with mean of 4.7 cm and standard deviation 1.1cm. Furthermore, the right liver lobe caudocranial length was found to be between6.1cm and 14.7cm with the mean of 10.5 cm and standard deviation 1.8cm.

The study found the ratio was between 0.30 and 0.69 with the mean of 0.448 and standard deviation of 0.731, as shown in table (4.2), in males the caudate lobe size was (48.06±13.06) and in females it is slightly lower (46.33±8.7). The study found that the right liver lobe size for male with mean 106.24 and standard deviation 21.427and in female with mean 104.49 and standard deviation16.347; it means that the transverse right lobe dimension was higher in male than female.

The caudate lobe to right lobe ratio of liver in male with mean 0.4514and standard deviation 0.7 and in female with mean 0.44 and standard deviation 0.6, as shown in table (4.5), but the study showed no significant difference for ratio between those different sex group (p value >0.05).There is lack of literature on the normal values for the caudate lobe right lobe generally, more so in Africa. Most of the reported Western values are in agreement that values less than 0.6 are normal,0.6 to 0.65 are borderline and above 0.65 is diagnostic of cirrhosis(Ahidjo et al., 2007).Our study is in agreement with these; however it is on the low side. Similarly there is no data on sex variation. We found there was a slight decrease of the ratio in females compared to males however, it was not significant statistically(Ahidjo et al., 2007).

Considering a widespread discrepancy regarding the ultrasound findings in cirrhotic patients, the caudate lobe right lobe ratio can be a useful tool. The study has determined the normal ratio in our environment, there is a need for another study to determine the ratio among cirrhotic patients.

5.2 Conclusion

Liver diseases and scanning are bulky work for clinician and sonologist that it because it is frequency affected by diseases processes and frequently asked to be scanned. Ultrasound is an accurate noninvasive tool for assessing various organs of the body specially the liver and components. Ultrasound is in assessing the ratio under study which is distributed if the liver is affected by some disease processes such as cirrhosis in which the ratio may be the first sign in ultrasound study and this might ring the bell early so as to try the prevent the progression of disease as early as possible. Sex, age, height and weight were obtained to assess their influence on the ratio under study.

The study assessed 107 subjects and the ratio measured varies between 0.30 and 0.67, the highest ratio observed in males. The mean of ratio obtained by the study was found to be well keeping with the international values.

The ultrasound is a good technique for assessing the liver for disease processes and to assess its size and normal measurements.

5.3 Recommendations:

- The study recommended that this type of examination is so valuable in investigating the liver for many disease processes and aids in making accurate diagnosis.
- Stimulation of abdominal measurement should be carried.
- Further study is highly recommended to make standard caudate-right hepatic lobe ratio in Sudanese patient.
- Caudate-right lobe ratio need to be compared with other modality as CT and MRI.

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Appendix (1)

Sudan University of science and technology

Faculty of graduate studies

Sonographic assessment of caudate lobe to right lobe ratio in Khartoum state

Data sheet

1\Sex male ( ) female ( )

2\Age ( )

3\Height ( )

4\Weight ( )

5\Past history of jaundice yes ( ) no ( )

6\Caudate lobe size ( )

7\Right liver lobe size ( )

8\Ratio ( )

Author:-Rogia Mohammed Ibrahim

Appendix (2)

