Chapter one

1.1 Introduction:

The liver is the largest of the abdominal viscera, occupying a substantial portion of the upper abdominal cavity. It occupies most of the right hypochondrium and epigastrium, and frequently extends into the left hypochondrium as far as the left lateral line. As the body grows from infancy to adulthood the liver rapidly increases in size. This period of growth reaches a plateau around 18 years and is followed by a gradual decrease in the weight from middle age. The ratio of liver to body weight decreases with growth from infancy to adulthood. The liver weighs approximately 5% of the body weight in infancy and it decreases to approximately 2% in adulthood. (Standriing, 1999)

It performs a wide range of metabolic activities required for homeostasis, nutrition and immune defense. It is an important site of haemopoiesis in the fetus. Conventionally, the liver has been considered to be divided into right, left, caudate and quadrate lobes by the surface peritoneal and ligaments attachments. (Standriing, 1999)

The caudate lobe (Spigelian lobe or Couinaud's segment I) is visible as a prominence on the inferior and posterior surfaces to the right of the groove formed by the ligamentum venosum: it lies posterior to the porta hepatis. To its right is 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 porta hepatis and above the epiploic foramen. Below and to the left, the caudate lobe has a small rounded papillary process. In gross anatomical descriptions this lobe is said to arise from the right lobe, but it is functionally separate. (Standriing, 1999) hypothesized that during second trimester the ductus venosus rotates rightward as the liver enlarges, so that a small portion of the liver become inserted behind the mesentery for the ductus venosus. This part of liver gives rise to caudate lobe of liver. (Dodds.1990)

Caudate lobe of liver is an anatomically independent entity as is evident from our findings about its blood supply and biliary drainage. The Shapes of caudate lobe display different patterns of variability in different populations. In our set of population less of caudate lobe is exposed to the surface. (Dodds.1990)

The caudate lobe indeed is an independent anatomical region in liver, making it relatively safe from many of the afflictions of the liver. It also has separate blood supply and biliary drainage. It has great clinical significance due to its paradoxical behavior with respect to rest of the liver in cirrhosis. (Dodds.1990)

The normal anatomy of the caudate lobe can create several pitfalls that may lead mistakenly to a diagnosis of disease. First, the caudal margin of the caudate lobe often ends in a papillary process that attaches to the caudate lobe by a narrow connection. On transverse ultrasound plane scan the connection of the papillary process may be missed and the process thereby judged to be an enlarged lymph node (Kowalczyk, 2014)

The most common abnormality of the caudate lobe is enlargement. Caudate enlargement generally occurs in the setting of primary cirrhosis of any type or is caused by venous occlusion (Kowalczyk, 2014)

The aim of this study was to study morphology and variations of caudate lobe to aid sonologists and surgeons for better interpretation and intervention.

1.2 Problem of study:

The normal anatomy of the caudate lobe can create several pitfalls that may lead mistakenly to be diagnosed as a disease. First, the caudal margin of the caudate lobe often ends in papillary process that attaches to the caudate lobe by narrow connection. On longitudinal ultrasound scans the connection of the papillary process may be missed and the process thereby judged to be an enlarged lymph node or a pancreatic mass.

Also the normal anatomy of the caudate lobe may be confused with tumor.

1.3 Objectives:

1.3.1 General objective:

- To characterize the normal caudate lobe in sudanese population using ultrasonography.

1.3.2 Specific objectives:

- To evaluate the shapes and location of the normal caudate lobe of liver.
- To evaluate the texture of the normal caudate lobe of liver.
- To measure the right to left diameter and antroposterior diameter of Caudate lobe of liver.
- To measure the transverse length of right lobe of liver.
- To evaluate the caudate to right lobe ratio.
- To correlate between caudate lobe size with age and gender .

1.4 Overview of the study:

Chapter one – introduction and objectives of the study.

Chapter two –Literature review (anatomy, physiology, pathology and ultrasonographic scanning of the liver).

Chapter three-Materials and Methods.

Chapter four – the Results.

Chapter five – Discussion, Conclusion and Recommendation

References and Appendix.

Chapter two

Literature review

2.1 anatomy:

The liver is formed by eight independent functional units, each with specific vascular and biliary connections. The identification of these units or segments first described in its current naming by the French surgeon and anatomist Claude Couinaud –in each individual organ is the key to are producible and clinically meaningful description of where liver lesions are localized, and to modern liver surgery. We present a simple way to identify liver segments in radiological examinations based on constant anatomical landmarks, and to memorize their numbering. The anatomy of the liver can be detailed based on the external appearance of the organ (external or descriptive anatomy) or based on its vascular and biliary architecture (vascular or functional anatomy). (Eills , 2006)

The descriptive anatomy was sufficient until abdominal surgeons had to perform liver resection, when it became important to respect the vascular integrity and the biliary drainage of the portion of the gland that would be spared. Two problems had to be addressed. The first was to simplify the intricacy of the vascular architecture of the liver to a relatively constant pattern to which even variations can be related (an ”ideal” functional anatomy). (Eills, 2006) The second was tolerate this ideal pattern to the individual anatomy of each liver (the”real” functional anatomy) and to follow this real anatomy in describing the location of liver lesions and in planning and performing the operations. (Eills , 2006)

The liver is the largest organ in the body. It is related by its domed upper surface to the diaphragm, which separates it from pleura, lungs, pericardium and heart. Its poster-inferior (or visceral) surface abuts against the abdominal esophagus, the stomach, duodenum; hepatic flexure of colon and the right kidney and suprarenal, as well as carrying the gall-bladder. (Eills, 2006)

The liver is divided into a larger right and small left lobe, separated superiorly by the falciform ligament and postero-inferiorly by an H-shaped arrangement of fossae anteriorly and to the right is the fossa for the gall-bladder; posteriorly and to the right is the groove in which the inferior vena cava lies embedded anteriorly and to the left is the fissure containing the ligamentum teres posteriorly and to the left is the fissure for the ligamentum venosum The cross-bar of the H is the porta hepatis. (Eills, 2006)

Two subsidiary lobes are marked out on the visceral aspect of the liver between the limbs of this H—the quadrate lobe in front and the caudate lobe behind.The ligamentum teres is the obliterated remains of the left umbilical vein which, in utero, brings blood from the placenta back into the fetus. (Eills , 2006)

The ligamentum venosum is the fibrous remnant of the fetal ductus venosus which shunts oxygenated blood from this left umbilical vein to the inferior vena cava, short-circuiting the liver. It is easy enough to realize, then, that the grooves for the ligamentum teres, ligamentum venosum and inferior vena cava, representing as they do the pathway of a fetal venous trunk, are continuous in the adult. Laying in the porta hepatis (which is 2 in (5 cm) long) are the common hepatic duct anteriorly the hepatic artery in the middle the portal vein posteriorly. As well as these, autonomic nerve fibers (sympathetic from the celiac axis and parasympathetic from the vagus), lymphatic vessels and lymph nodes are found there. (Eills, 2006)

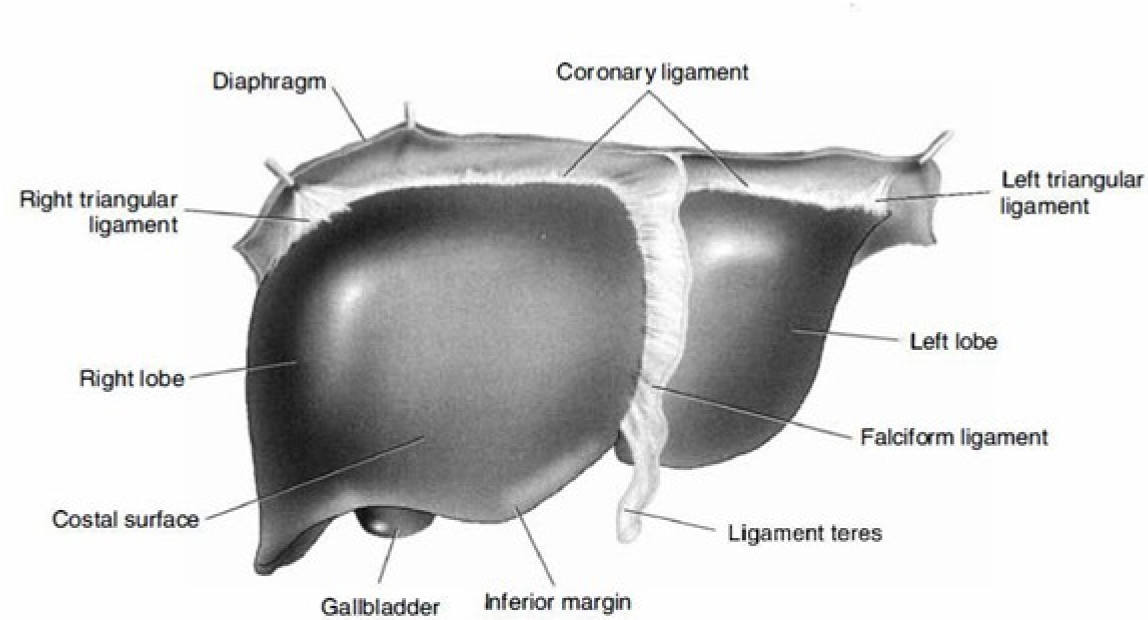

Figure 2.1: The Anterior view of the liver(Eills, 2006)

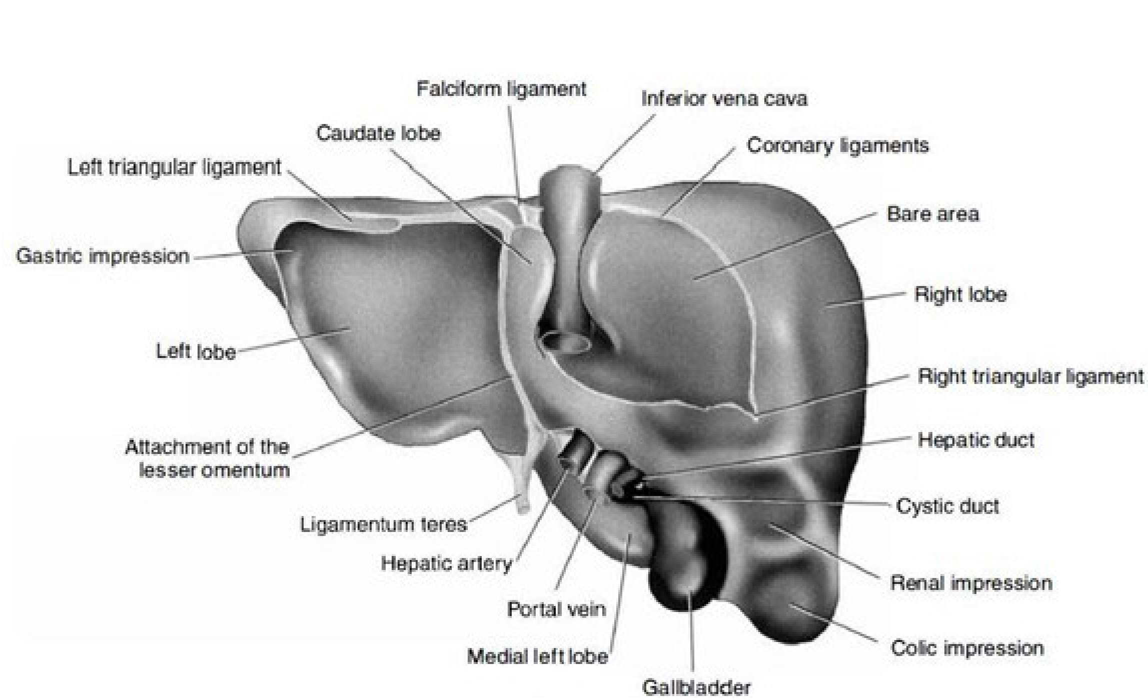

Figure 2.2: The posterior view of the liver(Eills, 2006)

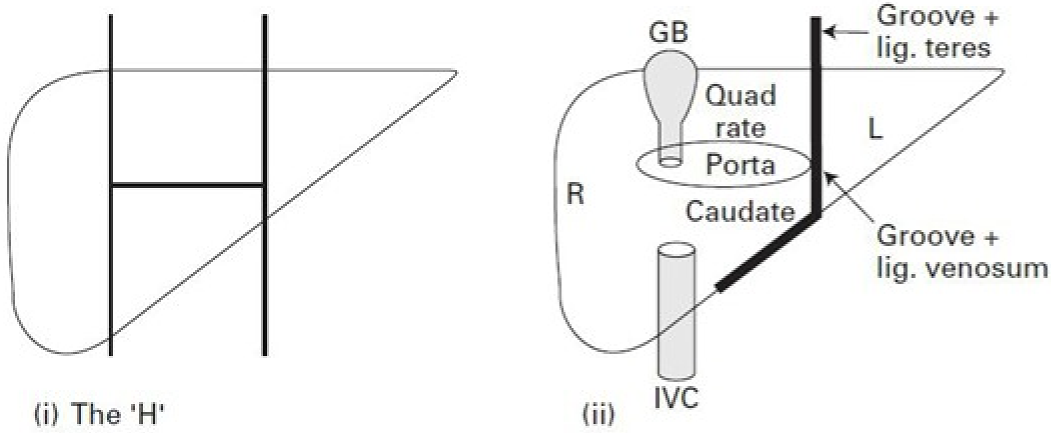

Figure2.3:The liver and its subdivisions. (i)“The H” . (ii) Inferior aspect (Eills, 2006)

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The liver is enclosed in peritoneum except for a small posterior bare area, demarcated by the peritoneum from the diaphragm reflected on to it as the upper and lower layers of the coronary ligament. To the right, these fuse to form the right triangular ligament. (Eills, 2006)

The falciform ligament ascends to the liver from the umbilicus, somewhat to the right of the midline, and bears the ligamentum teres in its free border. The ligamentum teres passes into its fissure in the inferior surface of the liver while the falciform ligament passes over the dome of the liver and then divaricates. Its right limb joins the upper layer of the coronary ligament and its left limb stretches out as the long narrow left triangular ligament which, when traced posteriorly and to the right, joins the lesser omentum in the upper end of the fissure for the ligamentum venosum.The lesser omentum arises from the fissures of the porta hepatics and the ligamentum venosum and passes as a sheet to be attached along the lesser curvature of the stomach. (Eills, 2006)

2.1.1 Segmental anatomy:

Current practice favors dividing the liver into eight segments, according to its vascular supply, which can aid in surgical resection. According to the French anatomist Couinaud, the liver can be divided into segments based on the branching of the portal and hepatic veins. The three main hepatic veins divide the liver longitudinally into four sections (Lorrie, 2007).

The middle hepatic vein divides the liver into right and left lobes. The right lobe is divided into medial and lateral sectors by the right hepatic vein, and the left lobe is divided into medial and lateral sectors by the left hepatic vein. Each section is then subdivided transversely by the right and left portal veins, creating nine segments numbered counterclockwise from the IVC. Each segment can be considered functionally independent with its own hepatic artery, portal vein, and bile duct and drained by a branch of the hepatic vein (Lorrie, 2007).

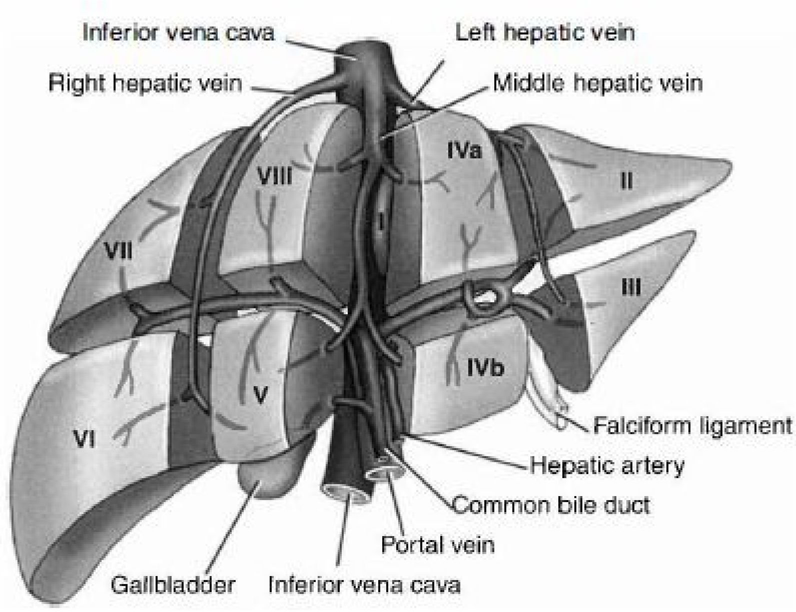


Figure 2.4: Anterior view of segmentation of liver(Lorrie, 2007)

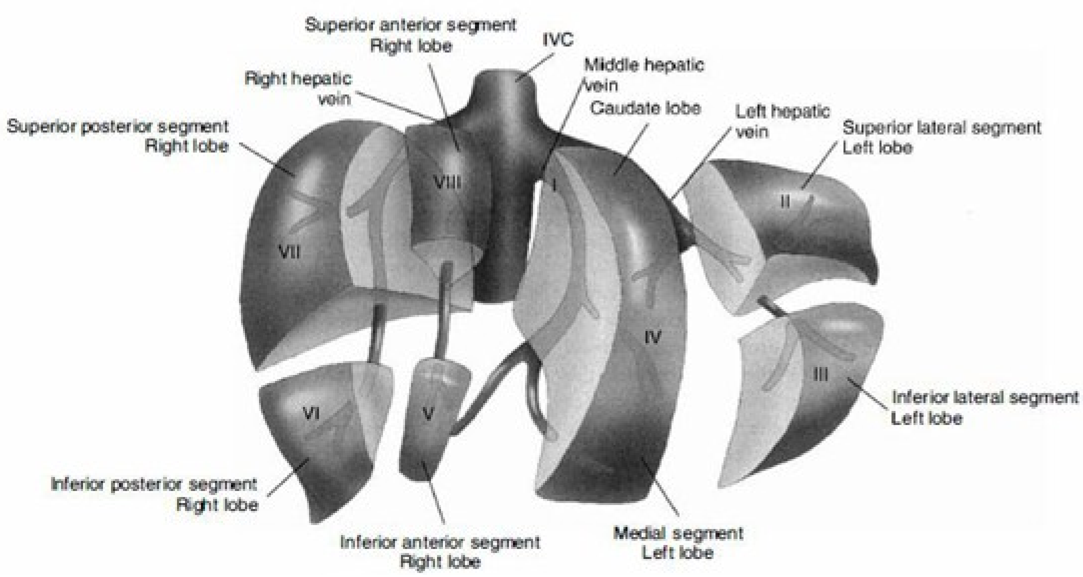


Figure 2.5: Couinaud's segmentation of the liver with hepatic

veins(Lorrie, 2007).

