Sudan University of Science and Technology

College of Graduate Studies

Measurement of Normal Common Bile Duct Diameter using Ultrasonography

قياس القطر الطبيعي للقناة الصفراوية المشتركة باستخدام الموجات فوق الصوتية

A thesis submitted for Partial Fulfillment of Master Degree in Medical Diagnostic Ultrasound

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الآية

قال تعالي :

﴿وَقُل رَّبِّ زِدْنِي عِلْمًا﴾

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Dedication

I dedicate my dissertation to my family and my friends. A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears. my brother who helped me a lot in this work.

To my husband who showed much patience and tolerance while I was preparing the thesis.

Acknowledgment

First of all thanks ***Allah*** the almighty.

A lot of thanks to my supervisor ***Dr. Salah Ali Fadlalla*** who was more than generous with his expertise and precious time and for his countless hours of reflecting, reading, encouraging, and most of all patience throughout the entire process.

I am indebted to the working team in ***Giad Hospital*** for their help during the process of collection of data.

Abstract

This was cross sectional study aimed to measure common bile duct diameter by ultrasound conducted in Giad hospital Gazira state, Sudan. From October 2018 to January 2019.The problem of the study was the various factors that affect the diameter of the common bile duct. However, no previous studies work done in Sudan to measure the diameter using US, to the best of the researcher's knowledge. The main objective of the study was to measure the normal common bile duct using Ultrasonography.

The data were collected from 70 patients classified and analyzed by SPSS (statistical package for the social science).

The study found that there was a linear relation between the common bile duct diameter and age, ($y = 0.0444x + 0.9648$) ($R^2 = 0.8811$) and there was no significant relation between the common bile duct diameter and body mass index and anthropometry.

The study was recommended further studies for measurement of the common bile duct in different locations and posture, and using larger sample.

المستخلص

هذه الدراسة المقطعية أجريت على 70مريضاً في الفترة من أكتوبر 2018 الي يناير 2019 وتكمن مشكلة الدراسة في العوامل التي تؤثر علي القياس الطبيعي لقطر القناة الصفراويه المشتركة مع انعدام الدراسات في هذا المجال في السودان على حد علم الباحثة. هدفت الدراسة إلى تحديد المدى الطبيعي لقطر القناة الصفراوية المشتركة. تم جمع البيانات في مستشفى جياد التخصصي بولاية الجزيرة السودان وتم تصنيفها وتحليلها بواسطة برنامج الحزمة الإحصائية للعلوم الاجتماعية.

وجدت الدراسة أن هناك علاقة ذات دلالة إحصائية بين التقدم في العمر وقطر القناة الصفراوية المشتركة ($R^2 = 0.8811$) ($y = 0.0444x + 0.9648$) وخلصت أن ليس هناك علاقة بين قطر القناة الصفراوية المشتركة ومؤشر كتلة الجسم والقياسات البشرية الأخرى.

أوصت الدراسة أن يتم قياس قطر القناة الصفراوية المشتركة في أماكن مختلفة بوضعيات جسدية مختلفة مع استخدام عدد عينات أكبر للدراسات اللاحقة.

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List of Abbreviations

1	**ALP**	Alkaline Phosphate Level
2	**CT**	Computed Tomography
3	**CBD**	Common Bile Duct
4	**CHD**	Common Hepatic Duct
5	**ERCP**	Endoscopic Retrograde cholangiopancreaticography
6	**FANA**	Fluroscent Antinuclear Antibody
7	**MRI**	Magnetic Resonance Imaging
8	**PBC**	Primary Biliary Cholangitis
9	**PSC**	Primary Scleroting Cholangitis
10	**PTC**	Percutaneous Transhepatic cholangiography
11	**RAD**	Right anterior duct
12	**RPD**	Right posterior duct
13	**US**	Ultrasound
14	**XGC**	Xanthogranulomtous cholecystitis

Chapter one

Introduction

Chapter one

Introduction

1.1.Introduction:

The size of the common bile duct is a predictor of biliary obstruction and its measurement is therefore an important component in the evaluation of the biliary system. Availability of normal measurements of the common bile duct would help to distinguish obstructive from non-obstructive causes of jaundice. Ultrasonography is an accurate, safe, non-invasive and inexpensive imaging modality, which is highly sensitive and specific for the detection of many biliary tree diseases. (Freitas,2006)

Ultrasonography is comparable in accuracy to oral cholecystography, radionuclide studies, computed tomography and magnetic resonance imaging, and more cost-effective. With the development of high resolution scanners, the luminal diameters of the common bile duct can be assessed accurately. The normal internal diameter of the common bile duct on ultrasonography is 6 mm Different opinions regarding the size of the common bile duct have been revealed in literature. Study done by Daradkeh, Tarawneh E and Al-Hadidy A in Jordan university hospital diameter found to be significantly affecting the diameter of the common bile duct ($P<0.05$) were age, previous cholecystec to my and body mass index. Another study done in Department of Radiology, Addis Ababa University, Medical Faculty, Addis Ababa, Ethiopia by Admassie D the result found to be the mean diameter of the common bile duct diameter was found to be 3.9 mm; measured diameter ranged from 2.1 to 6mm.

There was also appositive correlation between the common bileductdiameter with age and weight. No significant difference was noted between the two sexes and common bile duct diameter. No association was observed with height and common bile duct diameter (mittal R,2010).

It is an established fact that variations exist in the anthropometric features of various populations and regions Studies have suggested correlation between different kinds of body builds and diseases. However, despite technological advancements, the association of anthropometric measurements with the diameters of common bile duct has remained controversial (mittalR,2010)

1.2. Problem of the study:

Changes in caliber of the CBD related to various factors including hepatobiliary disease this study tries to assess the range of normal measurements in relation with age, sex and anthropometry.

1.3.Objectives:

1.3.1.General objective:

To Measure Normal Common Bile Duct Diameter using Ultrasonography.

1.3.2. Specific objectives:

- To measure CBD diameter.
- To measure chest circumference.
- To measure physical measurements (height, weight, chest circumference, circumference at the umbilicus).
- To compare the association of CBD diameter with age.
- To compare the association of CBD diameter with gender.
- To compare the association of CBD diameter with physical measurements (height, weight, chest circumference, circumference at the umbilicus).
- To compare the findings with known international range.