Case (1) 28 years male with caudate-right lobe ratio of .55

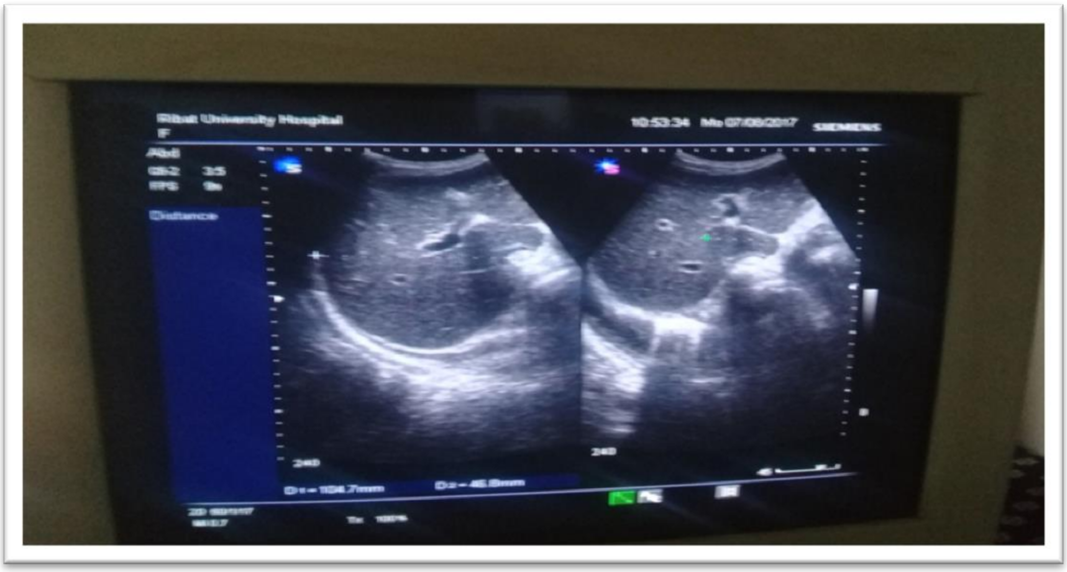

Image (1) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (2) 54 years male with caudate-right lobe ratio of .52

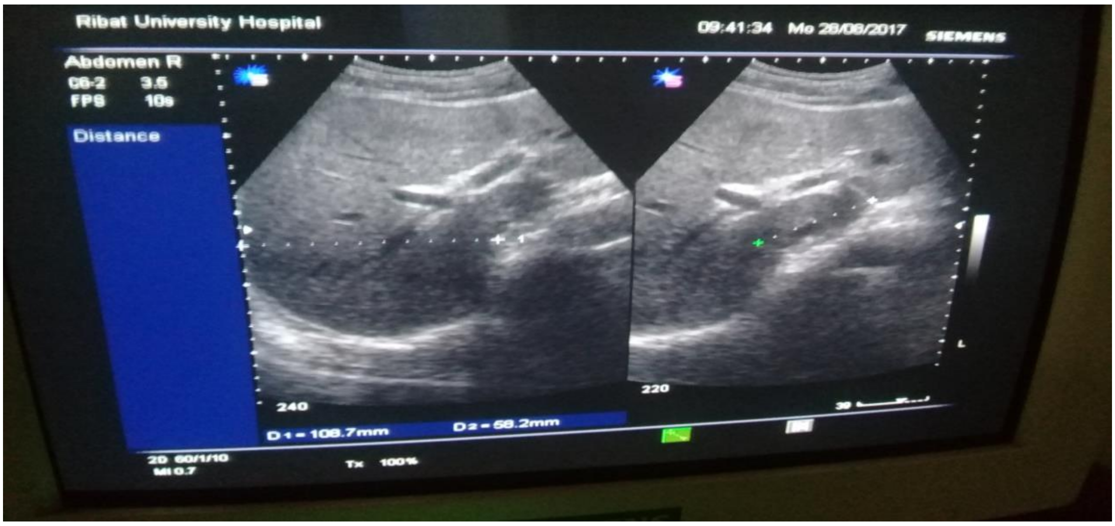

Image (2) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (3) 35 years male with caudate-right lobe ratio of .37