There are three major hepatic veins, comprising a right, a central and a left. These pass upwards and backwards to drain into the inferior vena cava at the superior margin of the liver. Their terminations are somewhat variable but usually the central hepatic vein enters the left hepatic vein near its termination. In other specimens it may drain directly into the cava. In addition, small hepatic venous tributaries run directly backwards from the substance of the liver to enter the vena cava more distally to the main hepatic veins. Although these are not of great functional importance they obtrude upon the surgeon during the course of a right hepatic lobectomy. (Lorrie.L.K, 2007).

The three principal hepatic veins have three zones of drainage corresponding roughly to the right, the middle and left thirds of the liver. The plane defined by the falciform ligament corresponds to the boundary of the zones drained by the left and middle hepatic veins. Unfortunately for the surgeon, the middle hepatic vein lies just at the line of the principal plane of the liver between its right and left morphological lobes and it is this fact which complicates the operation of right hepatic resection (Lorrie.L.K, 2007).

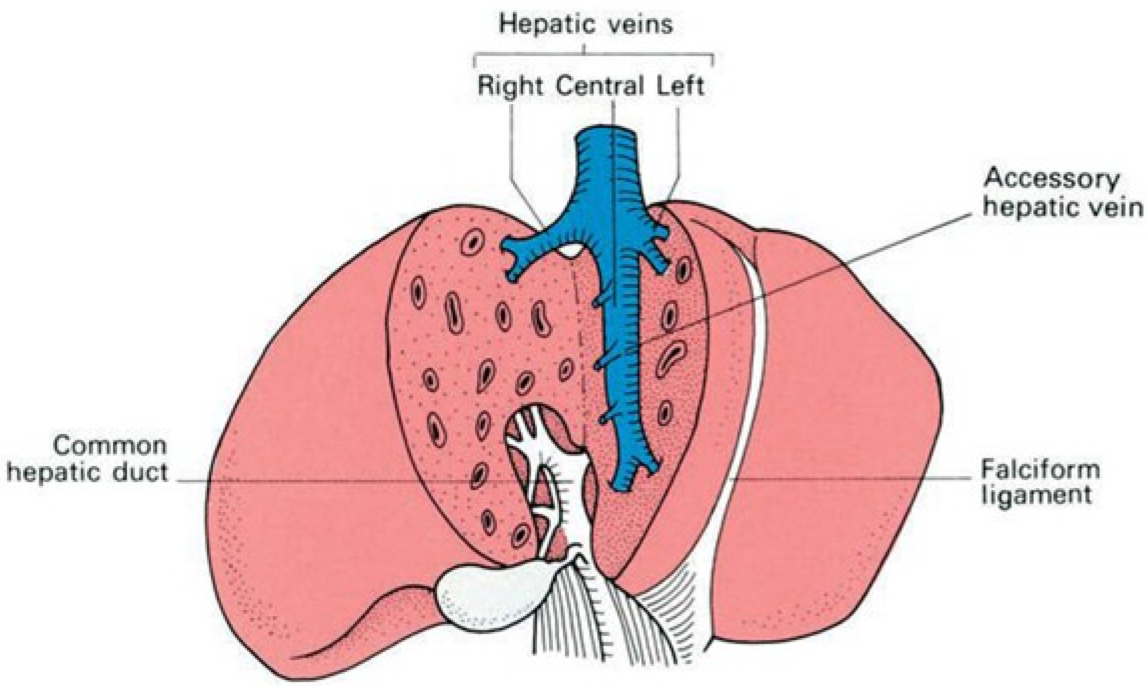


Fig.2.6: Liver split open to demonstrate the tributaries of the hepatic vein.

2.1.2 The Caudate Lobe of the Liver:

Caudate lobe is a central structure of the liver that generally is seen readily on abdominal imaging studies such as sonography or CT . Caudate anatomy, however, is complex and may cause difficulties in the interpretation of transverse images. (Wylie .J, dodds 1990)

The hepatic segment of the left lobe of the liver describe the caudate lobe as a midline, vertically oriented hepatic lobe, seen on the posterior aspect of the liver separating a portion of the right and left hepatic lobes in an H configuration. (Wylie .J, dodds 1990)

The horizontal bar of the H configuration represents the portal hepatics, which includes the horizontal portion of both portal veins. Above the bar is the caudate lobe of the liver and below the bar is the medial segment, or quadrate lobe, of the left lobe of the liver. Although such descriptions delineate the topography of the liver, they do not adequately describe the relationship of the caudate lobe to the interior of the liver (Wylie .J, dodds 1990)

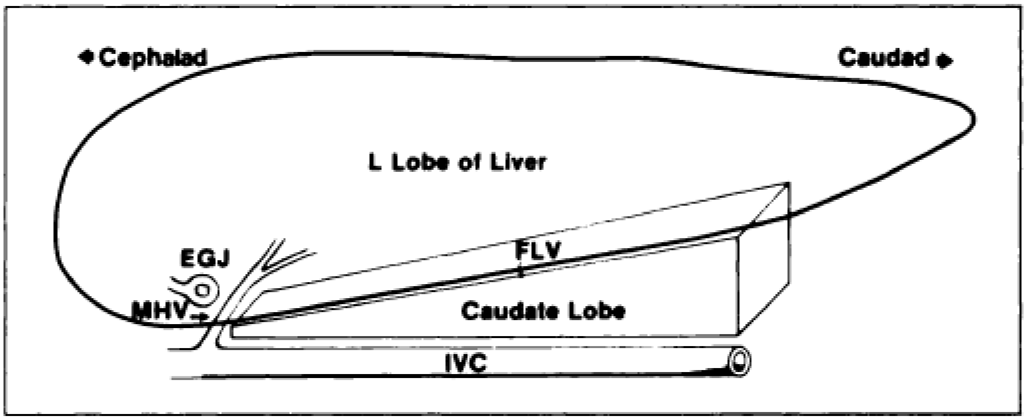
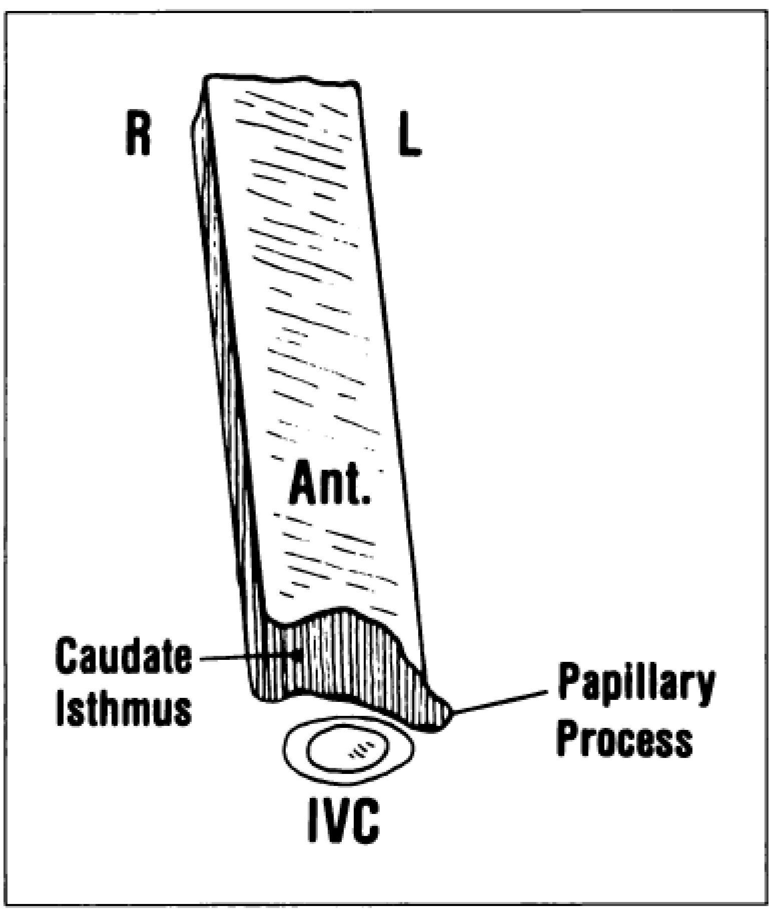


Fig. 2.7: Schematic representation of lateral view of caudate lobe.

Fig. 2.8: Schematic



representation of frontal view of caudate lobe.

R = right, L = left ,IVC = inferior vena cava.

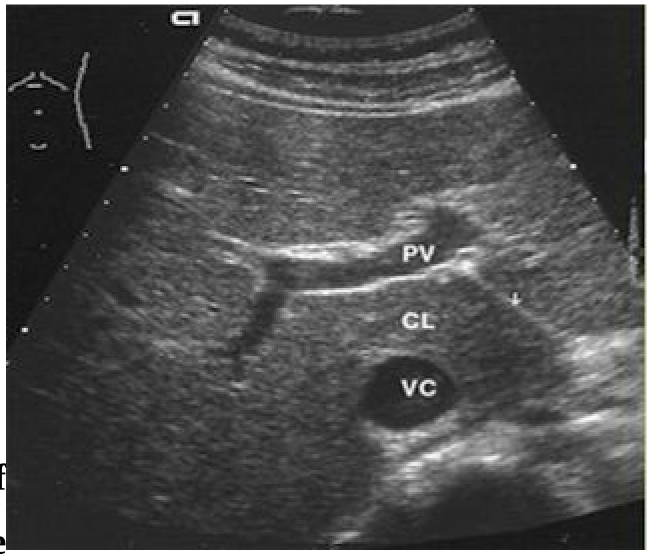


Fig. 2.9: ultrasound scans through caudate lobe.

2.1.3 Development of the caudate lobe:

Development of the caudate lobe is shrouded in mystery; it has been said to develop from either the left or right hepatic lobe. The origin of the blood supply to the caudate lobe is uncertain. To address this problem, we propose a unifying hypothesis about developmental caudate embryology that we think clarifies existing anatomic findings in the adult. We propose that the key to understanding the development of the caudate lobe is the ducts venous, which in early embryonic life is suspended within the superior portion of the dorsal mesentery of the liver. In the early embryo, the primitive gastrointestinal tract, including the esophagus, is suspended along its length by both a dorsal and ventral mesentery. (Wylie .J, dodds 1990)

Most of the ventral mesentery disappears, but the liver develops in the ventral mesentery, resulting in a dorsal portion of lesser omentum with persistence of the gastro hepatic and hepatoduodenal ligaments. All vascular structures to the liver that connect to posterior structures, such as the aorta or the vena cava, must run through the dorsal mesentery of the liver and dorsal mesentery of the duodenum to reach the liver. For example, the gastro hepatic artery originates from the aorta, but through a series of mesenteric twists and folding, its original mesentery is no longer apparent in the adult. Yet the course of this artery and its major branches provides clear evidence of the original location of their mesentery .In similar fashion, we propose that the ductus venosus originally was suspended by a dorsal mesentery early in embryologic development, and part of this mesentery later disappeared. (Wylie .J, dodds 1990)

The history of this mesentery delineates the development of the caudate lobe. At present, there is little argument that a ligament (within the original mesentery) persists from the original ductus venosus in the adult liver In adults, the ligament of the ductus venosus passes through the liver from the base of the left portal vein to the vena cava to which it is attached. The ligament venosum passes between the leaves of the original dorsal mesentery of the liver (Wylie .J,dodds 1990)

The mesentery persists as the fissure for the ligamentum venosum. During the second trimester the right umbilical vein becomes atrophic and disappears. The persistent left umbilical vein runs in the free margin of the falciform ligament to attach at the base of the left portal vein. From this juncture, a large vessel, the ductus venosus, suspended within the cephalad portion of the dorsal mesentery of the liver, shunts placental blood through the liver to the heart by coursing directly to the vena cava or middle hepatic vein near their junction with the heart .During the second trimester the liver and mesentery of the ducts venosus rotate rightward as the liver enlarges, so that a small portion of the liver becomes inserted behind the mesentery for the ductus venosus, within the sagittally oriented angle formed by the ductus venosus and the inferior vena cava. Subsequently, the extra hepatic portion of the ductus mesentery shortens and folds over so that the vena cava lies against the spine and there is no longer an identifiable complete mesentery between the duct sand vena cava. (Wylie .J, dodds 1990)

The ductus venosus becomes obliterated shortly after birth, and the former ductus Venosus persists as the ligamentum venosum. Studies in cadavers have shown that this ligament runs through the liver from the base of the left portal vein to attach to the inferior vena cava or base of the middle hepatic vein. (Wylie .J, dodds 1990)

2.1.4 sonographic anatomy of the caudate lobe:

The caudate lobe of the liver is anatomically distinct from the left and right hepatic lobes. Its interposed between the inferior vena cava IVC posteriorly ,the left hepatic lobe anteriorly, and superiorly and the main portal vein inferiorly . Certain anatomic landmarks easily seen on ultrasonograms define the limits of the caudate lobe. The proximal left portal vein courses over the anterior margin of the inferior caudate lobe, separating it from the more anteriorly positioned left hepatic lobe. Upon reaching anterior aspect of the midportion of the caudate lobe .the left portal vein ascending in the left intersegmental fissure (ascending or umbilical segment of the portal vein).thus the posterior surfaces of the proximal left portal vein serves as accurate anatomic boundary of the anterior caudate lobe margin. (Brown et al,1982)

The anterior margin of the caudate lobe is sharply separated from lateral segment of the hepatic lobe by intervening fissure of the ligamentum venosum.

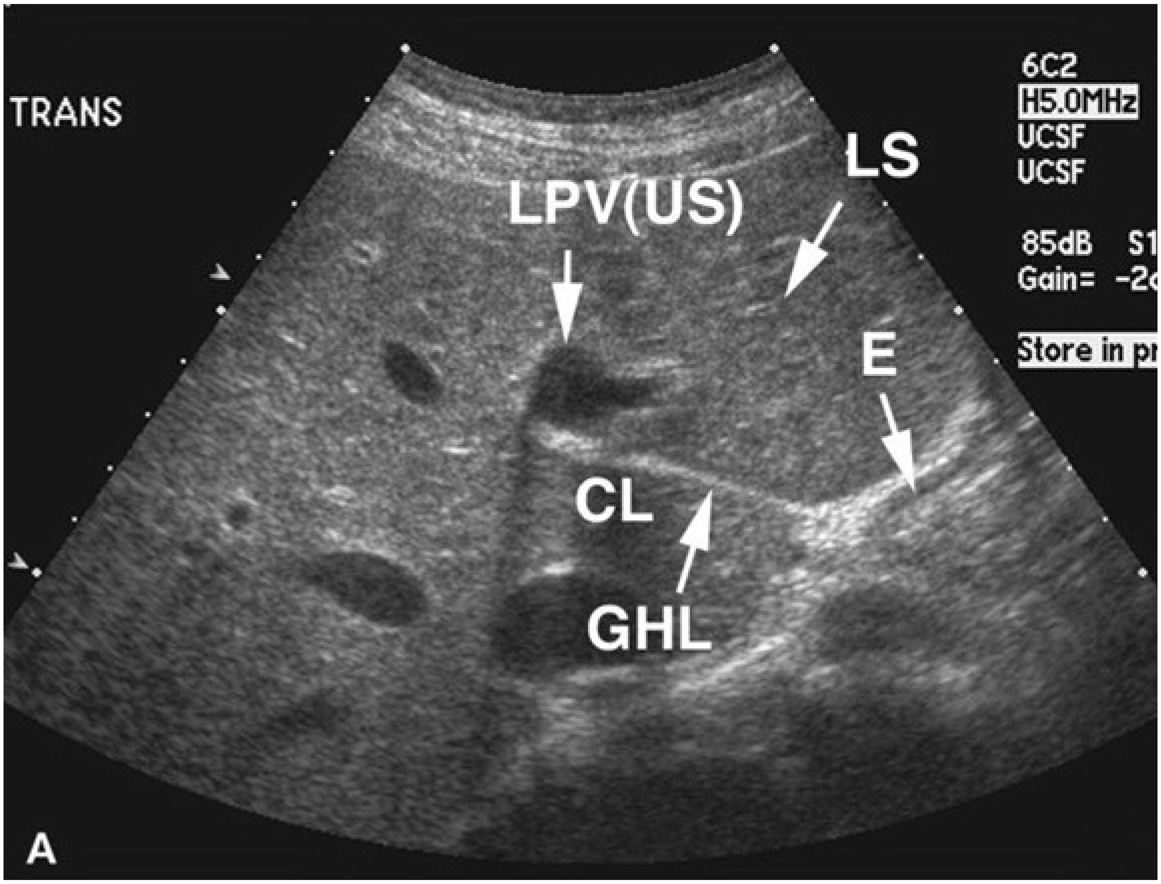
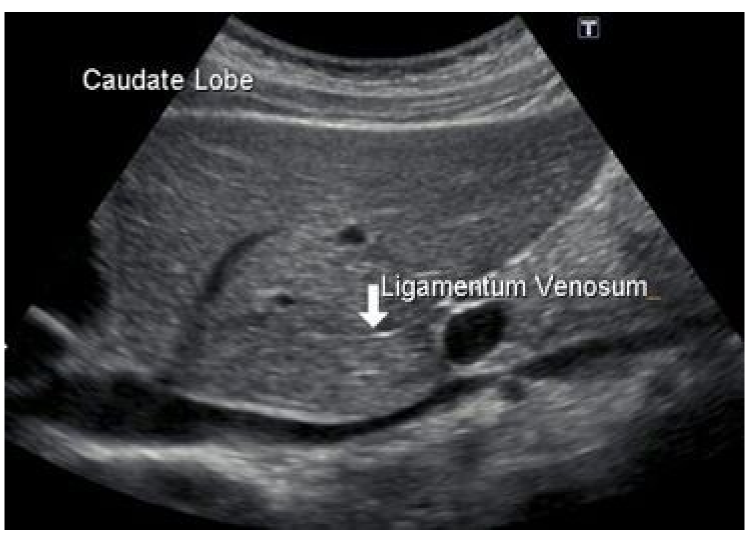


Figure 2.10 show transverse ultrasonogram high in the abdomen in which the caudate lobe(CL) and its bordering landmarks can be seen.the left anterior margin of the left lobe is sharply separated from the lateral segment of the left lobe(LS) by the intervening fissure of the ligamentum venosum(GHL), LPV= left portal vein, E= distal esophagus near the stomach.