Chapter Two

Literature Review and Previous Studies

Chapter Two

Literature Review and Previous Studies

2.1.Theoretical background:

2.1.1. Anatomy and normal variant:

The biliary tract is the conduit between the liver and the duodenum and is designed to store and transport bile, under control of neuronal and hormonal regulation. Bile is formed in the hepatocytes and steadily secreted into canaliculi, which transport it to the larger extrahepatic ducts. The sphincter of Oddi regulates the flow of bile into the duodenum or to the cystic duct and the gallbladder. When stimulated, the gall-bladder contracts steadily, the sphincter relaxes and bile flow into the duodenum increases (Bonheur,2016)

2.1.1.1 Bile Ducts:

The tubes that carry bile through the liver and gallbladder are known as bile ducts and form a branched structure known as the biliary tree. Bile produced by liver cells drains into microscopic canals known as bile canaliculi. The countless bile canaliculi join together into many larger bile ducts found throughout the liver. These bile ducts next join to form the larger left and right hepatic ducts, which carry bile from the left and right lobes of the liver Those two hepatic ducts join to form the common hepatic duct that drains all bile away from the liver. The common hepatic duct finally joins with the cystic duct from the gallbladder to form the common bile duct, carrying bile to the duodenum of the small intestine. Most of the bile produced by the liver is pushed back up the cystic duct by peristalsis to arrive in the gallbladder for storage, until it is needed for digestion. (Bonheur, 2016)

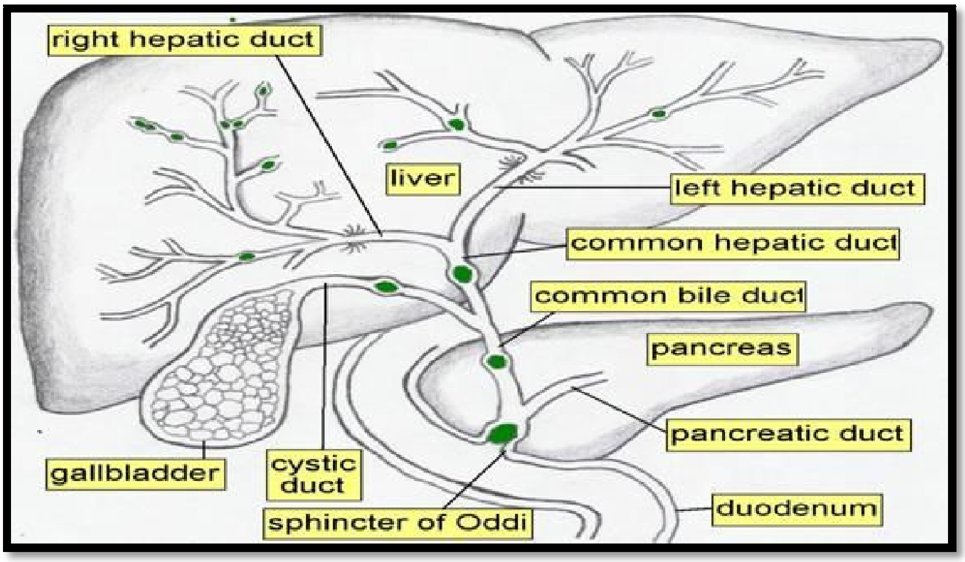

Figure (2.1): shows liver anatomy (Awayne, 2012)

An understanding of the normal location of the bile ducts and common anatomic variations is important in staging of malignancies and directing intervention. In biliary terminology, proximal denotes the portion of the biliary tree that is in relative proximity to the liver and hepatocytes, whereas distal refers to the caudal end closer to the bowel. The term branching order applies to the level of division of the bile ducts starting from the common hepatic duct (CHD); first-order branches are the right and left hepatic ducts, second-order branches are their respective divisions (also known as secondary biliary radicles), and so on. Central specifies proximity to the porta hepatis, whereas peripheral refers to the higher- order branches of the intrahepatic biliary tree extending well into the hepatic parenchyma. Knowledge of Couinaud's functional anatomy of the liver is also vital in description of the intrahepatic biliary abnormalities. The intrahepatic ducts are not in a fixed relation to the portal veins within the portal triads and can be anterior or posterior to the vein or even tortuous about the vein. The right and left hepatic ducts, that is, the first-order branches of the CHD, are routinely seen on sonography, and normal second-order branches may be visualized. The use of spectral and color Doppler ultrasound is often needed to distinguish hepatic arteries from ducts. In our experience, visualization of third-order or higherorder branches is often an abnormal finding and requires a search for the cause of dilation. Most of the right and left hepatic ducts are extrahepatic and, along with the CHD, form the hilar or central portion of the biliary tree at the porta hepatis. This is the most common location for cholangiocarcinoma. The normal diameter of the first-order and higher- order branches of the CHD has been suggested to be 2 mm or less, and no more than 40% of the diameter of the adjacent portal vein. The most common branching pattern of the biliary tree occurs in 56% to 58% of the population On the right side, the right hepatic duct forms from the right anterior and right posterior branches, draining the anterior (segments 5 and 8) and posterior (segments 6 and 7) segments of the right lobe of the liver, respectively. On the left side, segment 2 and 3 branches join to the left of the falciform ligament to form the left hepatic duct. This duct becomes extrahepatic in location as it extends to the right of the falciform ligament, where it is joined by ducts of segments 4 and 1.The key to understanding the common normal variants of biliary branching lies in the variability of the site of insertion of the right posterior duct (RPD) (segments6 and 7). The RPD often extends centrally toward the porta hepatis in a cranial direction. It passes superior and posterior to the right anterior duct (RAD) and then turns caudally, joining the RAD to form the short right hepatic duct. Three other common sites of insertion of the RPD account for the majority of the anatomic variations. If the RPD extends more to the left than usual, it can join the junction of the right and left hepaticducts ("trifurcation pattern"; ~8% of normal variants) or the left hepatic duct (~13%)If the RPD extends in a caudal-medial direction instead, it can join the CHD or common bile duct (CBD) directly (~5%). Anomalous drainage of various segmental hepatic ducts directly into the common hepatic ducts is less common. (Carol M.2011).

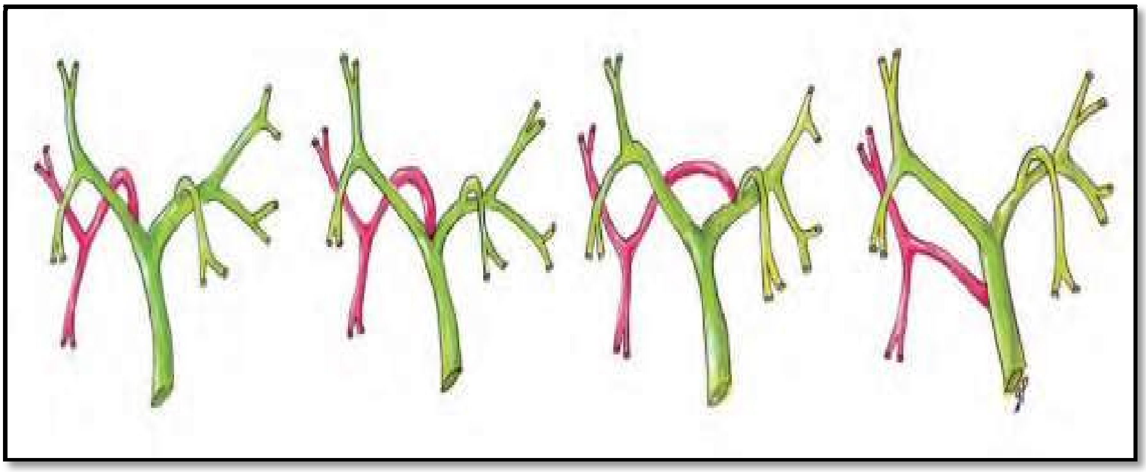

Figure (2.2): Common variants of bile duct branching, (Carol M.2011).