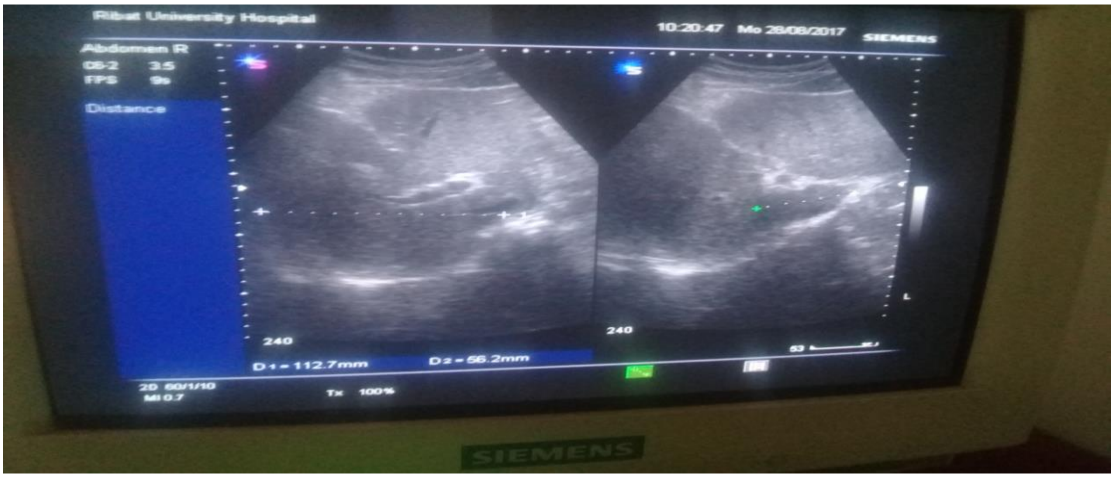

Image (3) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (4) 67 years male with caudate-right lobe ratio of .44

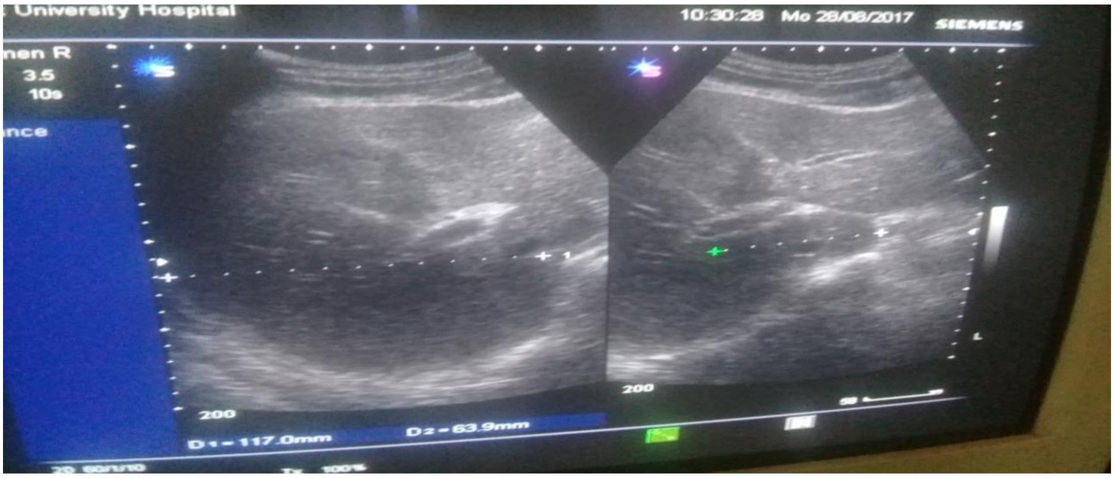

Image (4) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (5) 43 years male with caudate-right lobe ratio of .35

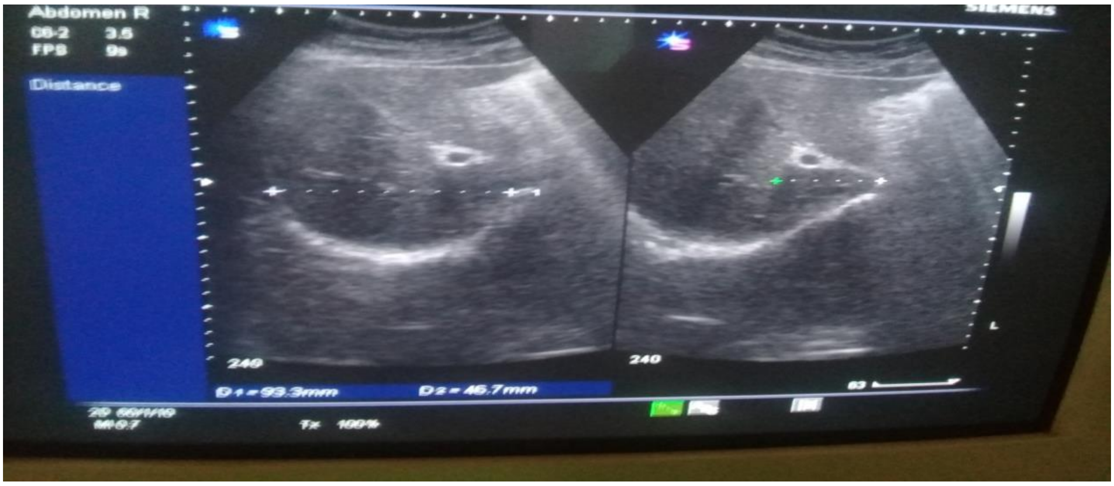

Image (5) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (6) 71 years male with caudate-right lobe ratio of .67