Figure 2.11 longitudinal ultrasonogram in show the fissure of the ligamentum venosum



separating the caudate lobe from the lateral segment of the left hepatic lobe .

As the caudate lobe is situated immediately posterior to the insertion of the gastrohepatic ligament in to the fissure of the ligamentum venosum,the left margin of the caudate lobe from the hepatic boundary of the superior recess of the lesser sac. The right inferior margin of the caudate lobe extends in the tongue-like projection, known as the caudate process , between the IVC and adjacent main portal vein , and the medial portion of the right hepatic lobe .the relationship of the main portal vein to the IVC is determined by the size of caudate process . In the most individual the caudate process is small , permitting contact between the main portal vein and IVC,elevating the main portal vein.(Brown et al,1982)

The caudate lobe has anatomically distinct afferent blood vessels (portal vein and hepatic artery),efferent blood vessels(hepatic veins)and bile ducts, both left and right portal triads give off portal venous and hepatic arterial branches to the caudate lobe and receive bile duct tributaries. In many thin adults, ultrasonography possesses sufficient resolution to visualize portal venous branches to the lobe originated from the proximal left portal vein and right portal vein.(Brown et al,1982)

As stated above , the left portal vein may be divided into an initial segment (pars transversa)and a distal segment (ascending or umbilical segment). The latter lies in the intersegmental fissure separating the medial and lateral segments of the left hepatic lobe. The angle at which the pars transversa originates from the main portal vein varies. This variability is directly related to the size and inferior surface contour of the caudate lobe.as the caudate lobe enlarges, the initial left portal vein segment shows increasing deflection from the course of the main portal vein.(Brown et al,1982)

As the initial left portal vein segment courses over the anterior portion of the inferior caudate lobe, it give several caudate lobe branches prior to reaching the intersegmental fissure. The two distal most caudate lobe branches from the left portal vein are accompanied by hepatic artery and bile duct branches, all caudate lobe branches from the left portal triad lie close to the intersegmental fissure. Unfortunately, this surgically important hepatic artery and bile duct branches to the caudate lobe cannot be visualized ultrasonically.(Brown et al,1982)

The efferent vascular drainage of the caudate lobe is independent of the right, middle, and left hepatic veins.instead, the caudate lobe is drained by series of small,short venous channel that extend directly from posterior aspect of the caudate lobe into the IVC adjoining the posterior margin of the caudate lobe(figure3). These hepatic venous channels from the caudate lobe are also too small to be seen ultrasonically.(Brown et al,1982)

2.1.5 Measurements of the caudate lobe:

Transverse length of Right lobe: A midpoint was fixed on falciform ligament between superior & inferior borders of liver. From this point three readings were taken up to the lateral border of right lobe.(Harbin et al, 1980)

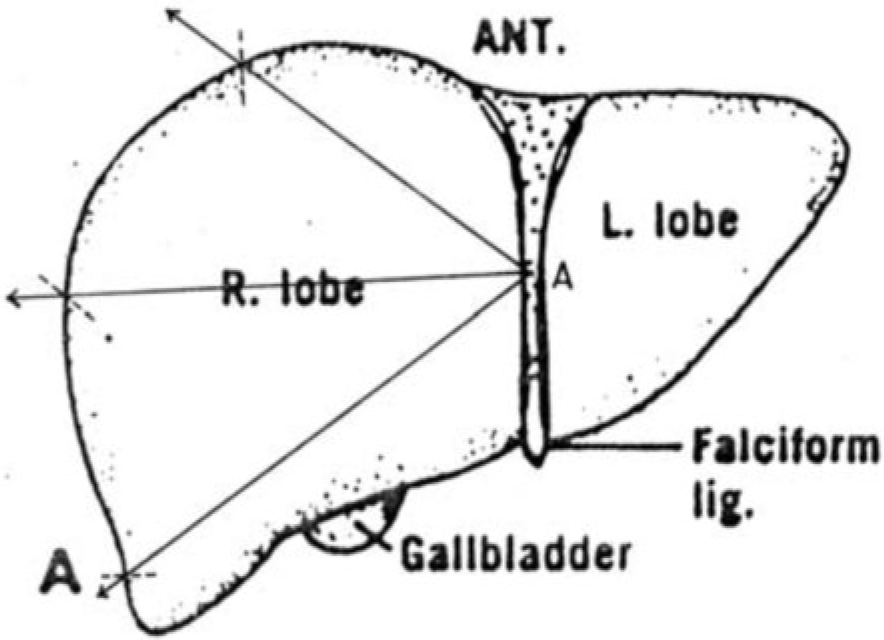


Figure 2.12 diagrammatic illustration of the Transverse length of Right lobe.

Antro-posterior measurement of caudate lobe: Three measurements were taken. First at the fissure for ligament venosum, second at middle of the caudate lobe & third from groove for inferior vena cava.(Harbin et al, 1980)

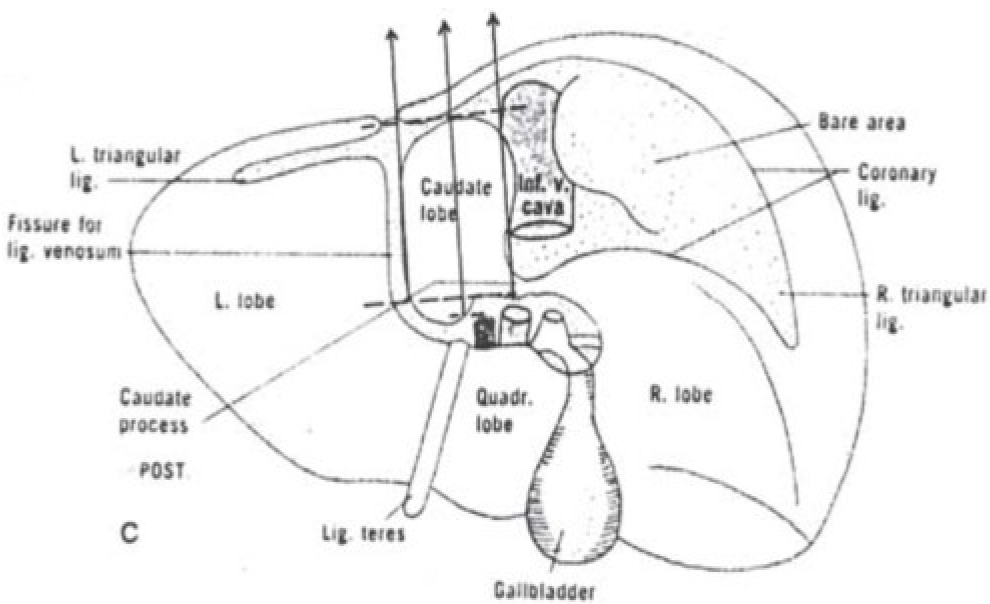


Figure 2.13: diagrammatic illustration of the Antro-posterior measurement of caudate lobe.

Right to left measurement of caudate lobe: Three measurements were taken. First at the superior border, second at middle & third at post. margin of porta hepatis.(Harbin et al, 1980)

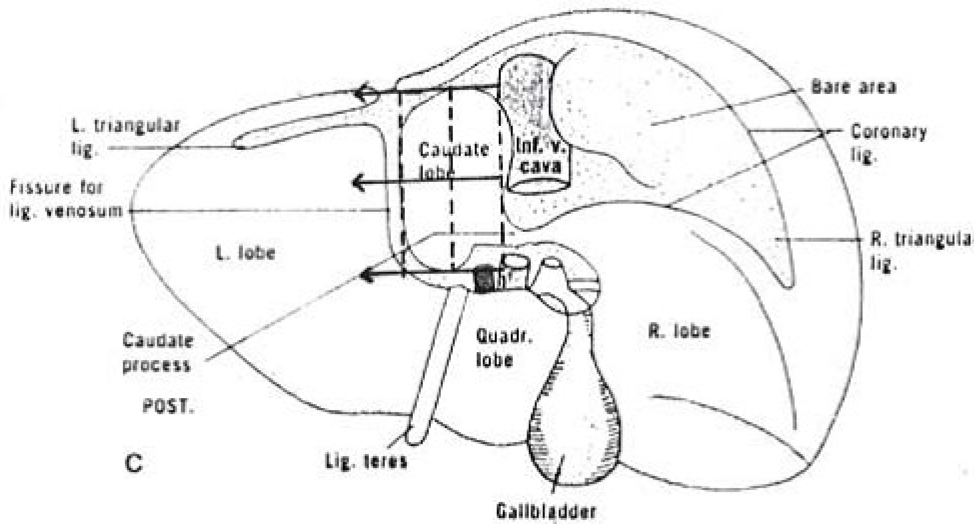


Figure 2.14: Show Right to left measurement of caudate lobe.

Caudate right-lobe ratio (CRL-R): In transverse planes distances of the right lateral border of the right portal vein bifurcation(line 1) to the lateral margin of the right hepatic lobe (RL) and to the most medial margin of the caudate lobe(line 2) (C) are measured in an exactly horizontal direction (line 3). The two distances were divided C / RL (caudate lobe / right lobe) and defined as the caudate-right-lobe ratio (CRL-R).(Harbin et al, 1980)

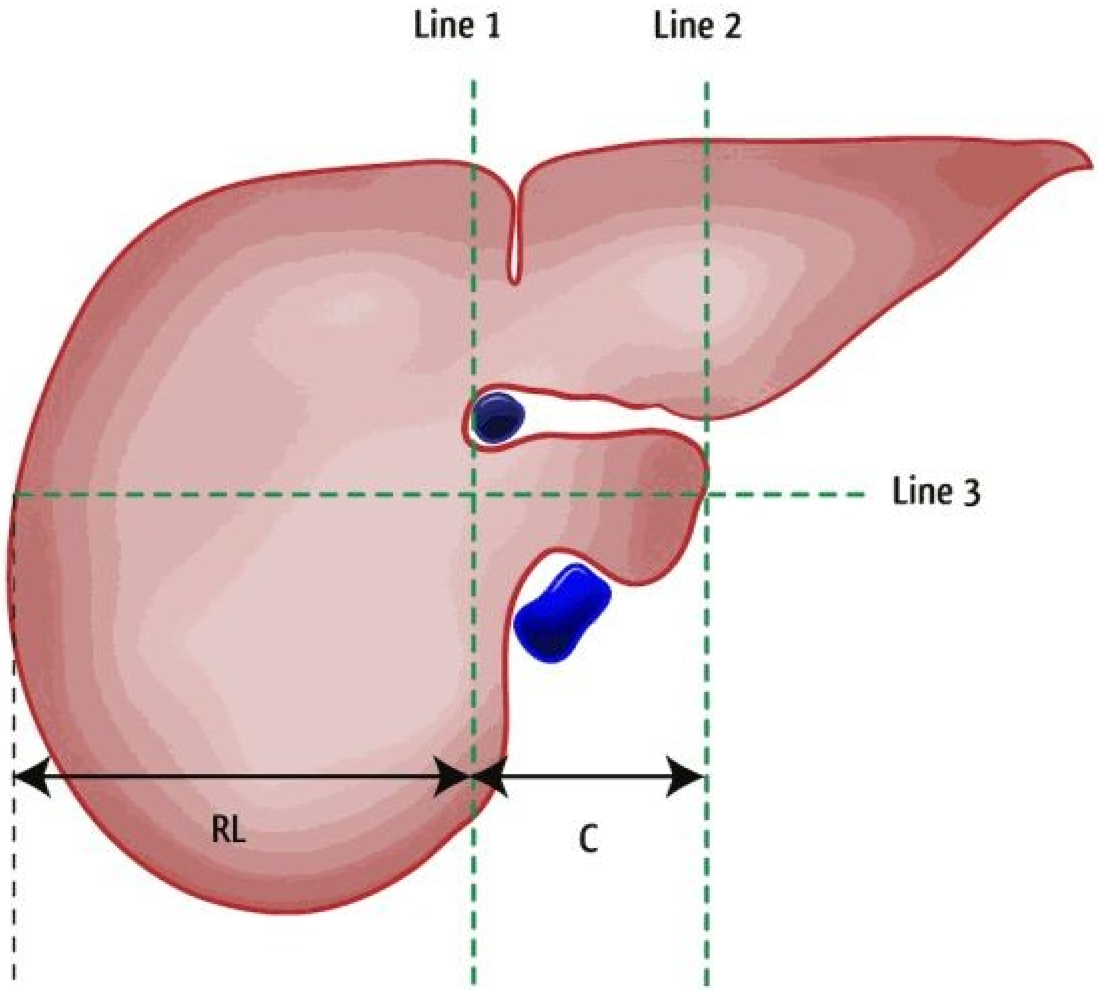


Figure 2.15: Show Caudate right-lobe ratio (C/RL).

2.2 Physiology:

The bile produced in the liver is collected in bile canaliculi, which merge from bile ducts. These eventually drain into the right and left hepatic ducts, which in turn merge to form the common hepatic duct. The cystic duct (from the gallbladder) joins with the common hepatic duct to form the common bile duct. (http://en.wikibooks.org/wiki/Human_Physiology)

Bile can either drain directly into the duodenum via the common bile duct or be temporarily stored in the gallbladder via the cystic duct. The common bile duct and the pancreatic duct enter the duodenum together at the ampulla of Vater. The branching of the bile ducts resemble those of a tree, and indeed term "biliary tree" is commonly used in this setting. The liver is among the few internal human organs capable of natural regeneration of lost tissue: as little as 25% of remaining liver can regenerate into a whole liver again. This is predominantly due to hepatocytes acting as unipotential stem cells. There is also some evidence of bio potential stem cells, called oval cell, which can differentiate into either hepatocytes or cholangiocytes (cells that line bile ducts).

The various functions of the liver are carried out by the liver cells or hepatocytes.

The liver produces and excretes bile requires for dissolving fats. Some of the bile drains directly into the duodenum, and some is stored in the gallbladder. (http://en.wikibooks.org/wiki/Human_Physiology)

The liver performs several roles in carbohydrate metabolism such as gluconeogenesis (the formation of glucose from certain amino acids, lactate or glycerol), Glycogenolysis (the formation of glucose from glycogen), Glycogenesis (the formation of glycogen from glucose) and the breakdown of insulin and other hormones. The liver is responsible for the mainstay of protein metabolism. The liver also performs several roles in lipid metabolism: cholesterol synthesis**,** the production of triglycerides (fats)**.**

The liver produces coagulation factors I (fibrinogen), II (prothrombin), V, VII, IX, X and XI, as well as protein C, Protein S and antithrombin.The liver breaks down hemoglobin, creating metabolites that are added to bile as pigment and also breaks down toxic substances and most medicinal products in a process called drug metabolism. This sometimes results in toxication, when the metabolite is more toxic than its precursor. The liver converts ammonia to urea and stores a multitude of substances, including glucose in the form of glycogen, vitamin B12, iron, and copper. The liver is responsible for immunological affects the reticuloendothelial system if the liver contains many immunologically active cells, acting as a 'sieve' for antigens carried to it via the portal system. (http://en.wikibooks.org/wiki/Human_Physiology).

2.3 Pathology:

Alcohol is a known toxin, which, when metabolized by the liver, causes cellular damage; alcohol abuse has long been associated with liver disease. Alcohol cannot be stored in the human body, and therefore, the liver must convert it, through oxidation, to alcohol dehydrogenase, acetaldehyde, and acetate, all of which reduce cellular function. This leads to interference with carbohydrate and lipid metabolism. Oxidation also results in reduced gluconeogenesis and increased fatty acid synthesis associated with alcohol metabolism. Chronic alcohol abuse often leads to fatty liver followed by hepatitis, cirrhosis, hepatocellular carcinoma, or all of these diseases. (Kowalczyk.N, 2014)

Fatty liver is the most frequent early response to alcohol abuse. Changes in liver function result in a buildup of lipids such as triglycerides, which are deposited in the liver cells. This condition is usually asymptomatic; however, patients may have hepatomegaly. Fatty infiltration may be demonstrated by using CT or sonography, but sonography is currently the examination of choice. sonography demonstrates the fatty deposits as hyperechogencity . (Kowalczyk.N, 2014)

Areas throughout the liver Inflammation often follows fatty changes within the liver, leading to alcoholic hepatitis. At this stage, many patients present with jaundice. This inflammation is diffuse throughout the liver cells and culminates in liver necrosis. This disease may be fatal, progressing quickly to liver failure; or if the individual survives the hepatitis, the condition progresses to alcoholic cirrhosis of the liver, which is an end-stage disease. (Kowalczyk.N, 2014)

Factors other than alcohol abuse may also lead to fatty infiltrates within the liver. Obese individuals with type 2 diabetes mellitus, metabolic syndrome, hyperlipidemia, or all of these diseases are at an increased risk of developing nonalcoholic fatty liver disease (NAFLD). This pathology develops as lipids accumulate within the hepatocytes forming free radicals. At some point, the liver cannot rid itself of the excessive triglycerides. This results in an excess of fatty acids within the liver, which leads to fatty infiltration of the liver, termed steatosis, and fatty liver disease. In the early stages, NAFLD is often asymptomatic, and diagnosis requires biopsy of liver tissue. Although the disease progresses slowly, it may advance to cirrhosis of the liver if left untreated. Management includes implementation of weight loss programs and exercise programs as treatment for insulin resistance and associated metabolic disturbances. (Kowalczyk.N, 2014)

Cirrhosis is a chronic liver condition in which the liver parenchyma and architecture are destroyed, fibrous tissue is laid down, and regenerative nodules are formed. In its early stages, it is usually asymptomatic, as it may take months or even years before damage becomes apparent. Cirrhosis affects the entire liver and is considered an end-stage condition resulting from liver damage caused by chronic alcohol abuse, drugs, autoimmune disorders, metabolic and genetic disease, chronic hepatitis, cardiac problems, and chronic biliary tract obstruction. (Kowalczyk.N, 2014)

sonography is the primary modality for evaluating the complications arising from cirrhosis. Fatty infiltration of the liver is well visualized by sonography. The most characteristic finding in cirrhosis is an increase in the ratio of the caudate lobe and the right lobe.