2.1.2. Physiology

Bile is produced by the liver and is channeled by the biliary ductal system into the intestinal tract for the emulsification and absorption of fats. Biliary disease is caused by abnormalities in bile composition, biliary anatomy, or function. The liver determines the chemical composition of bile, and this may be modified later by the gallbladder and the biliary epithelium. Cholesterol, ordinarily insoluble in water, comes into solution by forming vesicles with phospholipids (principally lecithin) or mixed micelles with bile salts and phospholipids. (Bonheur,2016)

When the ratio of cholesterol, phospholipids, and bile salts is outside an optimum range, cholesterol monohy drate crystals may come out of solution from multi lamellar vesicles. Cholesterol super saturation of bile appears to be a prerequisite for gallstone formation, which involves a variety of factors that affect the activity of low-density lipoprotein (LDL) uptake, hepatic 3-methylglutaryl coenzyme A reductase (HMG CoA), acyl cholesterol-lecithinacyltransferase,and7-alphahydroxylase.(Bonheur, 2016)

By itself, cholesterol supersaturation is inadequate for explaining gallstone pathogenesis. Nucleation, the initial step in gallstone formation, is the transition of cholesterol from a soluble state into a solid crystalline form. Within the gallbladder bile, biologic molecules influence the process in a positive or negative fashion.For example, mucus may function to promote nucleation, whereas bile-specific glycoproteins may function to inhibit nucleation. Mucin hypersecretion by the gallbladder mucosa creates a viscoelastic gel that fosters nucleation. Arachidonyl lecithin, which is absorbed from the alimentary tract and secreted into the bile, stimulates prostanoid synthesis by gallbladder mucosa and promotes mucus hypersecretion, while inhibitors of prostaglandin inhibit mucus secretion. Finally, gallbladder hypomotility and bile stasis appear to promote gallstone formation and growth, which may be important in diabetes, pregnancy, oral contraceptive use in women, and prolonged fasting in critically ill patients on total parenteral nutrition (Bonheur, 2016)

2.1.3. laboratory tests and Investigationsdone:

2.1.3.1.Laboratory tests:

2.1.3.1.1. Urine bilirubin levels:

Urine bilirubin normally is absent. When it is present, only conjugated bilirubin is passed into the urine. This may be evidenced by dark-colored urine seen in patients with obstructive jaundice or jaundice due to hepatocellular injury. However, reagent strips are very sensitive to bilirubin, detecting as little as 0.05 mg/dl. Thus, urine bilirubin may be found even in the absence of hyperbilirubinemia or clinical jaundice. (Bonheur, 2016)

2.1.3.1.2. Serum bilirubin level:

Regardless of the cause of cholestasis, serum bilirubin values (especially direct) are usually elevated. However, the degree of hyper bilirubinemia cannot help reliably distinguish between the causes of obstruction. Extrahepatic obstruction: This is typically associated with considerable direct and indirect bilirubin elevation., Intra hepatic obstruction: Both conjugated and unconjugated bilirubin fractions may increase in varying proportions.

2.1.3.1.3. Alkaline phosphatase (ALP) level :

Amembrane - bound enzyme localized to the bilecanalicular pole of hepatocytes, ALP is markedly elevated in persons with biliary obstruction. However, high levels of this enzyme are not specific to cholestasis. To determine whether the enzyme is likely to be of hepatic origin, measure gamma-glutamyl transpeptidase or 5-prime-nucleotidase. These values tend to parallel the ALP levels in patients with liver disease. GGT is used most commonly. While it is part of the routine evaluation of biliary obstruction, the degree of elevation of ALP cannot be used to reliably discriminate between extrahepatic and intrahepatic causes of biliaryobstruction.

2.1.3.1.4. Prothrombin time:

This may be prolonged because of malabsorption of vitamin K. Correction of the PT by parenteral administration of vitamin K may help distinguish hepatocellular failure from cholestasis. Little or no improvement occurs in patients with parenchymal liverdisease

2.1.3.1.5. Antimitochondrial antibody levels:

The presence of antimitochondrial antibodies, usually in high titers, is indicative of PBC. They are usually absent in patients with mechanical biliary obstruction or PSC (Bonheur,2016)

2.1.3.2. Investigations Done:

2.1.3.2.1. CT and MRI (MRCP):

Both magnetic resonance (MR) imaging and computed tomographic (CT) cholangiography have the advantages of allowing detailed evaluation of thebiliarytractwithalargefieldofview,excellentpatienttolerance,andthree dimensional (3D) data sets that can be cholangiographically displayed, Both imaging modalities are less likely to cause patient discomfort or injury than is endoscopic retrograde cholangiopancreatography (ERCP), an invasive procedure, and either study may be preferred as an initial noninvasive test if immediate therapy for a known problem is not the primary aim. MR imaging offers the advantages of improved stone conspicuity and absence of ionizing radiation, whereas CT is generally less prone to artifacts. Determination as to whether MR imaging or CT is preferred is based on (among other variables) opinion, local expertise, and the vagaries of technologic advances. The potential impact of the latter variable is illustrated by the fact that the role of 3D respiratory-gated MR imaging, the use of hepatobiliary contrast agents for both MR imaging and CT, and newer multi-detector CT scanners all remain areas of clinical study. However, biliary stones and gallstones are generally better seen at MR imaging than at CT. A solid understanding of biliary disease and of the corresponding radiologic findings is essential to the effective application of any modality. (Bonheur,2016).

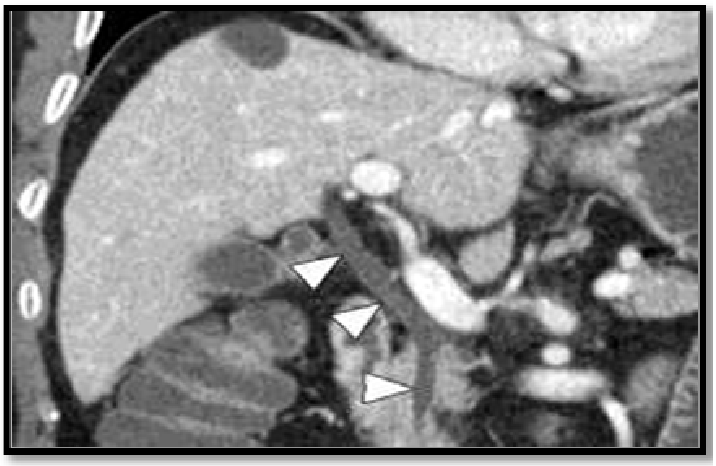

Figure (2.3): shows coronal intravenous contrast-enhanced reformatted image from CT data shows the CBD and CHD (arrowheads), which are normal caliber and have an imperceptible wall. The IBDs are barely visible (Radiopeadia, 2016).