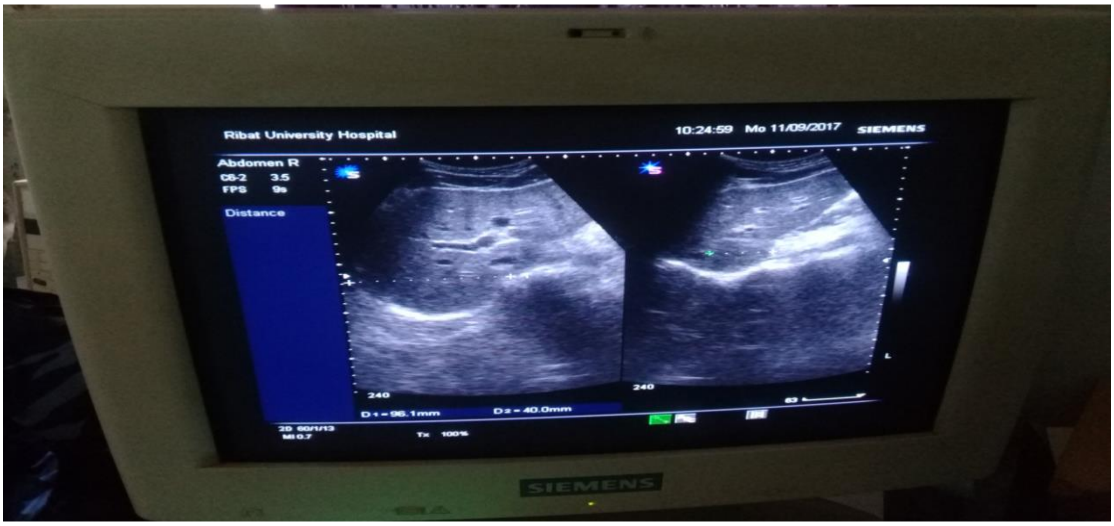

Image (6) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (7) 23 years male with caudate-right lobe ratio of .45

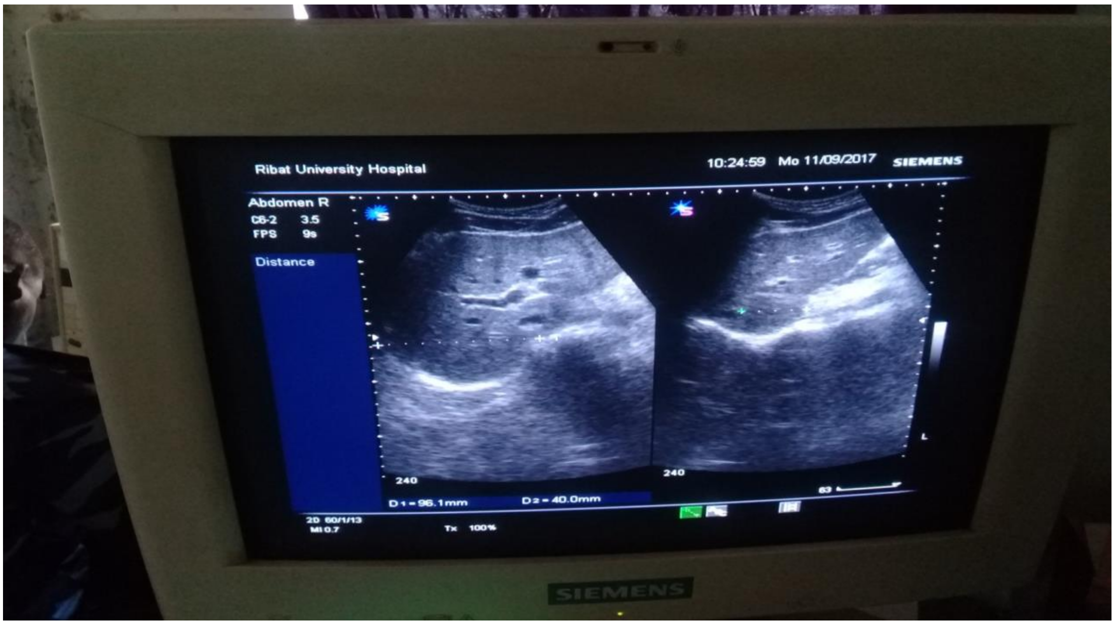

Image (7) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (8) 36 years male with caudate-right lobe ratio of .36