This occurs with cirrhosis because of atrophy of the right lobe and medial segment of the left lobe and hypertrophy of the caudate lobe and the lateral segment of the left lobe. Because of its dual arterial blood supply, the caudate lobe of the liver is usually spared in cirrhosis. Studies show that individuals with cirrhosis have an increased risk of developing hepatic carcinoma, so sonography is also of value in assessing the presence of complications of cirrhosis such as ascites and hepatocellular carcinoma. (Kowalczyk.N, 2014)

Ascites is the accumulation of fluid within the peritoneal cavity is also seen as a result of portal hypertension and the leakage of excessive fluids from the portal capillaries. Much of this excess fluid is composed of hepatic lymph weeping from the liver surface. It is associated with approximately 50% of deaths from cirrhosis.

Ascites may also result from chronic hepatitis, congestive heart failure, renal failure, and certain cancers. (Kowalczyk.N, 2014)

Hepatocellular adenoma is a benign tumor of the liver. Most tumors are asymptomatic, but the incidence of this disease has increased over the past few years. Hepatocellular adenomas occur most often in women using oral contraceptives, which play a role in the development of these benign lesions. In terms of imaging, both CT and sonography are useful in demonstrating hepatic lesions. (Kowalczyk.N, 2014)

A hemangioma is the most common tumor of the liver. It is a benign neoplasm composed of newly formed blood vessels, and these neoplasms may form in other places within the body. For instance, a port-wine stain on the face (a superficial purplish red birthmark) is an example of a hemangioma elsewhere in the body.

Hemangiomas are generally well-circumscribed, solitary tumors. They may range in size from microscopic to 20 cm. They are more common in women than in men, especially in postmenopausal women. (Kowalczyk.N, 2014)

Diagnosis may be complicated when it occurs with a known malignancy because its characteristics may be difficult to distinguish from metastasis.. A sonography of the liver following CT and an injection of IV contrast medium demonstrates the hemangioma with peripheral enhancement with fibrosis within the tumor. (Kowalczyk.N, 2014)

Hepatocellular carcinoma, a primary neoplasm of the liver. An association between cirrhosis and hepatocellular carcinoma exists, with chronic hepatitis B or C and alcoholism associated with each. Thus, the incidence of this neoplasm is on the rise because of an increase in chronic hepatitis B and C infections in the United States.

Most primary hepatomas originate in the liver parenchyma, creating a large central mass with smaller satellite nodules. Although vascular invasion is common, death occurs from liver failure, often without extension of the (Kowalczyk.N, 2014)

Cancer outside the liver. Hepatocellular carcinoma is suspected in patients with cirrhosis who experience an unexpected deterioration and in patients with increased jaundice, abdominal pain, weight loss, an RUQ mass, ascites, or a rapid increase in liver size. Plain abdominal radiographs may demonstrate hepatomegaly.

Sonography and CT are often used to reveal the extent of the tumor

(Kowalczyk.N, 2014)

Metastatic liver lesions are much more common than primary carcinoma because of the liver's role in filtering blood. The liver is a common site for metastasis from other primary sites such as the colon, pancreas, stomach, lung, and breast Primary cancers located in the abdomen, especially those drained by the portal venous system, often metastasize to the liver (Kowalczyk.N, 2014)

Alcoholic cirrhosis. Caudate lobe is enlarged and left hepatic lobe atrophic.

Ascites is present Portal vein is replaced by multiple small veins and varices are located in gastrohepatic ligament B, Cirrhosis from occlusion of hepatic vein (Budd-Chiarl syndrome). Caudate lobe is markedly enlarged and compresses intrahepatic portion of inferior vena cava. Liver exhibits scattered areas of Increased and decreased enhancement. Hepatic veins are not seen. (Kowalczyk.N, 2014) With right lobar atrophy, the fissure for the ligamentum venosum may rotate counterclockwise. In some instances, the gallbladder relocates posterior to the liver and bowel interposes in front of the liver. Orientation of the fissure for the ligamentum venosum also may be useful for recognition not only of right lobar atrophy but also of volume loss from a partial right hepatic lobar resection.

Enlargement of the caudate lobe commonly accompanies occlusion of the hepatic veins, along with patchy areas of low and high attenuation on sonography. (Kowalczyk .N, 2014)

The explanation given is that the venous drainage of the caudate lobe is maintained by emissary veins that pass directly from the caudate lobe to the vena cava. Thus, obstruction of the hepatic veins causes greater blood flow through the caudate lobe and, thereby, hypertrophy of the caudate lobe. Although the patchy hepatic changes that occur with hepatic vein occlusion may occur with chronic right heart failure, right heart failure seldom causes enlargement of the caudate lobe.

Enlargement of the caudate lobe may narrow the intrahepatic portion of the vena cava (Kowalczyk .N, 2014)

Focal lesions similar to lesions elsewhere in the liver may involve the caudate lobe. For example, the caudate lobe may harbor a simple cyst, primary tumor, metastatic lesion, or abscess. Fatty infiltration confined to the caudate lobe may simulate a tumor. Traumatic fracture of the caudate, although rare, may occur (Kowalczyk .N, 2014).

2.4 ultrasound machine:

Medical ultrasound (also known as diagnostic sonography or ultrasonography)is a diagnostic image technique based on the application of ultrasound.

Modern diagnostic ultrasound systems use the principle of Piezoelectric effect to produce images of the human body. Piezoelectric crystals in the transducer convert an electrical voltage into a short pulse of high frequency sound. The transducer is coupled to the skin with gel and the pulse is transmitted into the body in a straight line. Tissue differences in the body produce echoes which are reflected back to the transducer. At the transducer the piezoelectric crystals convert each echo back into a small electrical voltage (echo signal). Each echo signal is then evaluated for just two parameters: time and strength. The time is used to calculate the distance to the reflector; echo strength is used to assign a brightness to the echo on the display.(Burwin 1982)

From the transducer, each echo signal is sent to a receiving circuit where it is amplified and processed. From there, the signal is sent to the system’s memory to be stored until a sufficient number of echoes are received to produce an image. This typically takes about 1/20th of a second. Once enough data has been stored, the data is read from memory and sent to the display monitor for viewing and to a recording device for archiving. Since the entire process happens so quickly, the system is able to generate a real-time display at a frame rate of about 20 frames per second.

Diagnostic ultrasound is a pulse-echo technique that uses a piezoelectric crystal to transmit short pulses of sound into the body, receive the echoes, and display that echo data in real-time 2D grayscale Images.(Burwin 1982)

Ultrasound scanners are complex, with many different components involved in the process of creating an image. Adding to the complexity, different ultrasound manufacturers often modify the design of various components. From a broad perspective, all makes and models of ultrasound scanners are similar in that they consist of a pulser, transducer, receiver, memory ,display and recording Device.(Burwin 1982)

The pulser produces the electrical voltage bursts that are sent to the transducer. In response to each voltage burst the piezoelectric crystals in the transducer vibrate to produce a pulse of ultrasound. Typically, the pulser may send 10,000 voltage bursts per second.(Burwin 1982)

The transducer contains the piezoelectric crystals. In response to each voltage burst from the pulser the crystals in the transducer vibrate, converting the electrical voltage into a pulse of ultrasound. Each voltage burst from the pulser produces one pulse of ultrasound. After each ultrasonic pulse is transmitted, the transducer then starts to receive the echoes produced by that pulse. Upon reception of each echo, the transducer vibrates again to convert the echo into a tiny electrical voltage called the echo signal. From the transducer, the echo signal is sent to the receiver.(Burwin 1982)

The receiver is essentially a sophisticated amplifier. It receives each echo voltage from the transducer and amplifies it.

The Memory is the component that puts the image together. The memory consists of a matrix of address locations (think of them as pigeon holes). Each echo signal from the receiver is evaluated for two characteristics: its time and its strength (amplitude). Echo location is then determined from the time, and echo brightness is determined from the strength. When an echo signal is received from the receiver, it is stored in memory at the correct location (pigeon hole), and assigned a number based on its amplitude. As each echo is received, it is stored in memory until a complete image is created. Once all the echo data for one complete image has been stored in memory, the data can be read from memory and sent to the display.(Burwin 1982)

The Display is the video screen that the sonographer views while scanning. The image information is read from memory and displayed on the video monitor in gray-scale. Strong echoes are white, mid level echoes are gray, and very weak or no echoes are black. Ultrasound systems produce a real-time display with frame rates averaging 15-20 frames per second.

The Recording Device is used to obtain a permanent record of the scan. Many different recording devices can be used. These can include film cameras, laser cameras, videotape recorders, and digital Picture Archiving and Communication Systems (PACS).(Burwin 1982)

2.5 Previous studies:

L Donoso et al., study 400 male and female with mean age of 50 years ultrasonography they found that the papillary process appeared to be separate from the liver on transverse sonograms in 62 patients (15.5%) and had egg shape with a maximal transverse diameter of 8-39mm. In all patients the papillary process appeared Above and in front of the common hepatic artery close to the portal vein and pancreatic isthmus. enlarged papillary process were more frequently seen in patients with chronic liver disease.

The morphometric study was done by kamal et al., they study the morphology of the caudate lobe of liver. The caudate lobe is visible on the posterior surface, bounded on the left by the fissure for the ligamentum venosum, below the porta hepatis 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. The Caudate lobe has a small rounded papillary process.

Resections a morphological study was carried out on caudate lobe. The Results of this study is various shapes of the caudate lobe were observed, rectangular being the commonest.

Elsafi Ahmed and Caroline Eayad, study 50 adult patients of known cases of schistosomiasis ultrasonography in Al-Fao area to evaluate caudate and right hepatic lobes ratio .They found that the Caudate /right lobe ratio in control group equal to (0.45±0.04std). Measuring the caudate and right hepatic lobes ratio using ultrasound appear to have a great value in diagnosis patients with *Schistosoma mansoni.*

Chapter Three

Materials and Methods

3.1 Materials:

3.1.1 Study sample:

The data was collected from fifty patients with different ages, sexes, and tribes, those patients were selected randomly when attending the Department of ultrasound at the Abu Jubaiyah education hospital for an abdominal ultrasonography.

3.1.2 Including and excluding criteria:

All Patients selected in the study referred to the ultrasound department for other indications rather than liver diseases, Patients with liver disease were excluded from the study.

3.1.3 area of the study:

Ultrasound department**,** Abu Jubaiyah Education Hospital and Alrayan Medical Center,south kurdufan state, Sudan.

3.1.4 study Duration:

This study was carried out During the period from May 2016 to August 2016.

3.1.5 Equipment:

Real time ultrasound machine Mindray model PD-10 fitted with 2-5 MHz and 5-6 HMHz (hormonic) transducer was used for the study.


DP-10
mindray
20160828-102938-A5C3
28-08-2016 10:30:13
35C50EB AP 97% MI 0.4 TIS 0.3
B
Cine
M Scale Off
iClear 3
Gray Map 1
Tint Map 12
L/R Flip Left
U/D Flip Up
Gray Invert Off
Rotation 0
Gray Rejection 0
γ 2
Curve
DP-10
Adult ABD
B
F 4.5M
D 18.1
G 66
FR 22
DR 130
iClear 3
480/480
10:30:50
Depth
Zoom
F.Pos
Freq.
Rotation
Freeze
Gain/iTouch

Figure 3.1: Real time ultrasound machine Mindray model PD-10

3.1.6 Method Of Data Collection :

The data has been collected for this study by a "Data Collecting Sheet"for the target population., which it designed especially for the study.

3.1.7 Method of data Analysis:

The data were first summarized into master sheet, and then analyzed by using statistical package SPSS version 15.0 . The relationships of the caudate lobe of the liver size with age and sex were determined, and then using Microsoft excels for graphical presentation.

3.1.8 Data Storage And Ethical Issue :

Patient's data sheets are kept in locked cabinet, and all data are stored on personal computer. No individual patient's details throughout this study.

3.2 Methods:

The caudate lobe ,like the other segments and lobe of the liver ,can be defined anatomically as well as pathologically utilizing gray-scale ultrasonography . It is anatomically distinct from left and right lobes as it has its own portal veins,hepatic arteries,hepatic veins ,and bile ducts.sonographically the limits of the caudate lobe can be defined using readily identifiable vascular landmarks such as the proximal left portal vein anteriorly ,the inferior vena cava inferiorly a wide variety of pathologic conditions that affect the caudate lobe ,including cirrhosis , infection , and neoplastic lesion can be demonstrated by ultrasonography.

Ultrasonography has demonstrated increasing ability to display detailed liver anatomy of the right and left lobes .the caudate lobe however has remained a source of a confusion on both ultrasonography and computed tomographic scans.

3.2.1 Sonographic technique and measurement:

Examination was done for patients in supine position; subjects were instructed to raise the right hands behind their head, thus increasing intercostals space and the distance from the lower costal margin to the iliac crest. The examination was carried out during deep inspiration and with a relaxed abdominal wall .The patient was fasting for 4 hours before the examination to reduce the amount of gasses and fecal masses. The image was taken in transverse and longitudinal planes.The whole liver was measured by caudal cranial technique .The caudate and right lobes were measured by antero- posterior technique and then calculated caudate/ right lobe ratio.

3.2.2 Image interpretation:

All ultrasound image were studied for different ages and gender, to evaluate caudate lobe from right to left, anterior to posterior and caudate lobe right lob ratio.

Chapter four

Results

The following tables and figures represent data obtained from randomly selected sample of patients (20 males and 30females) whom underwent abdomen ultrasound for other indications without evidence of liver diseases.

Table (4.1) Show frequency distribution of gender

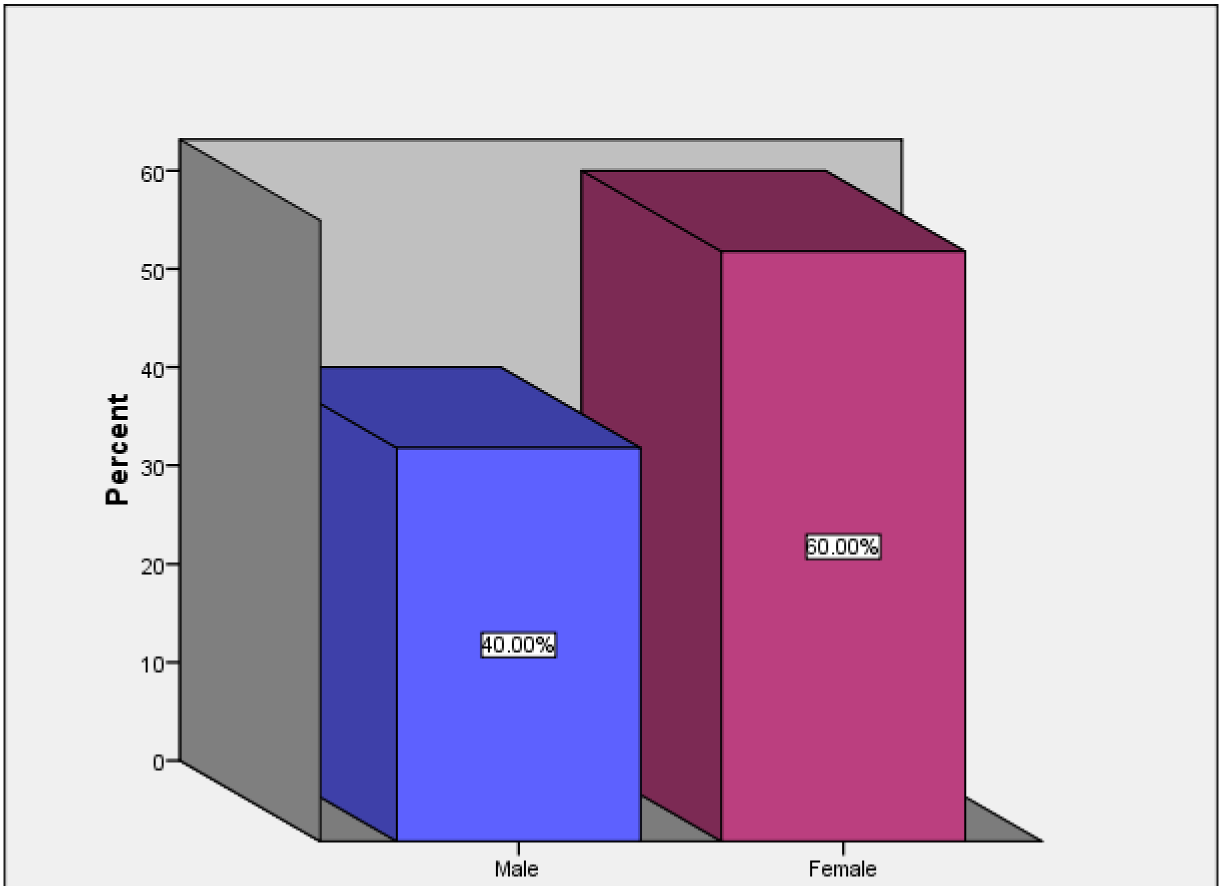


Figure (4.1) shows Frequency distribution of gender

Table (4.2) Frequency distribution of the age in range

Age	Frequency	Percent	Valid Percent	Cumulative Percent
20-30 years	6	12.0	12.0	12.0
31-40 years	10	20.0	20.0	32.0
41-50 years	19	38.0	38.0	70.0

51- 60 years	6	12.0	12.0	82.0
61-70 years	9	18.0	18.0	100.0
Total	50	100.0	100.0	
Means = 45.84 , minimum = 24 , maximum = 69 , std = 12.28631				