2.1.3.2.2.Endoscopic Retrograde CholangioPancraeticography(ERCP):

An endoscopic retrograde cholangiopancreatogram (ERCP) test checks the tubes (ducts) that drain the liver, gallbladder,and pancreas. A flexible, lighted scope (endoscope) and X-ray pictures are used. The scope is put through the mouth and gently moved down the throat. It goes into the esophagus, stomach and duodenum until it reaches the point where the ducts from the pancreas and gall bladder drain into the duodenum. X-rays will then be taken. ERCP can treat certain problems found during the test. In some cases the doctor can insert small tools through the scope to: Take a sample of tissue from an abnormal growth. Then it can be checked for problems. Remove a gall stone in the common bile duct. Open a narrowed bile duct. A narrowed bile duct can be opened by inserting a small wire- mesh or plastic tube (called a stent) in the duct.

Figure (2.4): shows normal ERCP (Radiopeadia, 2016).

2.1.3.2.3. Percutaneous transhepatic cholangiography

Percutaneous transhepatic cholangiography (**PTHC** or **PTC**) or percutaneous hepatic cholangiogram**:** is a radiologic technique used to visualize the anatomy of the biliary tract. A contrast medium is injected into a bile duct in the liver, after which x-rays are taken. It allows access to the biliary tree in cases where (ERCP) has been unsuccessful.

Figure (2.5): shows normal PTC (Radiopeadia, 2016).

2.1.3.2.4. Oral Cholecystogram:

Oral cholecystogram is an x-ray examination of the gallbladder, Oral" refers to the oral medication you take before the test. The medication is an iodine-based contrast agent that makes your gallbladder more clearly visible on the X-ray. The oral cholecystogram study is used to diagnose problems related to the gallbladder. The x-ray can show inflammation of the organ, and other abnormalities like polyps, tumors, and gallstones.

Figure (2.6): shows normal oral cholecystogram (Radiopeadia, 2016).

2.1.3.2.5. T-tube Cholangiography:

Cholangiography is the x-ray examination of the bile ducts (biliary tract) after administration of a contrast dye to delineate these channels on the images. The procedure may be performed either during gallbladder removal surgery(operative cholangiography) or postoperatively (T-tube cholangiography). Operative cholangiography involves injecting the contrast dye directly into the common bile duct during open surgery. x-ray films are then used to guide the surgeon and to identify any stones or other obstructions for immediate removal**.** T-tube cholangiography is typically performed 5 to 10 days after gallbladder removal. Contrast dye is injected through a T-shaped rubber tube placed in the common bile duct during surgery, and x-rays are then taken to detect any residual stones or other abnormalities. (Bonheur,2016)

2.1.3.2.6.Cholescintigraphy

Cholescintigraphy or hepatobiliary scintigraphy is scintigraphy of the hepatobiliary tract including the gall bladder and bile ducts. The image produced by this type of medical imaging, called a cholescintigram, is also known by other names depending on which radiotracer is used, such as HIDA scan, PIPIDA scan, DISIDA scan, or BrIDA scan. Cholescintigraphic scanning is a nuclear medicine procedure to evaluate the health and function of the gallbladder and biliary system. A radioactive tracer is injected through any accessible vein, and then allowed to circulate to the liver, where it is excreted into the bile ducts and stored by the gall bladder until released into the duodenum.

In the absence of gall bladder disaese, the gallbladder is visualized within one hour of the injection of the radioactive tracer. If the gallbladder is not visualized within 4 hours after the injection, this indicates either cholecystitis or cystic duct obstruction, such as by cholelithiasis. (Bonheur,2016)

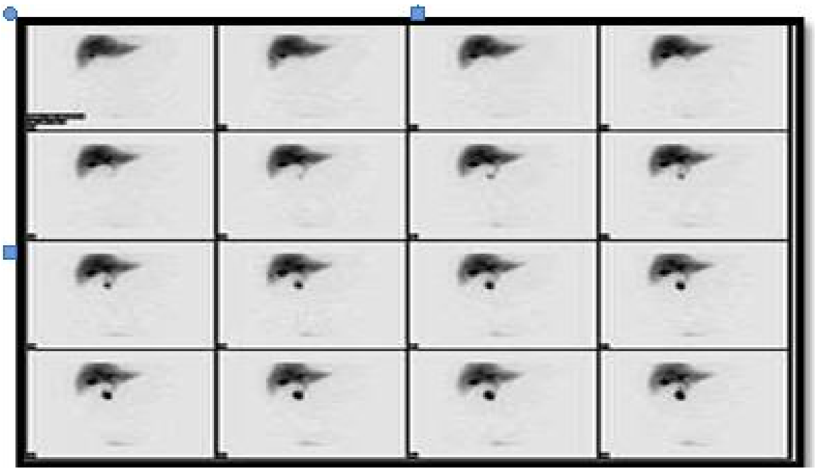

Figure (2.7): Normal hepatobiliary scan HIDA scan(Wikipeadia,2016).

2.1.3.3 Ultrasound(U/S):

Ultrasound relies upon the transmission of targeted sound waves of varying selected frequencies through tissues, with subsequent computerized conversion of the signals from the reflected waves into anatomical images on a screen. The degree of reflection of sound waves depends upon the interface between tissues with different acoustic properties. The degree of echogenicity depends upon the ability of the tissue being evaluated to reflect or absorb the ultrasound waves. Thus, a fatty liver will attenuate the ultrasound beam somewhat, limiting full evaluation of the liver parenchyma. Similarly, waves are not transmitted through air.

Normal measurements on ultrasound: Measurements of components of the hepatobiliary tree depend upon the skill of the ultrasonographer obtaining the measurements, and there is variability in terms of what is considered "normal." However, some general estimates are available regarding the expected sizes of structures in the hepatobiliary tree (ultrasoundpeadia,2007).

Figure (2.8): Diagram showing the scanning areas used to obtain each of the five basic images (Harlad. 1995)

Figure (2.9): Image show the normal appearance of the common bile duct in relation with portal vein (Harlad, 1995).

2.4 Previous studies:

Study done by Nidhi Lal in December 2014to obtain data on sonographically measured diameters of common bile duct in series of normal Rajasthani population and to measure its correlation with age, sex and anthropometry. the study include 200 participants with equal proportion belonging to either sex. CBD measured at three location at the porta hepatis. in the most distal aspect of the head of pancreas and mid- way between these points. Anthropometric measurements including height, weight. chest circumference, circumference at the transpyloric plane, circumference at umbilicus and circumference at the hip were obtained using standard procedure, the results revealed that Mean age of study subjects was 34.5 years (Range 18-85 years). Mean diameters of the common bile duct in the three locations were: proximal, 4.0 mm (SD 1.02 mm); middle, 4.1 mm (SD 1.01 mm); and distal, 4.2 mm (SD 1.01 mm) and overall mean for all measures 4.1 mm (SD 1.01 mm). Aerage diameter ranged from 2.0 mm to 7.9 mm, with 95 percent of the subjects having a diameter of less than 6 mm. We observed a statistically significant relation of common bile duct with age, along with a linear trend. There was no statistically significant difference in common bile duct diameter between male and female subjects. The diameter did not show any statistically significant correlation with any of the anthropometric measurements.