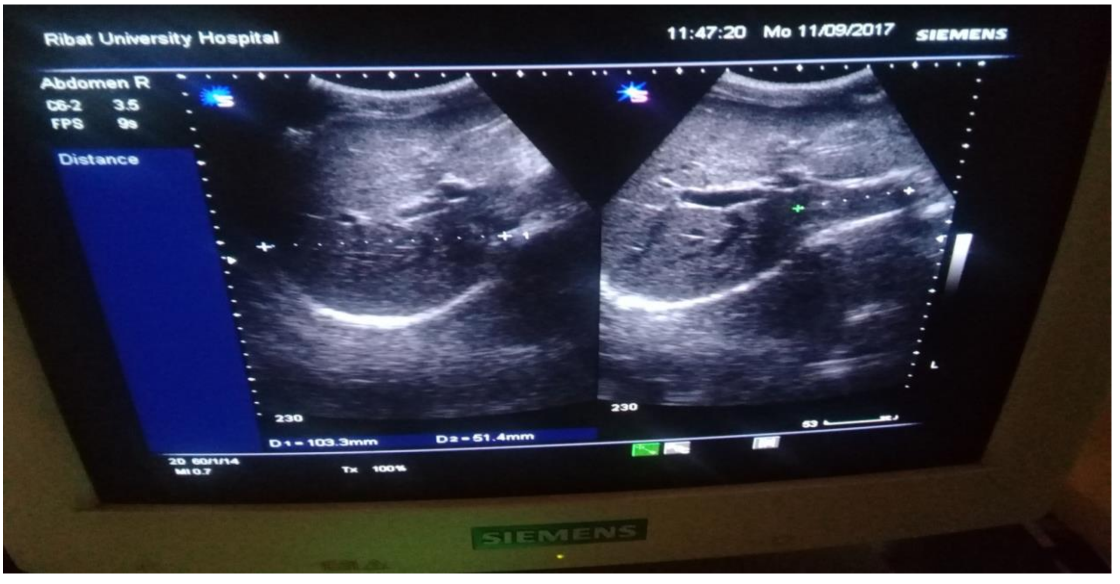

Image (8) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (9) 30 years male with caudate-right lobe ratio of .47

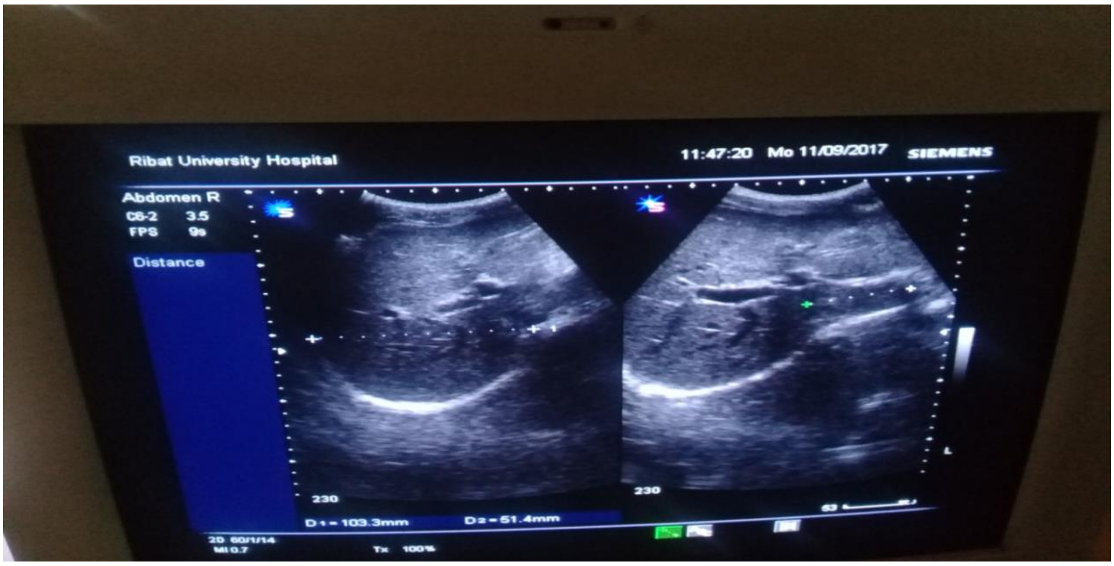

Image (9) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (10) 65 years male with caudate-right lobe ratio of .45