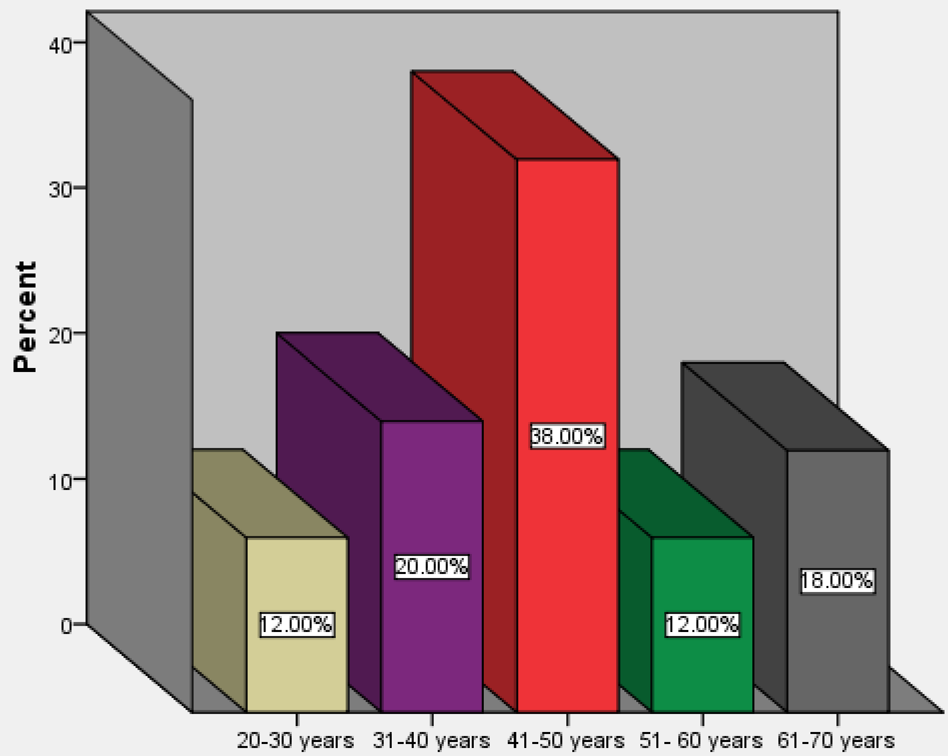


Figure (4.2) Shows frequency distribution of the age in range

Table (4.3) Frequency distribution of shape

Shape	Frequency	Percent	Valid Percent	Cumulative Percent
Rectangular	45	90.0	90.0	90.0
Triangular	4	8.0	8.0	98.0
Columnar	1	2.0	2.0	100.0
Total	50	100.0	100.0	

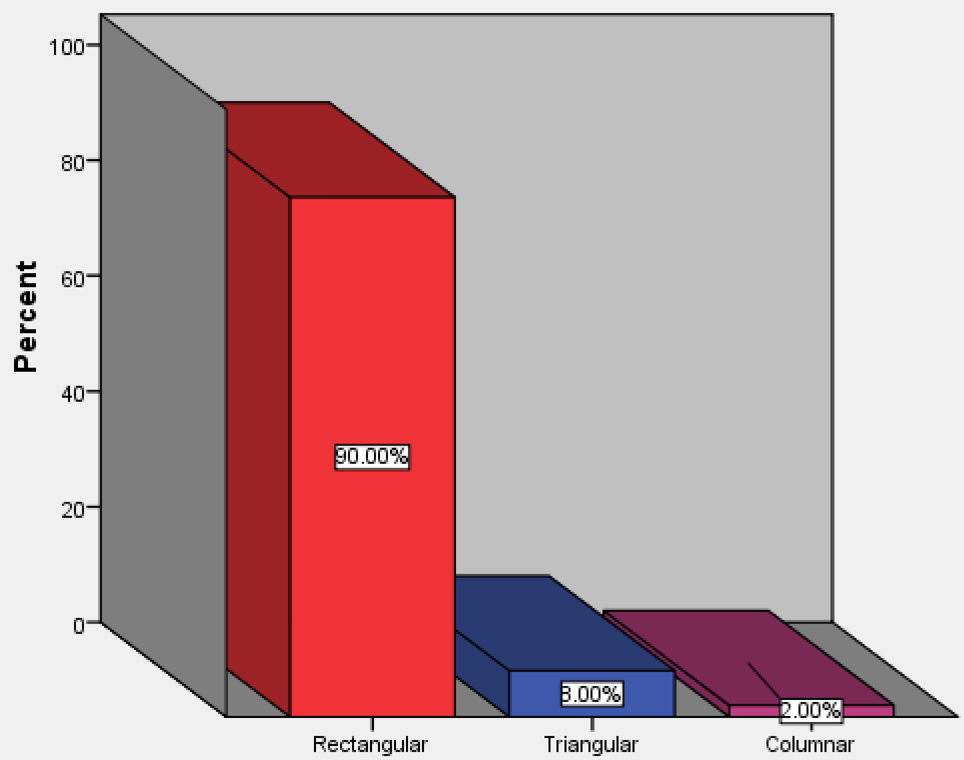


Figure (4.3) Shows frequency distribution of shape

Table (4.4) Frequency distribution of location

Location	Frequency	Percent	Valid Percent	Cumulative Percent
Inferior and posterior surfaces to the right of the groove formed by ligamentum venosum lies posterior to the porta hepatis	50	100.0	100.0	100.0

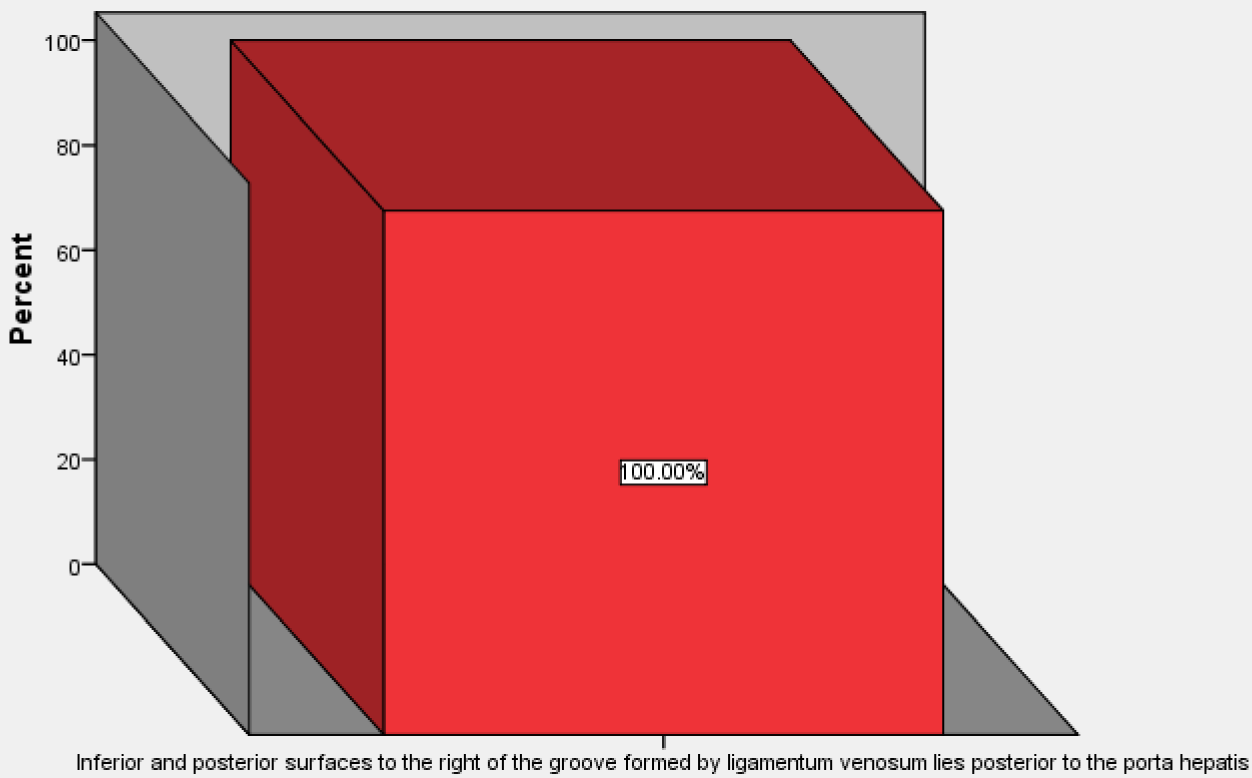


Figure (4.4) Shows frequency distribution of location

Table (4.5) Frequency distribution of echotexture

Echotexture	Frequency	Percent	Valid Percent	Cumulative Percent
Fine	44	88.0	88.0	88.0
Course	6	12.0	12.0	100.0
Total	50	100.0	100.0	

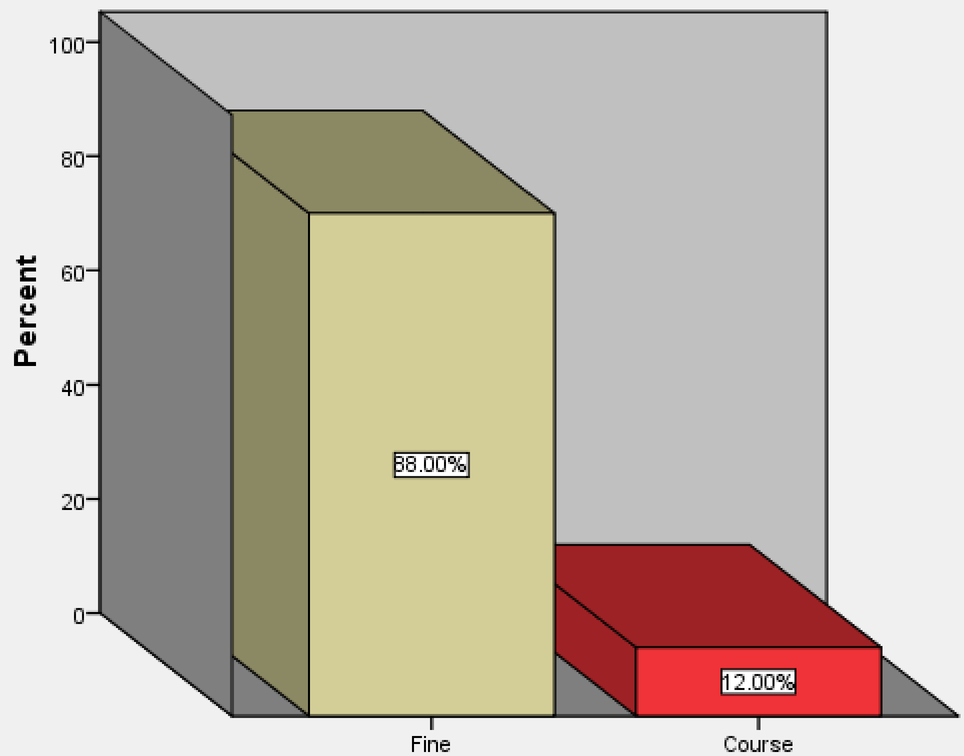


Figure (4.5) Shows frequency distribution of echotexture

Table (4.6) Diameter of caudate lobe cranicaudal in cm

Diameter CL craniocaudal	Frequency	Percent	Valid Percent	Cumulative Percent
2-3 cm	1	2.0	2.0	2.0
3.01-4 cm	23	46.0	46.0	48.0
4.01-5 cm	12	24.0	24.0	72.0
more than 5 cm	14	28.0	28.0	100.0
Total	50	100.0	100.0	
Means =4.2426, maximum =6.03, minimum= 2.30, std=0.80589, median= 4.0500				

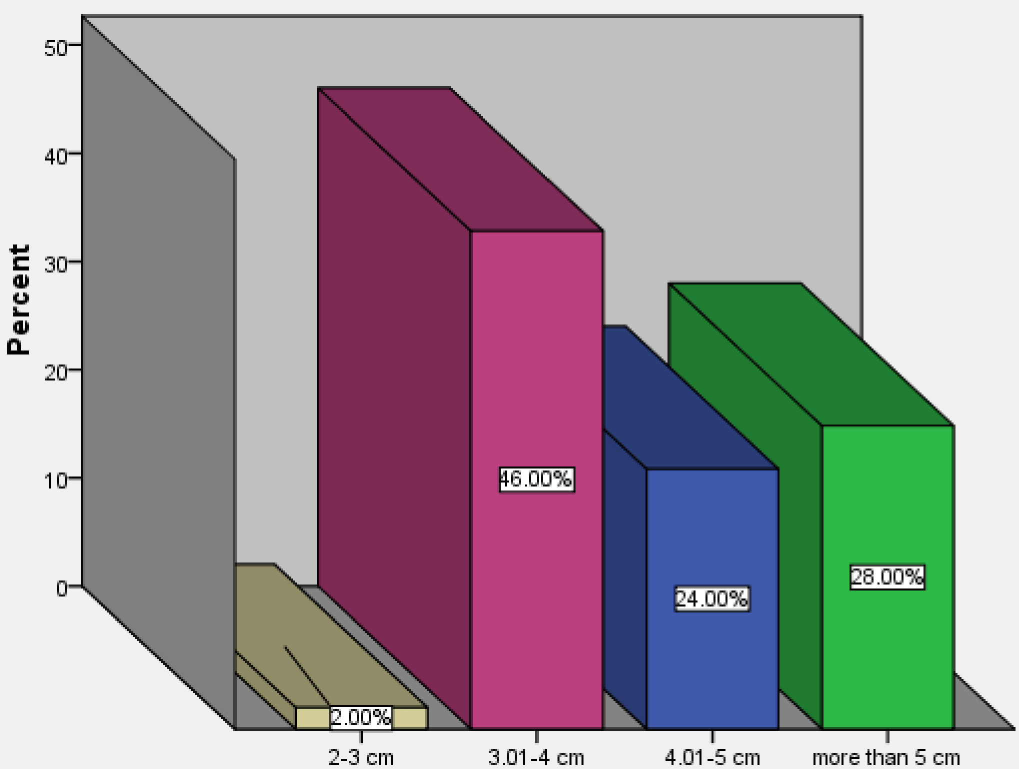


Figure (4.6) Shows frequency of the range of caudate lobe diameter cranicaudal

Table (4.7) Diameter of caudate lobe AP in cm

AP diameter	Frequency	Percent	Valid Percent	Cumulative Percent
less than 1 cm	1	2.0	2.0	2.0
1.01- 2 cm	28	56.0	56.0	58.0
2.01-3 cm	19	38.0	38.0	96.0
more than 3 cm	2	4.0	4.0	100.0
Total	50	100.0	100.0	
Minimum= 0.79, maximum= 3.22, mean= 2.1688, std = 0.55576				

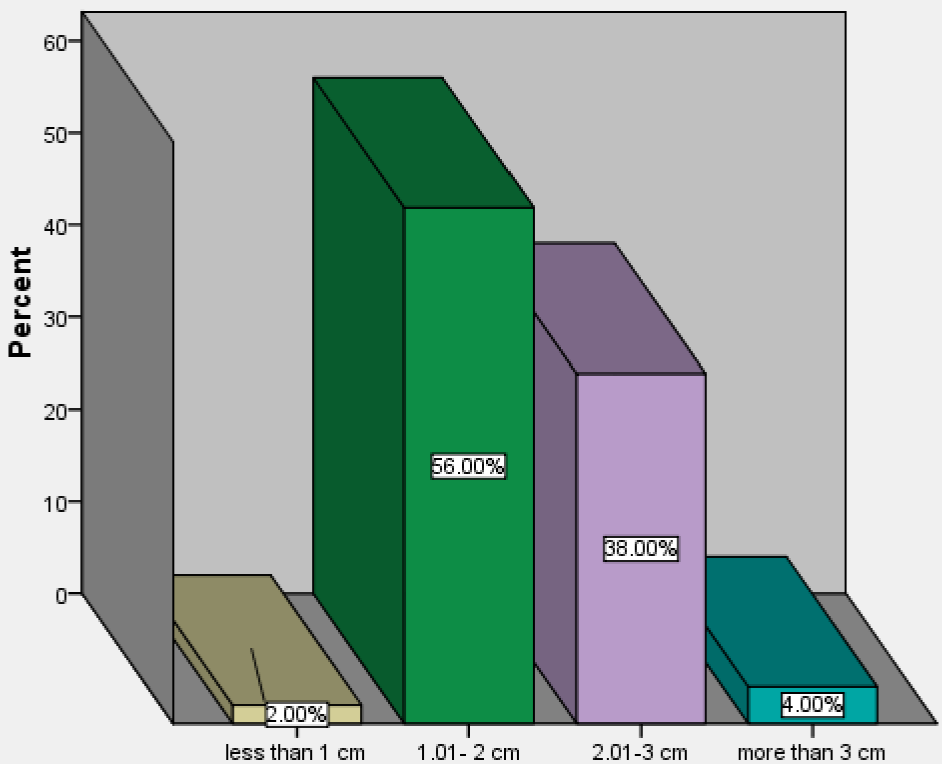


Figure (4.7) Shows diameter of caudate lobe in AP

Table (4.8) Diameter of the right lobe cranicaudal in cm

Diameter of Rt lobe	Frequency	Percent	Valid Percent	Cumulative Percent
6-7cm	11	22.0	22.0	22.0
7.01- 8cm	12	24.0	24.0	46.0
8.01-9 cm	22	44.0	44.0	90.0
more than 9cm	5	10.0	10.0	100.0
Total	50	100.0	100.0	
Minimum = 6.21, maximum= 9.47,means= 7.9996, std= 0.83039				