Another study done by Perret Raimed to evaluate the Common bile duct measurements in an elderly population done in 1,018 patients between the ages of 60 to 96 periods to determine if there is a significant change in its size with aging. All of the patients included in the study were being evaluatedprimarilyforcarotidorperipheralvasculardisease.Anypatientswith a history of biliary disease (i.e. bilirubin level greater than 1.5 mg/ml, cholecystectomy, or cholelithiasis) were excluded. Ultrasonography of the common bile duct was performed only in those patients with no subjective abdominal pain or icterus. Our results demonstrated a small although statistically significant increase in the caliber of the common bile duct with increasing age (60 years old or less, mean diameter 3.6 mm +/- 0.2mm, versus over 85 years old, mean diameter 4 mm +/- 0.2 mm, P = 0.009). Although the common bile duct did increase in size with aging, 98% of all ducts remained below 6 to 7 mm, the commonly accepted upper range of normal.

Another study done in November 2005 by Daradkeh. The purpose of the study was to see the effect of age, sex, body mass index, previous cholecystectomy, hepatomegaly and fasting status on the common bile duct diameter.A series of 463 patients, 283 females and 180 males, with no hepatobiliary or pancreatic pathology were included in this study, the mean age was 45 +/- 16 years. Their age, sex, weight, height, fasting status and previous cholecystectomy was assessed and recorded by a physician prior to ultrasound examination. All patients were examined by real-time ultrasound to see if there was any pathology in the hepatobiliary and pancreatic area. Those with history of common bile duct exploration, endoscopic sphincterotomy or with previous history of cholecystectomy of less than 6 months and patients with common bile duct pathology were excluded from the study. The mid portion of the common bile duct was taken as a fixed measurement for all patients and the size of the liver was also recorded. result showed that the factors found to be significantly affecting the diameter of the common bile duct were age, previous cholecystectomy and body mass index. If the CBD dilatation cannot be explained by age, previous cholecystectomy and BMI, a pathology causing obstruction should be ruled out.

Chapter Three

Materials and Methods

Chapter Three
Materials and Methods

3.1. Materials:

This was crosssectional study aimed to measure the normal diameter of the common bile duct. The data used in this study was collected from Giad Hospital from October 2018 to October 2019.

3.1.1. Subjects:

Study cases were 70 (35 females and 35 males) all were normal subject came for the ultrasound department for routine scan, all subjects have liver, biliary, pancreatic disease and pregnant ladies were excluded from the study, Common bile duct was measured at its association with the portal vein in the long axis of the gallbladder. Anthropometric measurements including height, weight, chest circumference, and abdominal circumference at umbilicus were obtained using standard procedures.

3.1.2. Machine used:

All patients where scanned by SIUI Apogee 1200 ultrasound machine using curve linear low frequency transducer (3.5-5MHz).

Figure (3.1): SIUI Apogee 1200 machine

3.2. Methods

Ultrasound scanning of 70 normal subjects was done by radiologist. Common bile duct internal diameter was measured in millimeters.

3.2.1. Technique used:

The area for evaluation was fixed and skin adequately lubricated to facilitate ultrasound transmission. The transducer was gently applied and longitudinal scan was taken.

Imaging protocol:

Patient should be fasted at least 4 hours prior to US examination. Sonographic evaluation of the bile ducts should include the following five images:

1. A subcostal oblique view to assess the ductal confluence anterior to the portal vein bifurcation at the portahepatis.
2. A transverse left lobe view for evaluation of left intrahepatic ducts (recumbent).
3. A right coronal intercostal view for evaluation of the right intrahepatic ducts.
4. A hepatoduodenal ligament view for assessment of the extrahepatic duct from the common hepatic duct to the pancreas head.
5. Views of the pancreas head to assess the distal common bile duct.

3.2.2.Image in terpretation:

The scan include sonographic information at the mid clavicular line, At this location the common bile duct and hepatic artery appear as two smaller circles anterior to the portal vein, giving an appearance of a face with two ears also called a 'Mickey Mouse' sign. With the indicator directed toward the patient's right, the right ear is the common bile duct and the left ear, the hepatic artery.

3.2.3. Data analysis:

It has been carried out by statically package for social sciences SPSS and Excel programmes

Chapter Four

Results

Chapter four

Results

Table (4.1) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	35	50.0	50.0	50.0
Female	35	50.0	50.0	100.0
Total	**70**	**100.0**	**100.0**	

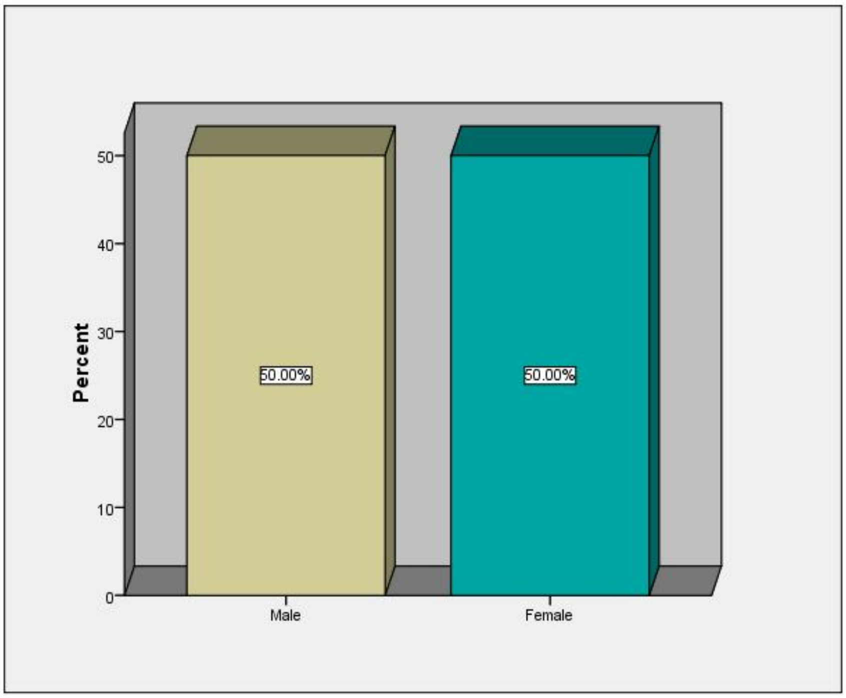

Figure (4.1) frequency distribution of gender

Table (4.2) frequency distribution of age (years):

Age \years	Frequency	Percent	Valid Percent	Cumulative Percent
18-27	15	21.4	21.4	21.4
28-37	17	24.3	24.3	45.7
38-47	10	14.3	14.3	60.0
48-57	9	12.9	12.9	72.9
58-67	6	8.6	8.6	81.4
68-77	7	10.0	10.0	91.4
78-87	3	4.3	4.3	95.7
more than 87	3	4.3	4.3	100.0
Total	**70**	**100.0**	**100.0**	