Image (10) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (11) 69 years male with caudate-right lobe ratio of .0.41

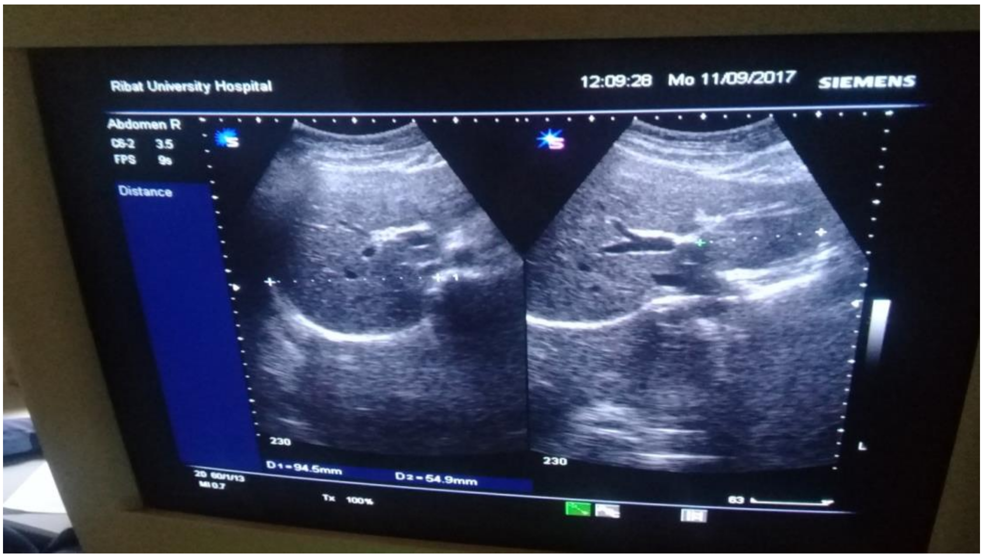

Image (11) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (12) 88 years male with caudate-right lobe ratio of .58

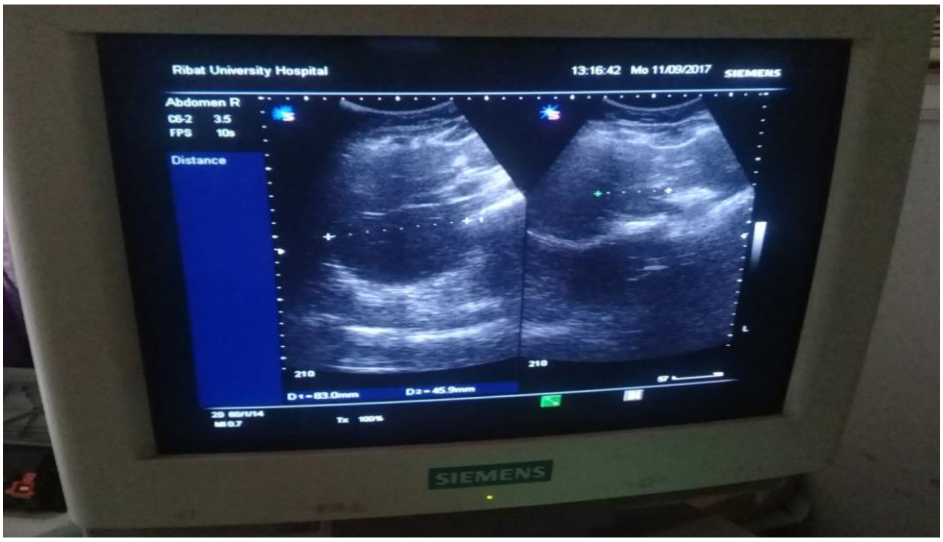

Image (12) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (13) 50 years male with caudate-right lobe ratio of .57

Image (13) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (14) 47 years male with caudate-right lobe ratio of .51