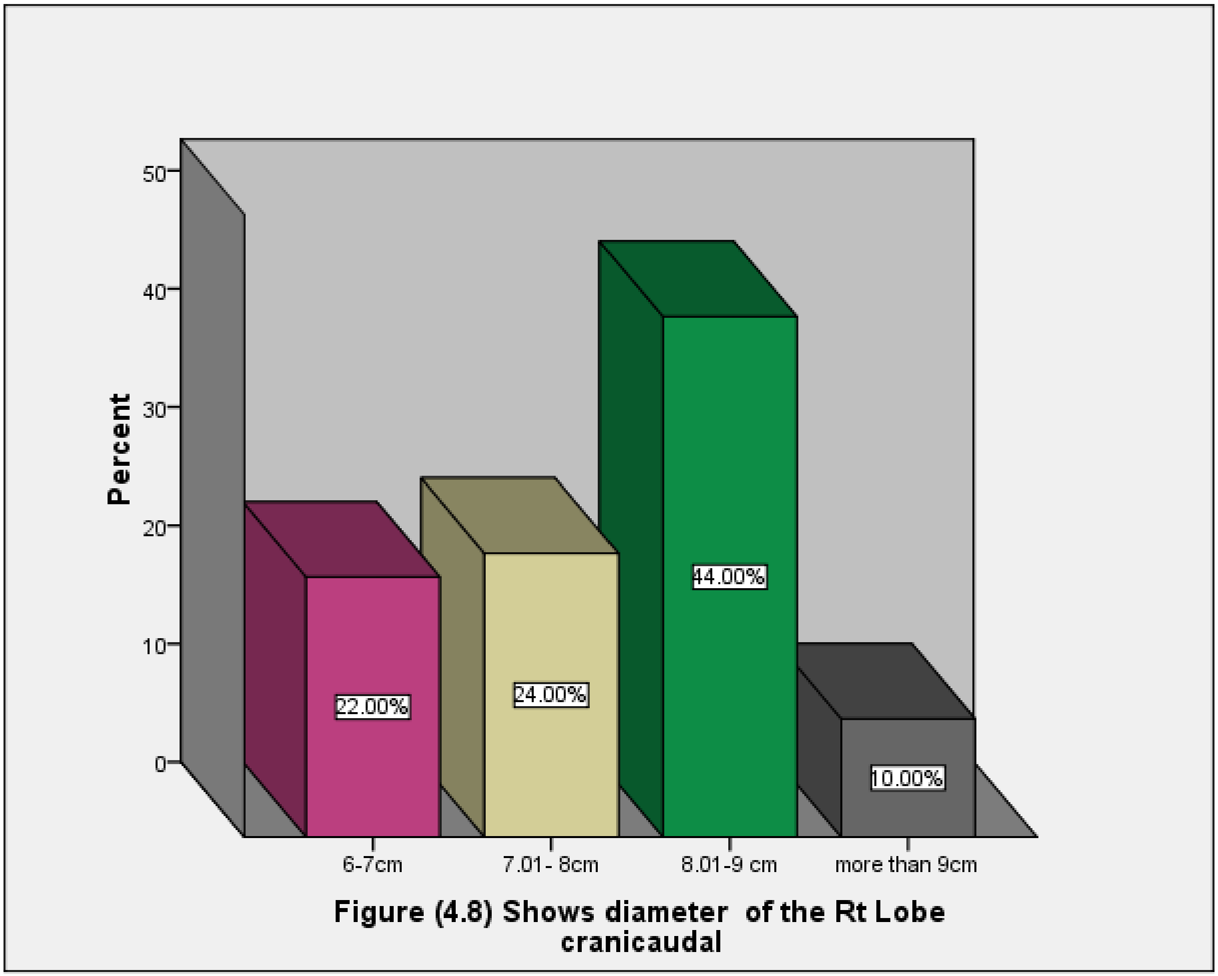


Table (4.9) Ratio of caudate lobe cranicaudal in cm\ **Right lobe CC in cm**

CL \ Rt lobe ratio	Frequency	Percent	Valid Percent	Cumulative Percent
0.3-0.4	4	8.0	8.0	8.0
0.41-0.5	14	28.0	28.0	36.0
0.51-0.6	23	46.0	46.0	82.0
0.61-0.7	9	18.0	18.0	100.0
Total	50	100.0	100.0	
Minimum= 0.36, maximum= 0.67, mean=0.5297, std=0.07724				

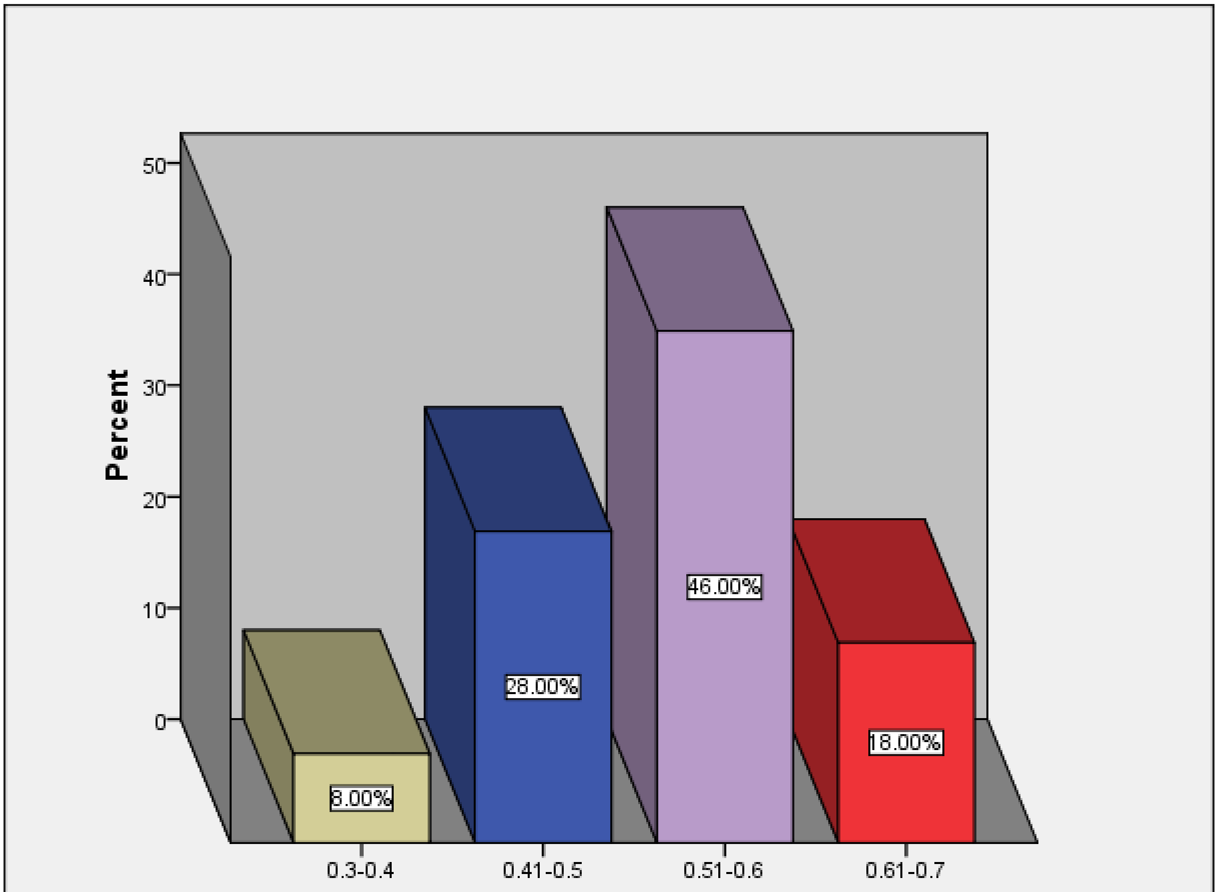


Figure (4.9) Shows ratio of caudate to right lobe

Table (4.10) other finding mention in ultrasound

Other	Frequency	Percent	Valid Percent	Cumulative Percent
No other finding	31	62.0	62.0	62.0
BPH	2	4.0	4.0	66.0
Calcified fibroid	1	2.0	2.0	68.0
Chronic appendicitis	1	2.0	2.0	70.0
Endometrial polyp	1	2.0	2.0	72.0
Fetal demise	1	2.0	2.0	74.0
Fibroid	2	4.0	4.0	78.0
Huge renal cyst	1	2.0	2.0	80.0
Incomplete abortion	1	2.0	2.0	82.0
Metrosapingitis	1	2.0	2.0	84.0
Mild splenomegally	1	2.0	2.0	86.0

Multiple renal cyst	1	2.0	2.0	88.0
Ovarian cyst	1	2.0	2.0	90.0
PID	2	4.0	4.0	94.0
Renal cyst	1	2.0	2.0	96.0
Renal stone	1	2.0	2.0	98.0
Rt ovarian mass	1	2.0	2.0	100.0
Total	50	100.0	100.0	

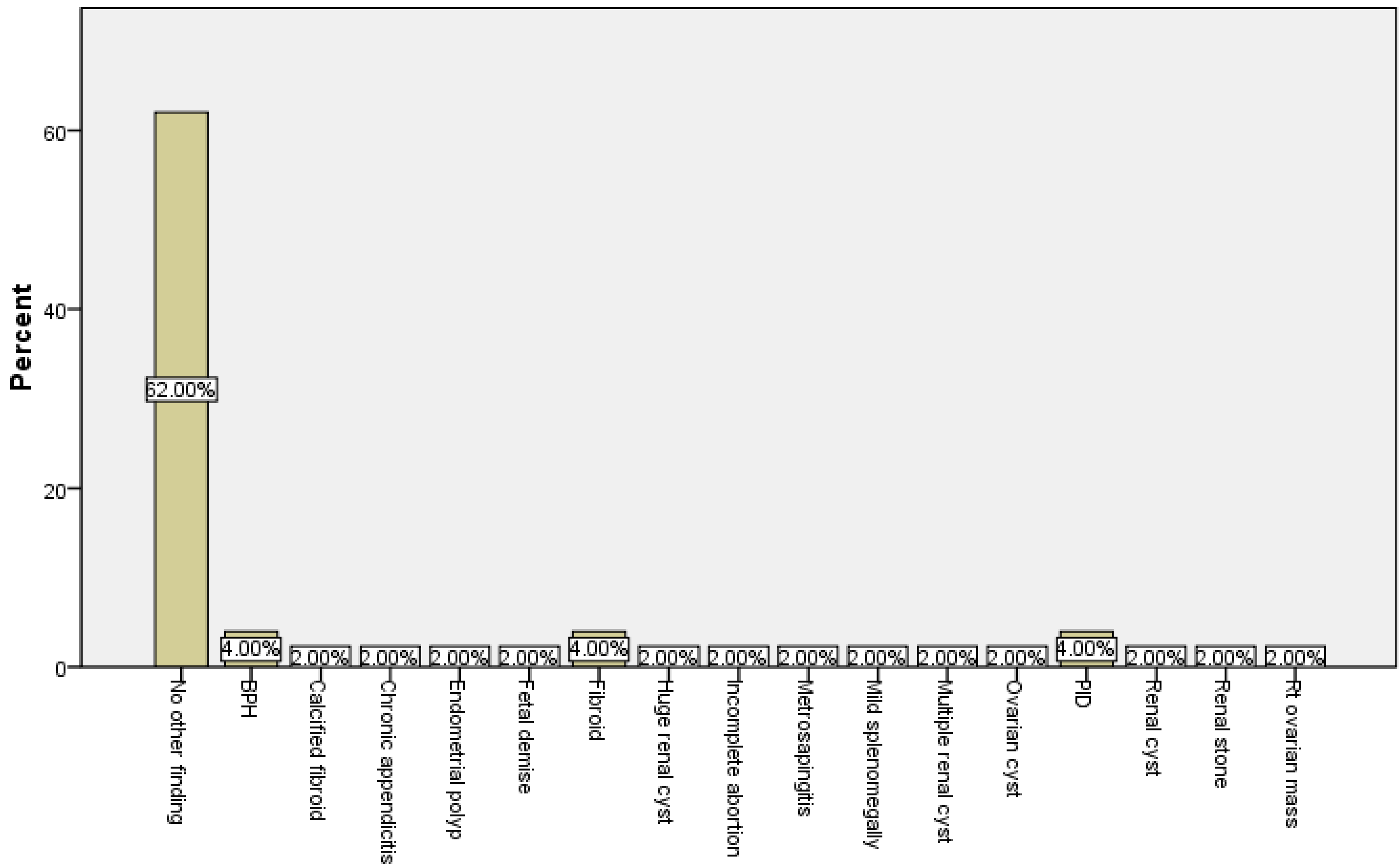


Figure (4.10) Other ultrasound finding

Table (4.11) T-test gender & diameter of CL (Craniocaudal,AP),Rt lobe diameter and C/RT ratio

	Gender	N	Mean	Std. Deviation	T-Test	d-f	P-Value
Caudate lobe -Rt to left diameter(cm)	Male	20	4.7435	1.03449	3.642	48	0.00*
	Female	30	3.8690	.35245			
Caudate lobe -AP diameter(cm)	Male	20	2.4595	.70845	3.050	48	0.01*
	Female	30	1.9520	.27883			
Rt lobe diameter(cm)	Male	20	8.3265	.91552	2.378	48	0.02*
	Female	30	7.7817	.70223			
C/RT ratio	Male	20	.5730	.07821	3.450	48	0.00*
	Female	30	.5050	.06090			

*Significant different at the 0.05 level.

Table (4.12) cross tabulation age & diameter of CL (CC)

Age	range of caudate lobe cc				Total
	2-3 cm	3.01-4 cm	4.01-5 cm	more than 5 cm	
20-30 years	1	5	0	0	6
31-40 years	0	9	1	0	10
41-50 years	0	7	3	9	19
51- 60 years	0	2	1	3	6
61-70 years	0	0	7	2	9
Total	1	23	12	14	50

Table (4.13) chi square age & diameter of CL (CC)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	39.996a	12	.000
Likelihood Ratio	41.354	12	.000
Linear-by-Linear Association	13.531	1	.000
N of Valid Cases	50		

a. 18 cells (90.0%) have expected count less than 5. The minimum expected count is .12

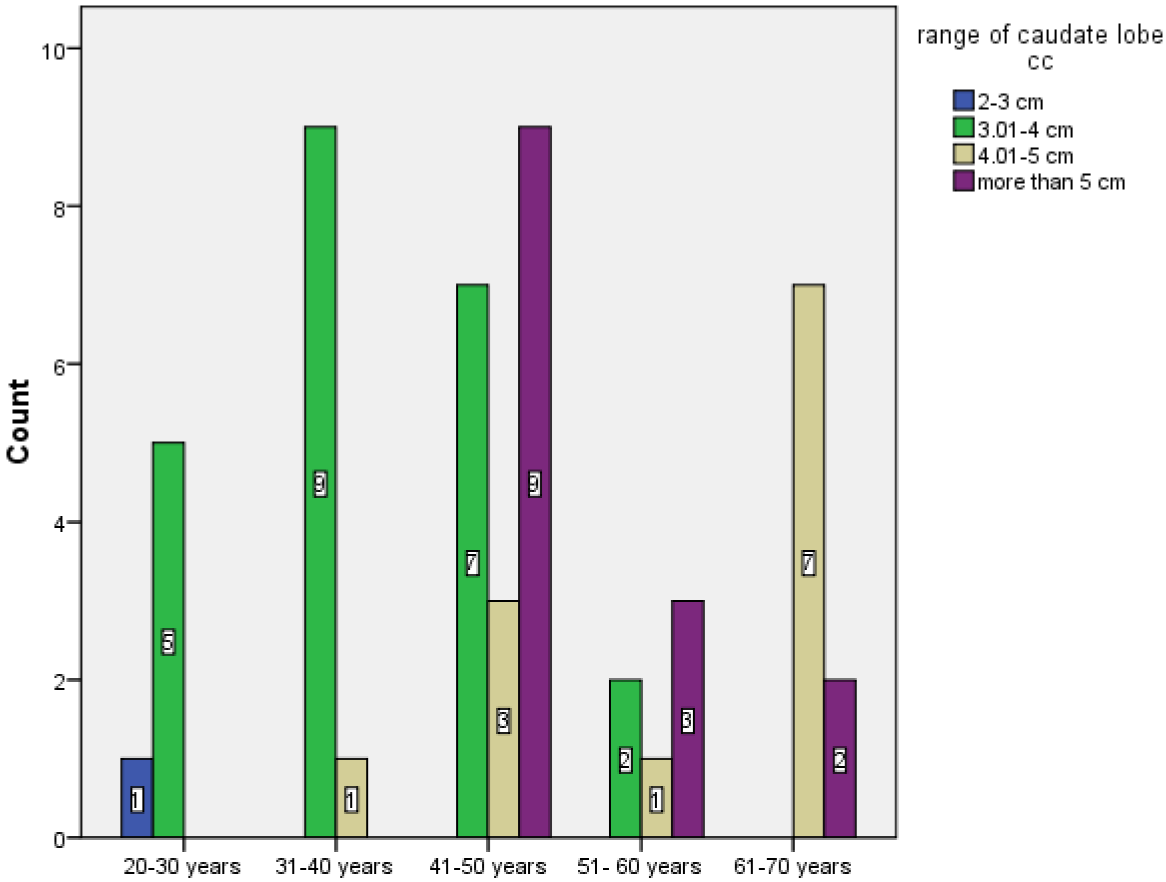


Figure (4.13) crosstab age & diameter of CL craniocaudal

Table (4.14) a- cross tabulation age & diameter of CL (AP)

Age range	range of caudate lobe AP				Total
	less than 1 cm	1.01- 2 cm	2.01-3 cm	more than 3 cm	
20-30 years	1	5	0	0	6
31-40 years	0	7	3	0	10
41-50 years	0	9	10	0	19
51- 60 years	0	2	3	1	6
61-70 years	0	5	3	1	9
Total	1	28	19	2	50

Table (4.14) b- chi square age & diameter of CL (AP)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.030a	12	.115
Likelihood Ratio	17.026	12	.149
Linear-by-Linear Association	6.064	1	.014
N of Valid Cases	50		

a. 16 cells (80.0%) have expected count less than 5. The minimum expected count is 12

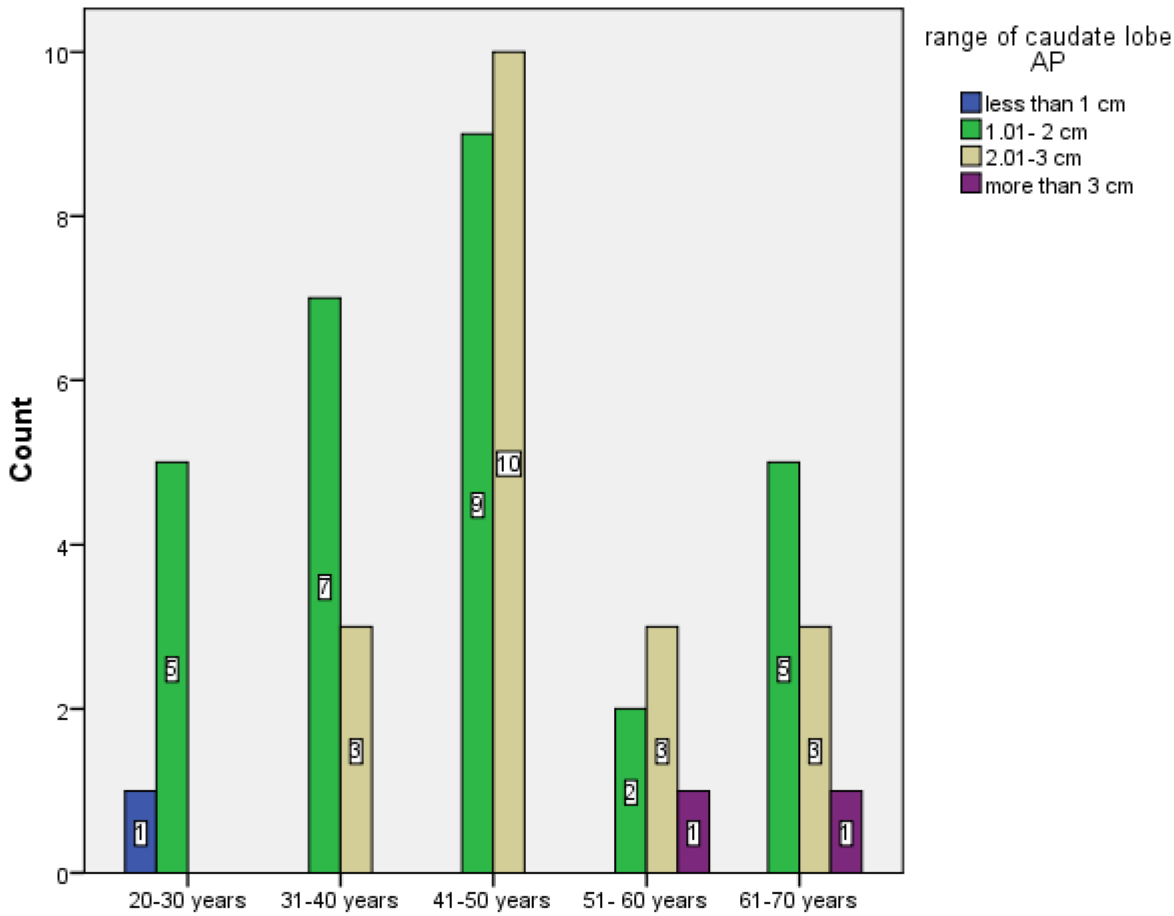


Figure (4.14) crosstab age in range &AP diameter ...