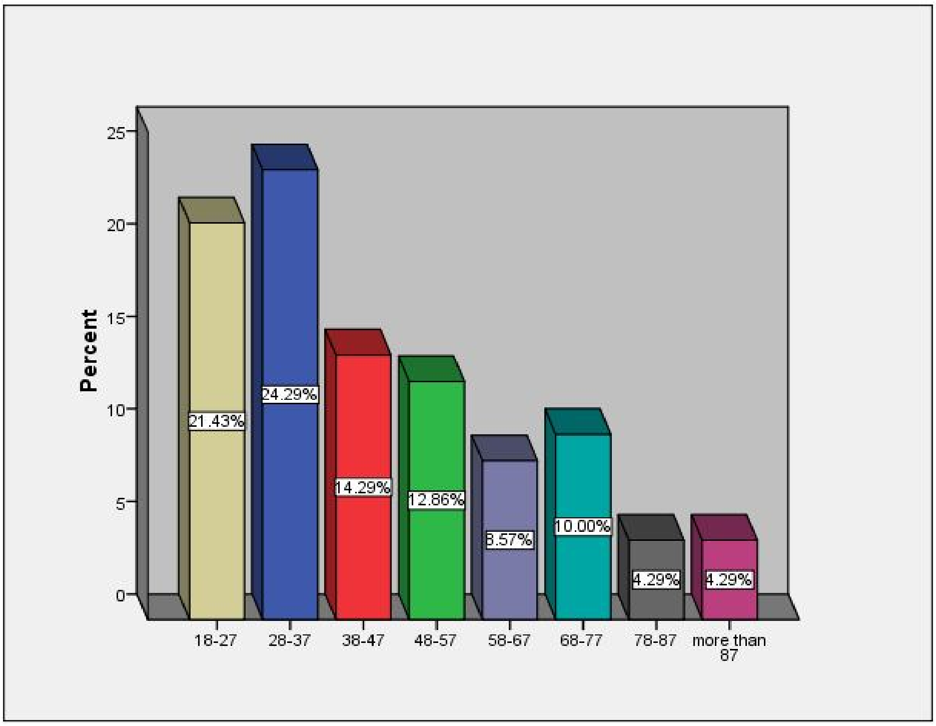

Figure (4.2) frequency distribution of age (years)

Table (4.3) descriptive statistic of age \years, height, weight,BMI CC, AC and CBD \mm (minimum, maximum, mean ± Std. Deviation)

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	70	18	96	45.29	20.10
Height (cm)	70	149	180	164.53	6.71
Weight (kg)	70	50	96	75.44	11.95
BMI	70	18.9	38.5	27.88	4.28
Chest circumference (cm)	70	66	120	94.07	15.75
Abd circumference (cm)	70	65	118	91.50	15.07
CBD (mm)	70	2.0	6.0	2.98	.95
Valid N (listwise)	70				

Table (4.4) comparison of mean measurements of CBD\mm in different age groups:

Age \years	CBD (mm)					P value
	Mean	N	Std. Deviation	Minimum	Maximum	
18-27	2.000	15	.0000	2.0	2.0	0.000
28-37	2.37	17	.48	2.0	3.0	
38-47	3.00	10	.004	3.0	3.0	
48-57	3.16	9	.32	3.0	4.0	
58-67	3.66	6	.48	3.0	4.0	
68-77	4.00	7	.0000	4.0	4.0	
78-87	4.67	3	.58	4.0	5.0	
more than 87	5.17	3	1.04	4.0	6.0	
Total	2.98	70	.95	2.0	6.0	

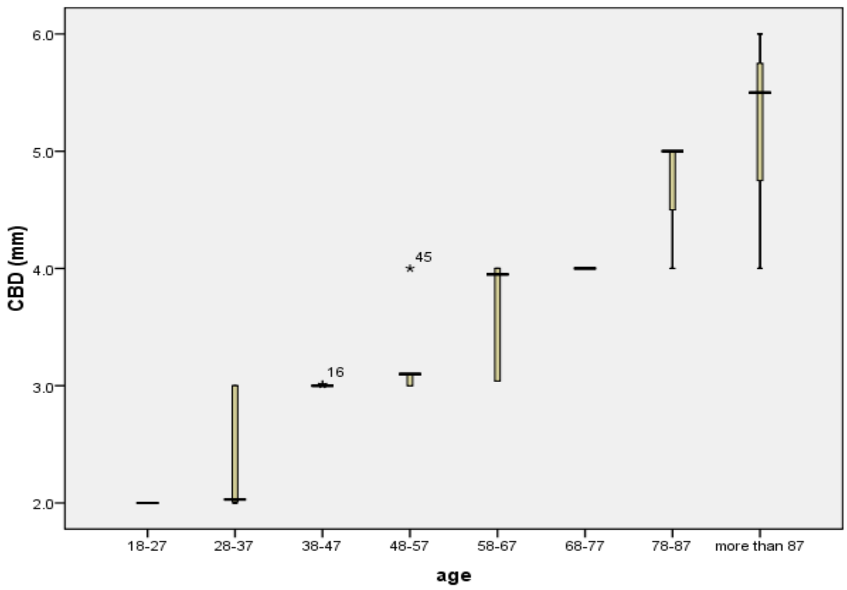

Figure (4.3) plot box shows mean measurements in different age groups

Table (4.5) independent sample t-test to compare mean measurements of CBD\mm in different gender

a) Mean

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Age	Male	35	50.71	23.08	3.901
	Female	35	39.86	15.05	2.544
CBD (mm)	Male	35	3.20	1.12	.1885
	Female	35	2.75	.67	.1179

b) t-test for compare mean

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Age	2.331	68	.023	10.857	4.657	1.565	20.150
	2.331	58.491	.023	10.857	4.657	1.537	20.177
CBD (mm)	2.028	68	.046	.4509	.2223	.0072	.8945
	2.028	57.064	.047	.4509	.2223	.0057	.8960

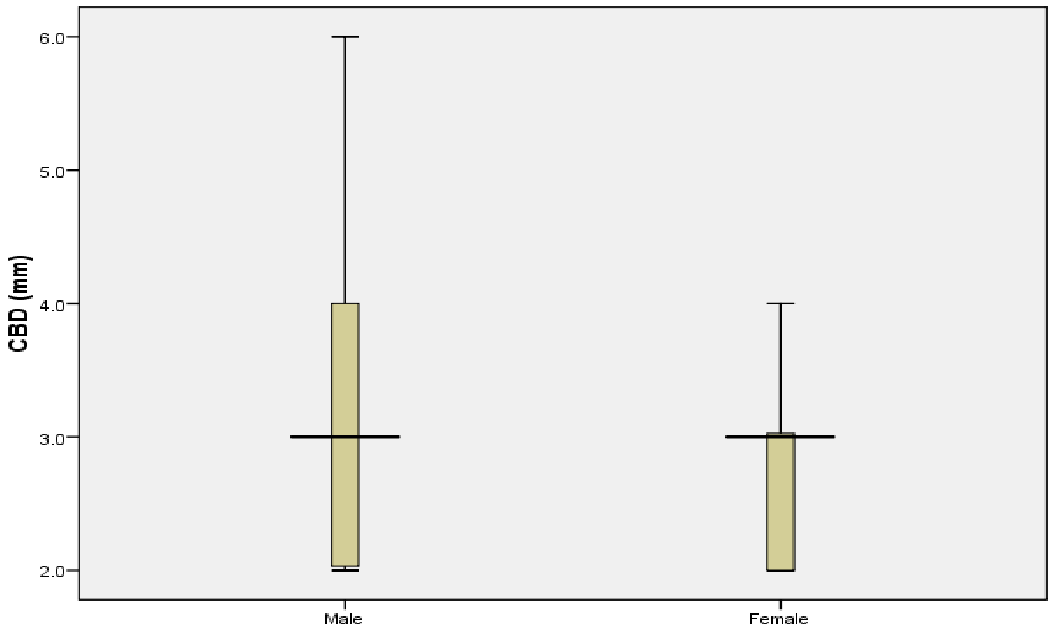

Figure (4.4) plot box shows mean measurements in different gender

Table (4.6) Correlation between age (years), height, weight, BMI, Chestcir (cm),Abdcir (cm) and CBD (mm):