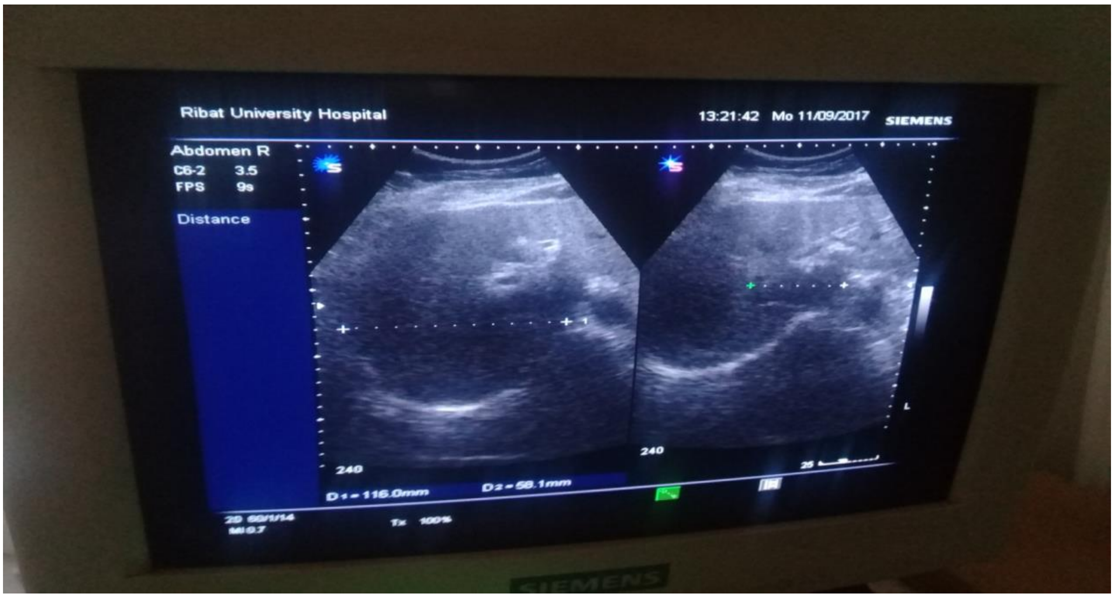

Image (14) sigital view showing caudocranial measurement of caudate and right lobes of liver

Case (15) 72 years male with caudate-right lobe ratio of .56

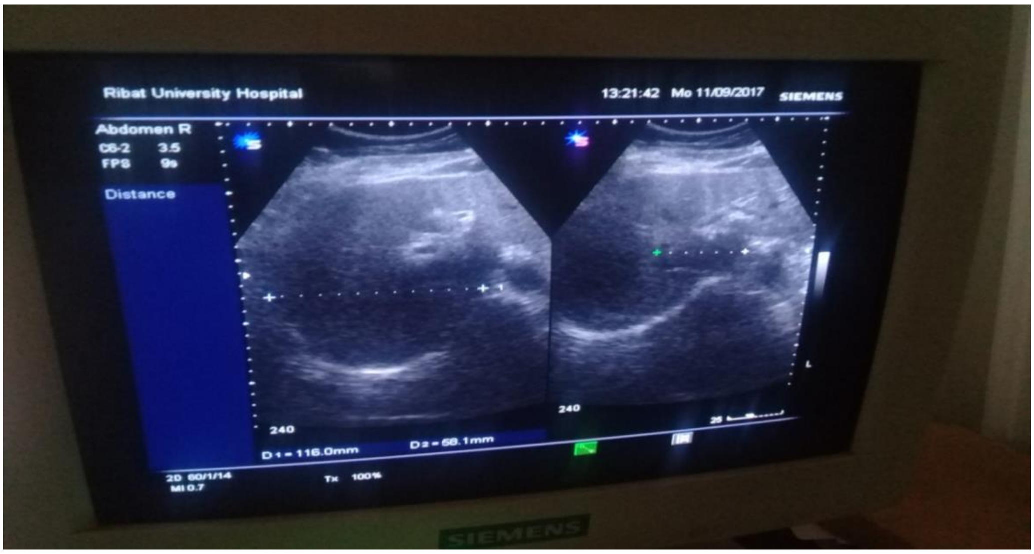

Image (15) sigital view showing caudocranial measurement of caudate and right lobes of liver