Table (4.15) correlation between CL (CC) and range of age (non parometric test)

			Diameter of caudate lobe cranicaudal in cm	Frequency distribution of the age in range
Spearman's rho	Diameter of caudate lobe cranicaudal in cm	Correlation Coefficient	1.000	.634**
		Sig. (2-tailed)	.	.000
		N	50	50
	Frequency distribution of the age in range	Correlation Coefficient	.634**	1.000
		Sig. (2-tailed)	.000	.
		N	50	50
**. Correlation is significant at the 0.01 level (2-tailed).				

Table (4.16) correlation between AP diameter of caudate lobe and range of the age (non parometric test)

			Frequency distribution of age	Diameter of caudate lobe AP in cm
Spearman's rho	Frequency distribution of age	Correlation Coefficient	1.000	.503**
		Sig. (2-tailed)	.	.000
		N	50	50
	Diameter of caudate lobe AP in cm	Correlation Coefficient	.503**	1.000
		Sig. (2-tailed)	.000	.
		N	50	50
**. Correlation is significant at the 0.01 level (2-tailed).				

Table (4.17) correlation between range of right lobe diameter &age (non parometric test)

		Frequency distribution of age	range of Rt lobe craniocaudal

Frequency distribution of age	Pearson Correlation	1	.331*
	Sig. (2-tailed)		.019
	N	50	50
range of Rt lobe craniocaudal	Pearson Correlation	.331*	1
	Sig. (2-tailed)	.019	
	N	50	50
*. Correlation is significant at the 0.05 level (2-tailed).			

Table (4.18) correlation between CL to Right lobe ratio &,age (non parometric test)

		Frequency distribution of age	Caudate to right lobe ratio
Frequency distribution of age	Pearson Correlation	1	.321*
	Sig. (2-tailed)		.023
	N	50	50
Caudate to right lobe ratio	Pearson Correlation	.321*	1
	Sig. (2-tailed)	.023	
	N	50	50
*. Correlation is significant at the 0.05 level (2-tailed).			

Chapter five

Discussion, Conclusion and recommendation

5.1 Discussion

The importance of the knowledge of the normal range of values of various viscera in the identification of early pathological changes in the size of these organs can never be overemphasized. This is cross sectional descriptive study has set baseline data with ultrasound, which can be used as a comprehensive guide to characterize the normal caudate lobe of the liver for the Sudanese adult within the age range of 24–69 years.The study took into consideration the normal caudate lobe measurements and correlated that with age and gender.Concerning the gender distribution the study found that 40% were male while 60% were female.

Regarding the age distribution most of diameter taken from 41- 50 years (38%) then 31- 40 years (12%) after that 61-70(18%) and lastly 20-30 years(6%) 51- 60 years(6%).

The minimum age = 24 years , the maximum = 69 years , the mean age =(45.84,±12.28631std).

The normal caudate lobe measurements were right to left Diameter (4.2426 Mean, ± 0.80589 std), the anteroposterior diameter were (2.1688 Mean, ±, 0.55576 std), right Lobe diameter were (7.9996 means,± 0.83039 std)and caudate to right lobe ratio (0.5297 mean,± 0.07724 std).this result agrees with international result of normal C/RT lobe ratio >0.67 .

The study showed that the caudate lobe location in all patients was in the inferior and posterior surfaces to the right of the groove formed by the ligamentum venosum: it lies posterior to the porta hepatis. And the most common shape and texture of the caudate lobe was rectangular 90 %,fine 88% respectively,which agree with previous studies.

The study showed that there was only one patient have papillary process of caudate lobe.(figure 5.7).

The study showed that no ultrasound pathology finding is the most common other ultrasound finding in this study 62%.

The correlation between the gender and the RT to LT diameter of caudate lobe the study showed that there was significant correlation at the 0.00 level and the RT to LT Mean diameter of caudate lobe in male greater than female =(4.7435±1.03449 std, 3.8690±0.35245 std) respectively.

The correlation between the gender and the AP diameter of caudate lobe the study showed that there was significant correlation at the 0.01 level and the AP Mean diameter of caudate lobe in male greater than female =(2.4595±0.70845 std, 1.9520±0.27883 std) respectively.

The correlation between the gender and the Rt lobe diameter of the liver the study showed that there was significant correlation at the 0.02 level and the Rt lobe Mean diameter of the liver in male greater than female =(8.3265±0.91552 std, 7.7817±0.70223 std) respectively.

The correlation between the gender and C/RT ratio the study showed that there was significant correlation at the 0.00 level and the Mean C/RT ratio in male greater than female =(0.5730±0.7821 std, 0.5050±0.06090 std) respectively.which a little greater than that found in Alpho area by Elsafi Ahmed and Caroline Eayad. This could be due to body habitus and agree with international standard result for value should be less than 0.67.

The correlation between the age and the RT to LT diameter of caudate lobe the study showed that there was significant correlation at the 0.00 level and the RT to LT diameter of caudate lobe increased by factor of 0.634 as the age increased.

The correlation between the age and the antroposterior Diameter of caudate lobe the study showed that there was insignificant correlation at the 0.11 level and the antroposterior Diameter of caudate lobe increased by factor of 0.503 as the age increased.

The correlation between the age and the right Lobe Diameter the study showed that there was significant correlation at the 0.05 level and the right Lobe Diameter increased by factor of 0.331 as the age increased.

The correlation between the age and the caudate to right lobe ratio the study showed that there was significant correlation at the 0.01 level and the caudate to right lobe ratio increased by factor of 0.321 as the age increased.

5.2 Conclusions

As the main of the study is to characterization of normal caudate lobe of the liver in adult Sudanese population using ultrasonographic scanning tool, the researcher concluded that:

- The incidence of morphological variations of caudate lobe is very high in this study. The papillary process of caudate lobe is a potential source of pitfalls in interpretation of ultrasound images at and just below the porta hepatis. Knowledge of these variations is important for sonologists to achieve correct diagnosis and for surgeons to plan for surgery and to achieve good surgical outcome.

- There is significant proportional relation between patient age and caudate lobe measurements (right to left Diameter antroposterior Diameter, caudate to right lobe ratio) and the right lobe diameter , and thus the the size of liver and caudate lobe are apparently increased as the age increased.

-Also the study showed that the caudate lobe measurements (right to left Diameter antroposterior Diameter, caudate to right lobe ratio) and the right lobe diameter greater in male than female .

-The right lateral border of the right portal vein bifurcation should be taken as standard reference point to measure the length of CL and Rt lobe craniocaudal for finding CL/RL ratio, on transverse plane, for diagnosing conditions of liver.

-The percentage of the normal caudate lobe to right lobe ratio within lower level of international references.

-Diagnostic ultrsonographic finding are critically dependent on the examiner training and experience.

5.3 recommendation

- For further assessment another study should be done using large sample of patient.

- For further assessment another study should be done using anthropometric measurements of body size indicators such as WT, HT, body surface area (BSA), and body mass index .

- Another researches should be done with MRI and compare it with ultrasound to evaluate which the best modality to characterize the caudate lobe clearly.

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Appendices

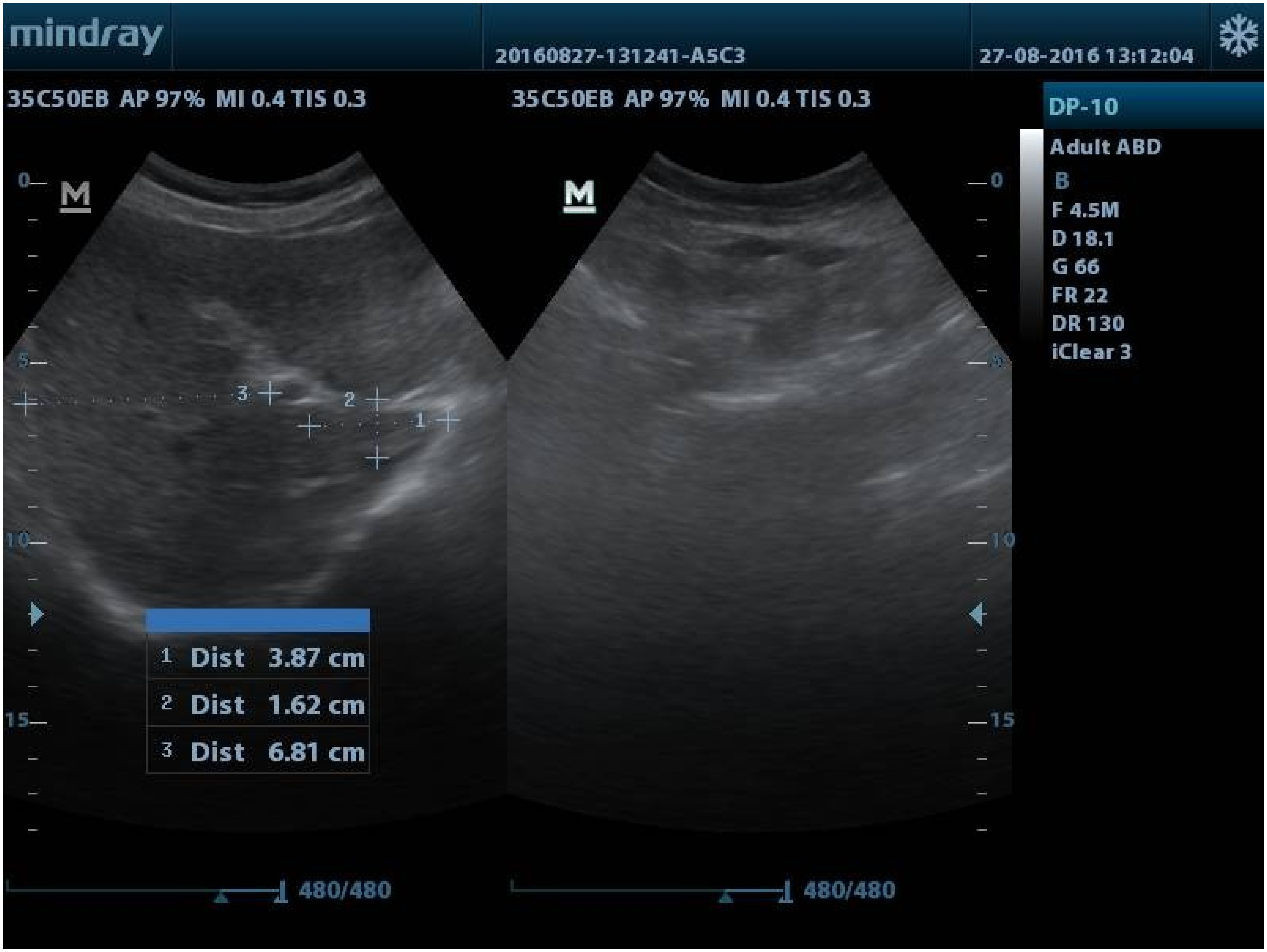

Figure 1: transverse ultrasound image for female (24 years) show measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

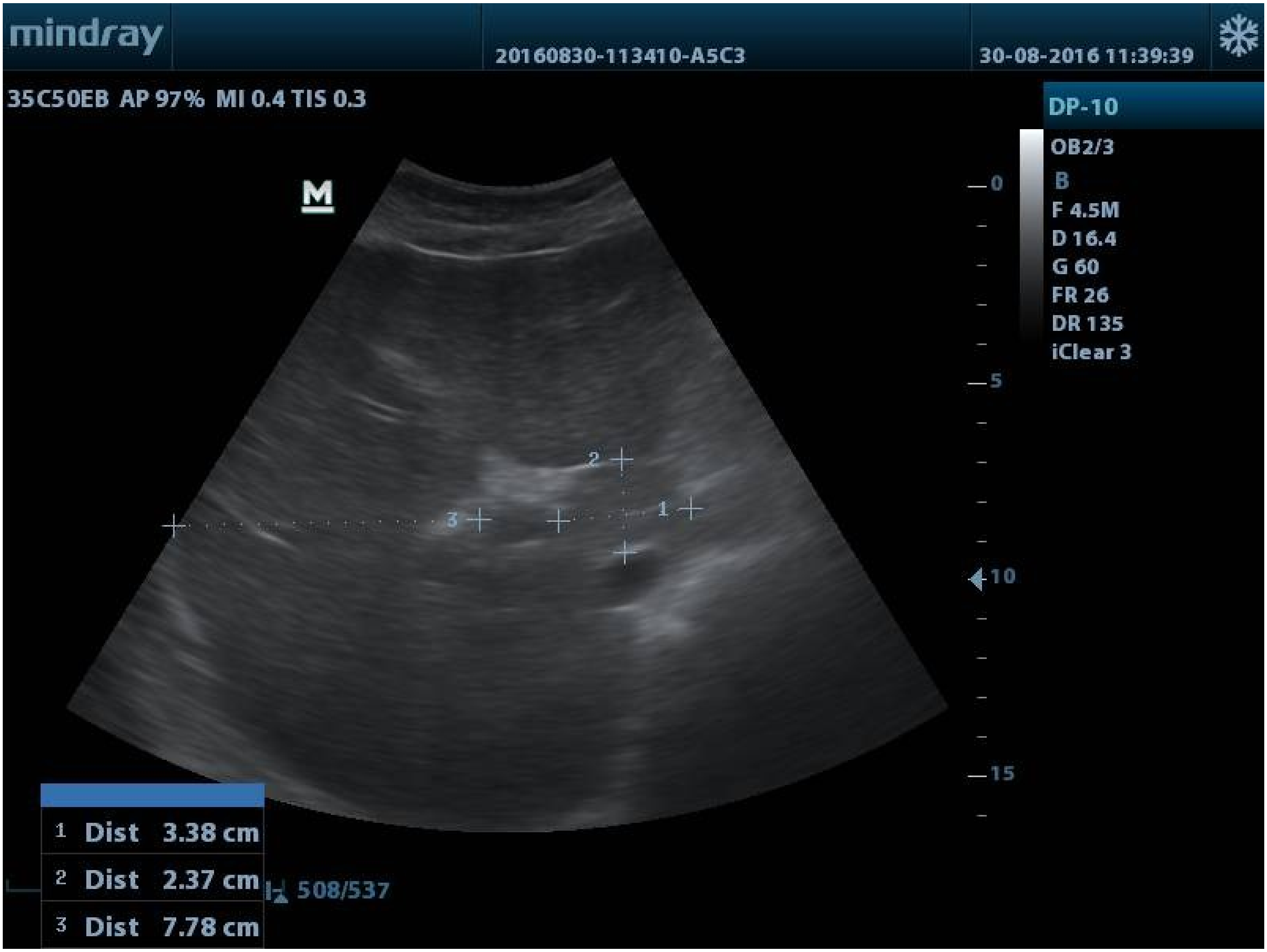

Figure 2:transverse ultrasound image for Female (38years) shows measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