		Age	Hight (cm)	Weight (kg)	BMI	Chest cir (cm)	Abdcir (cm)
CBD (mm)	Pearson Correlation	.939**	-.053-	.174	.198	.015	.023
	Sig. (2-tailed)	.000	.664	.151	.100	.904	.848
	N	70	70	70	70	70	70

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

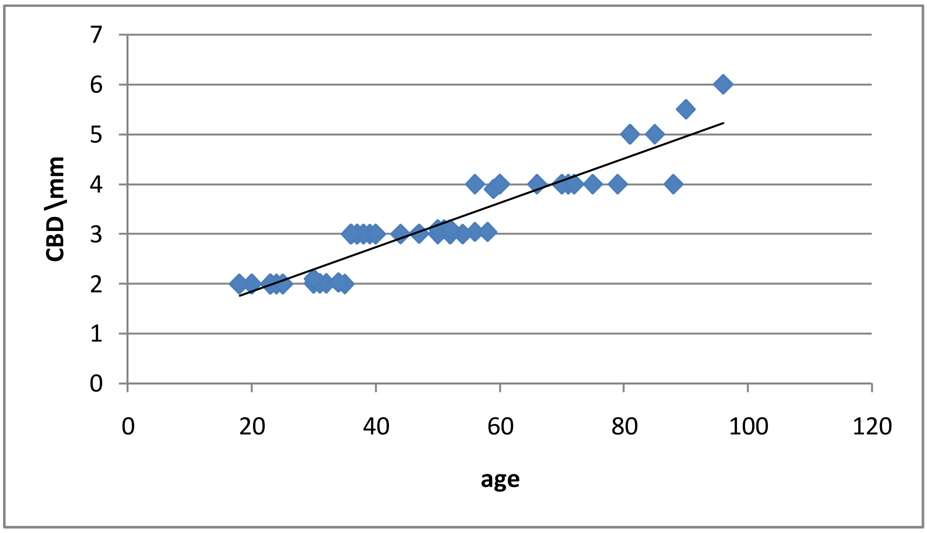

Figure (4.5) scatter plot shows strong linear association between age and CBD \mm (R^2= 0.88)

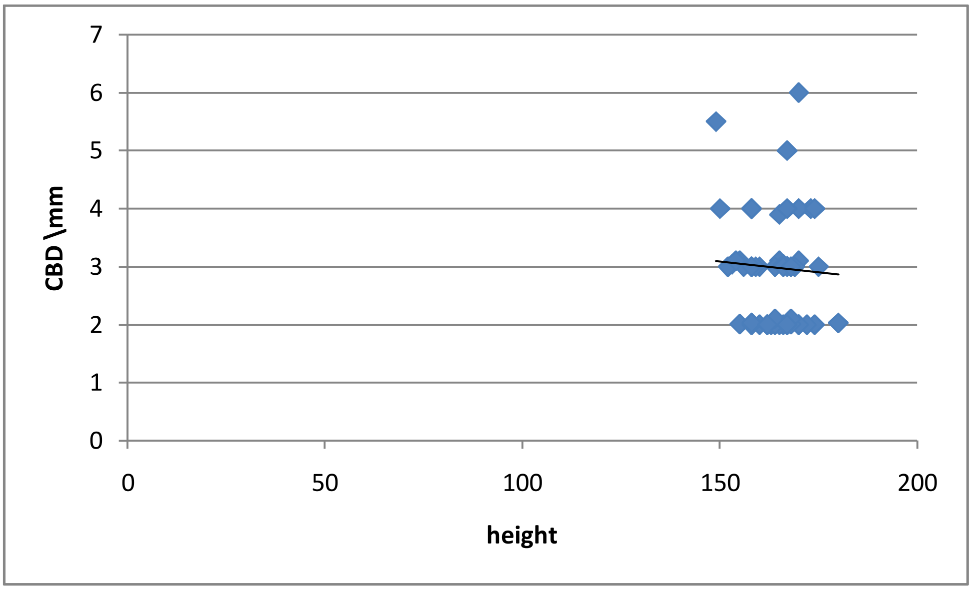

Figure (4.6) scatter plot shows association between height and CBD \mm (R^2= 0.0028)

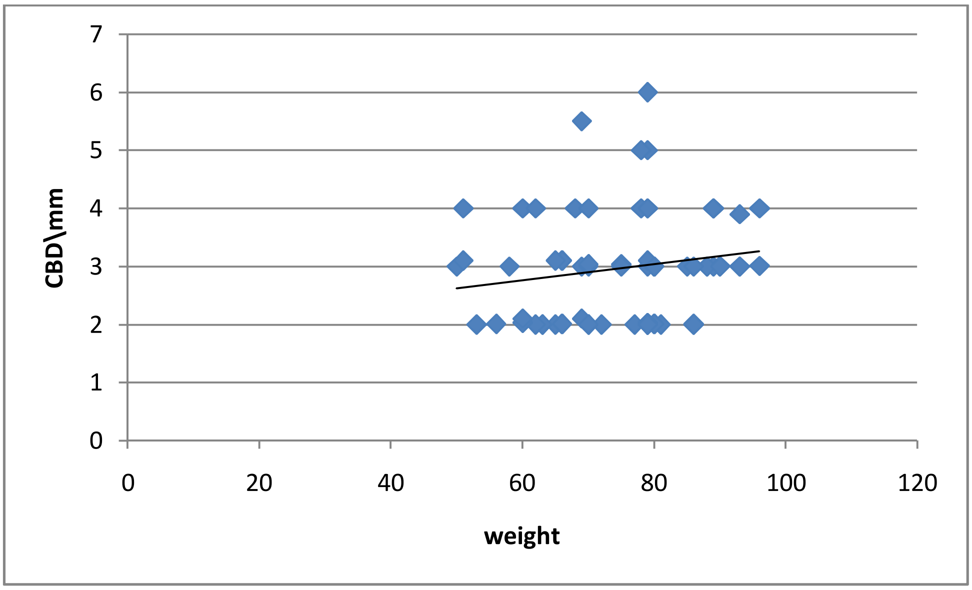

Figure (4.7) scatter plot shows association between weight and CBD \mm (R^2= 0.0301)