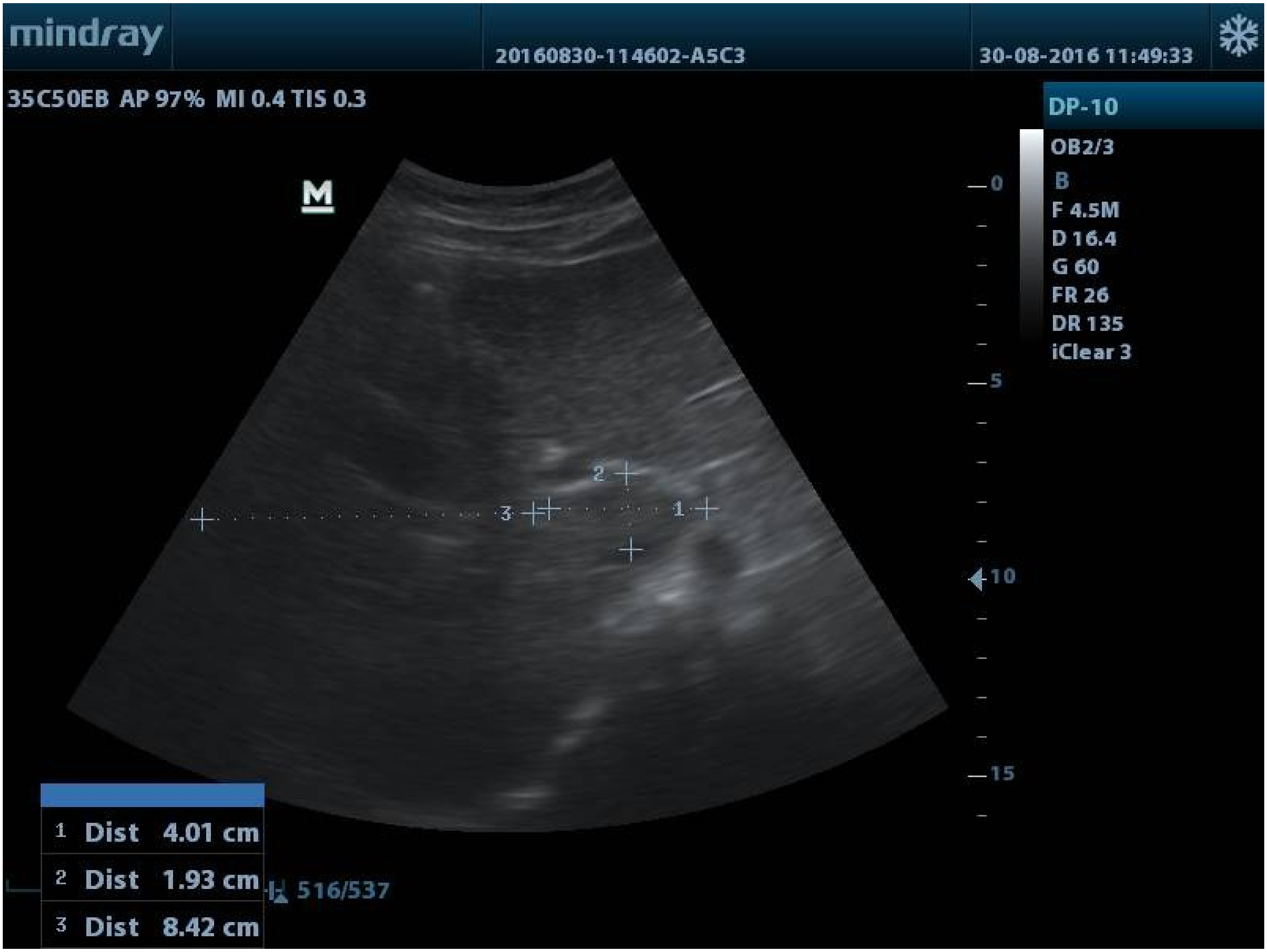

Figure 3 transverse ultrasound image for female (46 years) shows measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

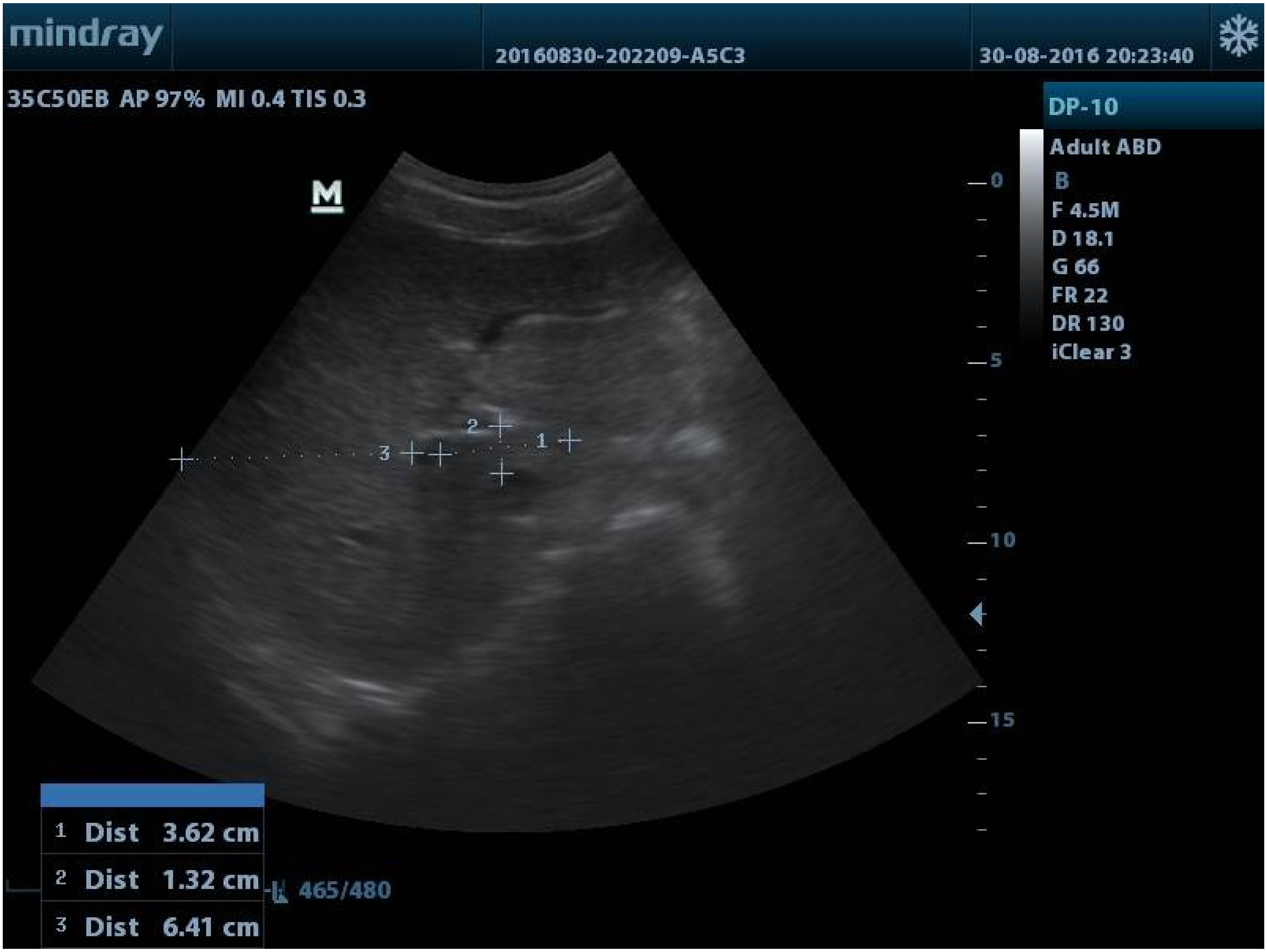

Figure 4 transverse ultrasound image for male (41 years) shows measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

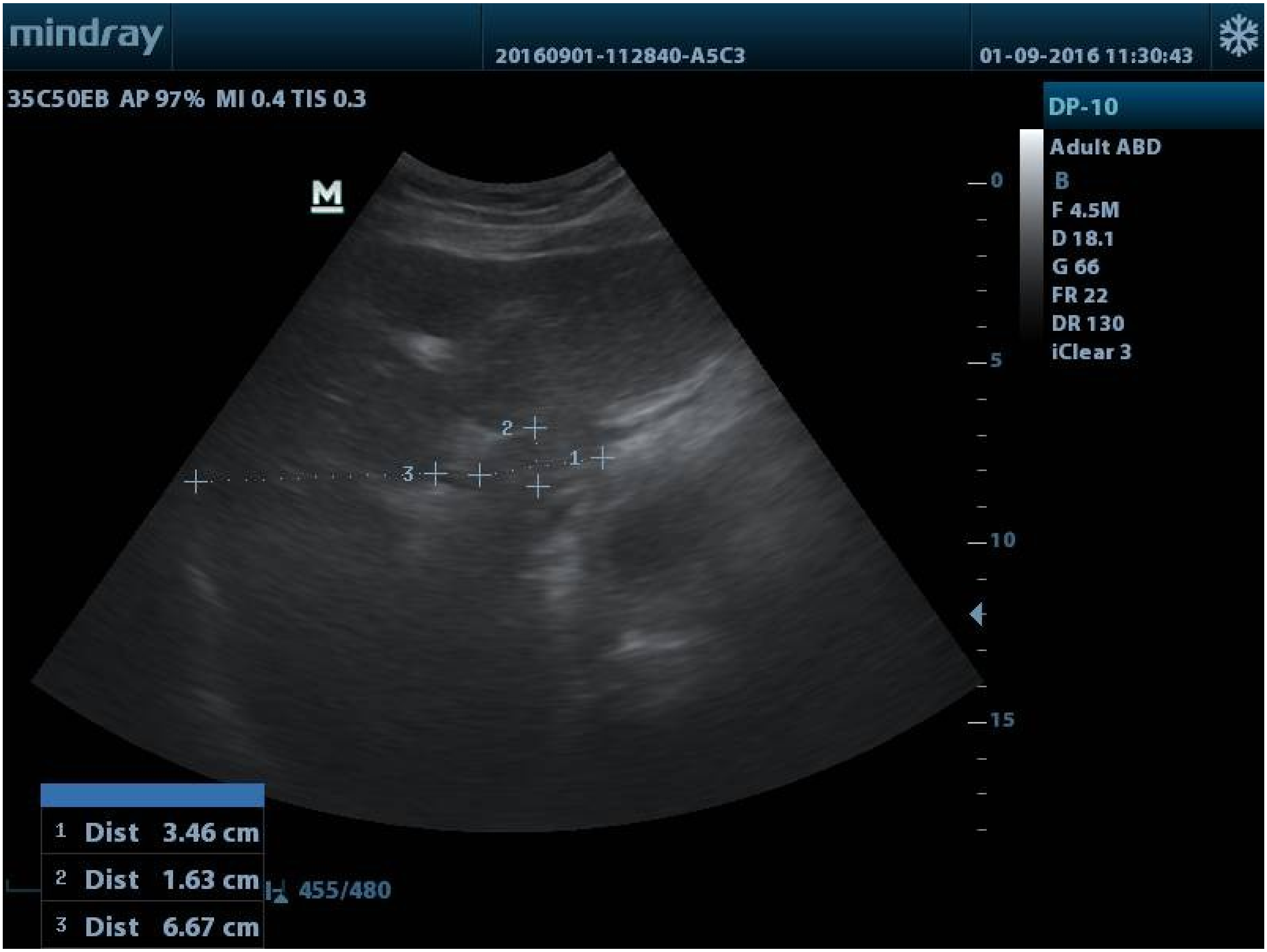

Figure 5 transverse ultrasound image for male (36 years) shows measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

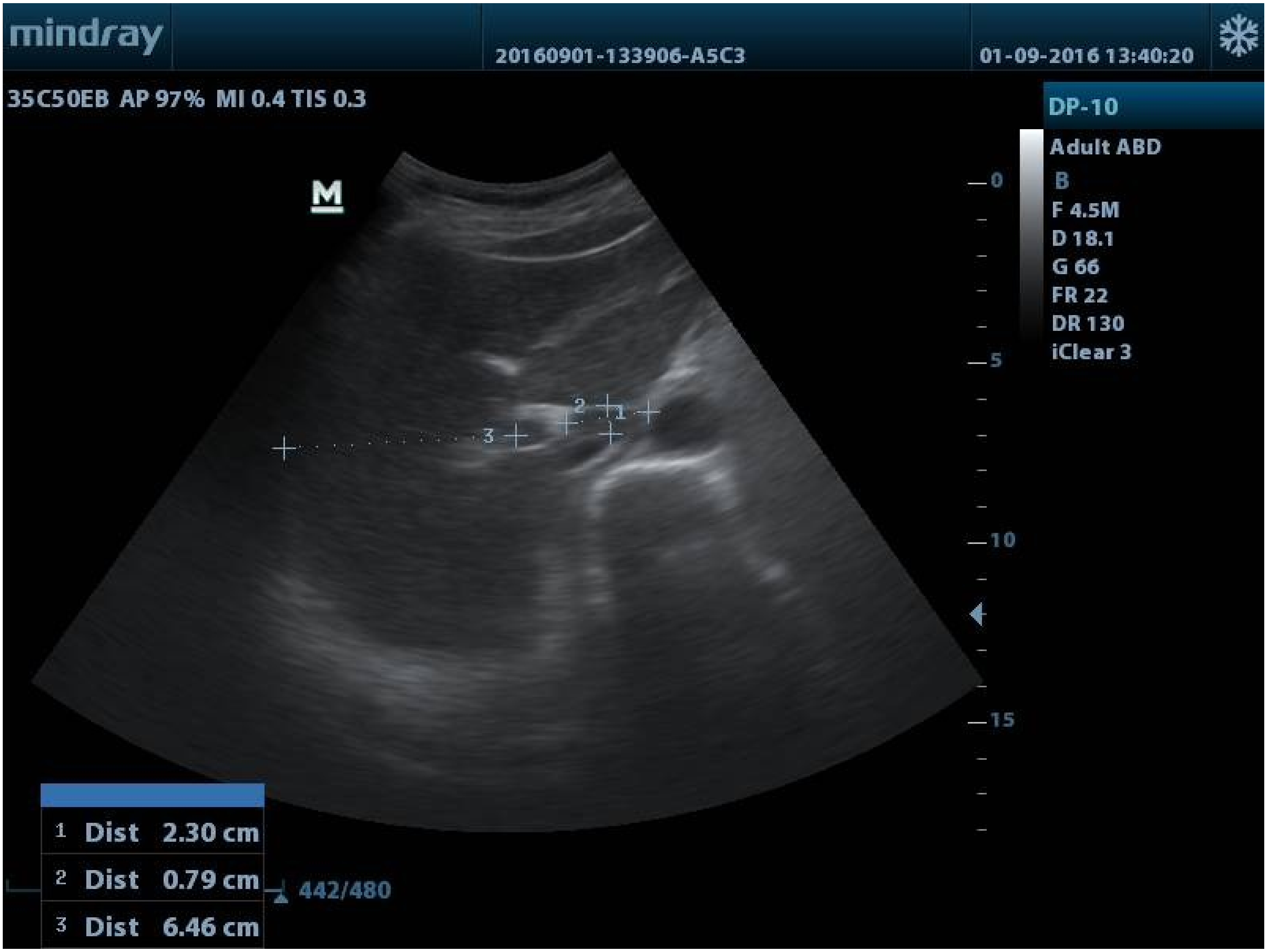

Figure 6 transverse ultrasound image for male (29 years) shows measurements of caudate lobe right to left, Antroposterior and right lobe diameters.

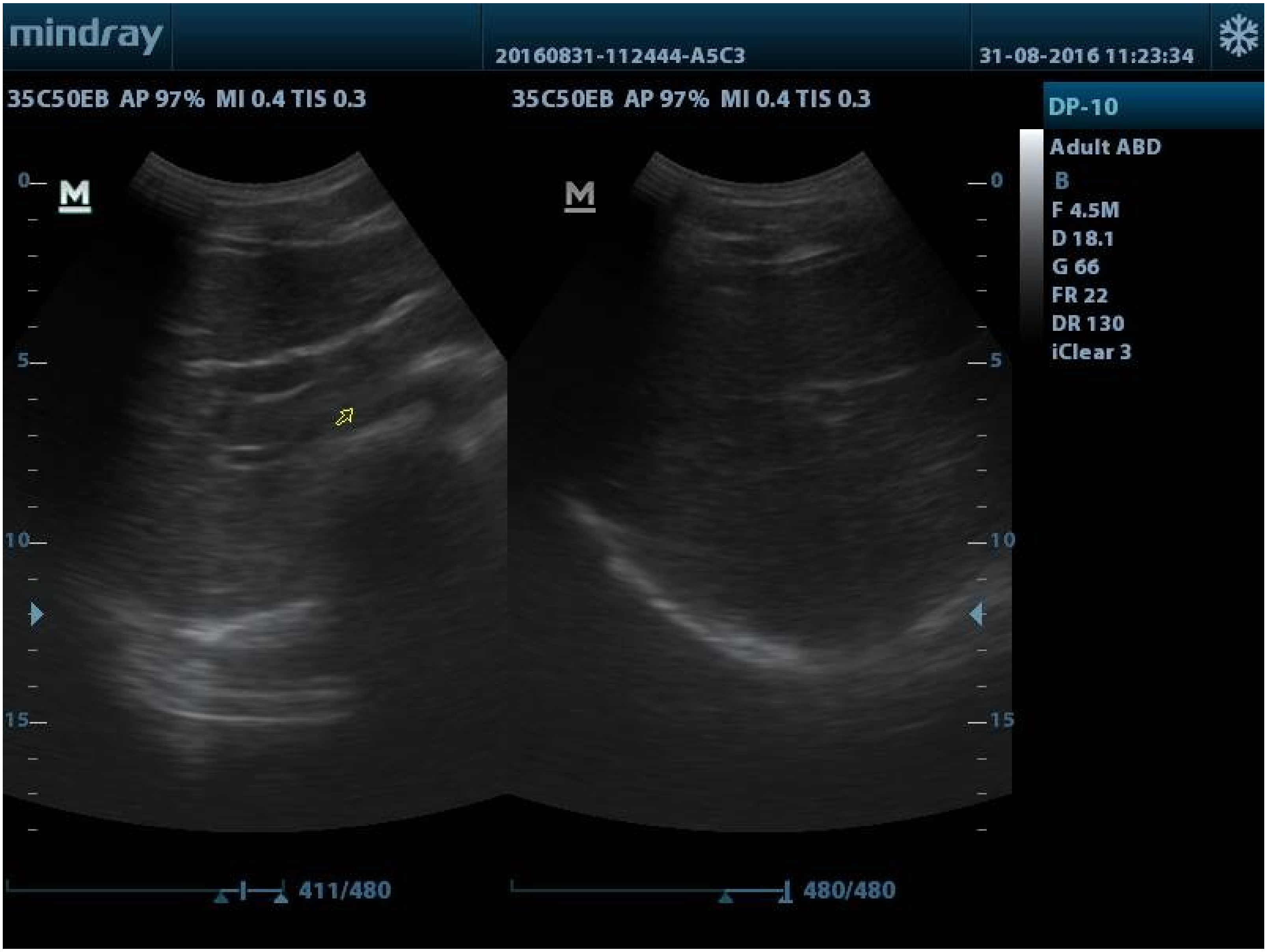

Figure 7 transverse ultrasound image for male (26 years) shows papillary process of caudate lobe arrow.