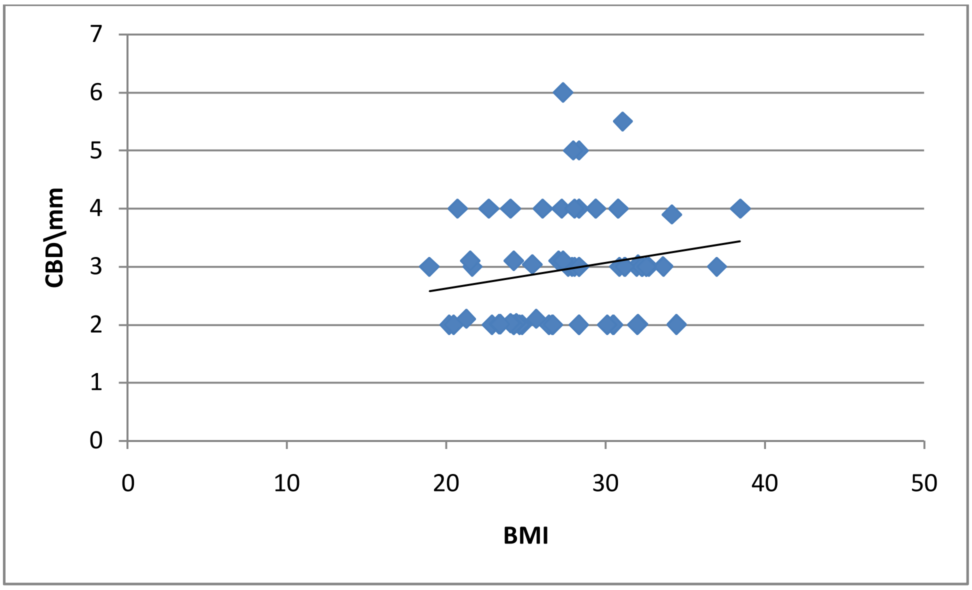

Figure (4.8) scatter plot shows association between BMI and CBD \mm (R^2= 0.0393)

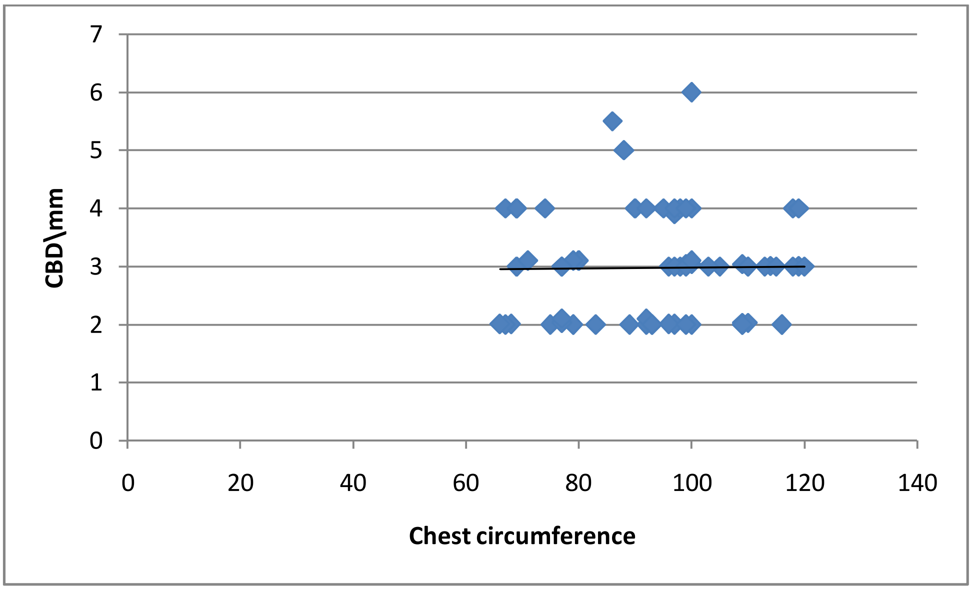

Figure (4.9) scatter plot shows association between Chest circumference and CBD \mm (R^2= 0.0002)

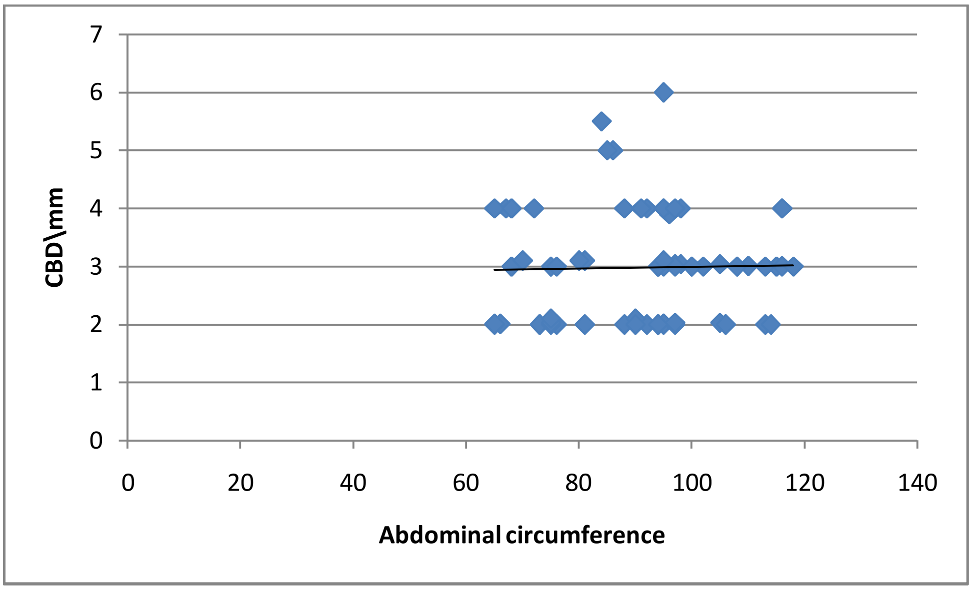

Figure (4.10) scatter plot shows association between abdominal circumference and CBD \mm (R^2= 0.0005)

Chapter Five

Discussion, Conclusion and Recommendations

Chapter five

Discussion, conclusion and recommendations

5.1. Discussion:

This study was conducted on 70 normal patients belonging to the state of Gazira. The study included equalnumberofmalesandfemalesintheagegroup18-96 years of age. The mean age was 45.29 years (SD 20.10years) as mentioned in Table 4.1. A majority of the participants belonged to the age group 28-37 years (frequency 17). As mentioned in Table 4.2, were included in the study. The subjects underwent ultrasonography measurements of common bile duct diameters by experienced sonologist at the Hospital of Giad in Gazira State. In addition, anthropometric data on weight, height, chest circumference, abdomen circumference, were obtained for each of the study subjects.

The mean diameter observed in the study was 2.98mm with a standard deviation (SD) of 0.95 mm. and the average diameter ranged from 2mm - 6mm with 45% measured (2.98mm) as seen in Table 4.4.This was not similar to that reported by Nidhi Lal in his study on 200 normal subjects which reported that the mean diameter equals to 4.1 mm with SD equal to 1.01mm, Average diameter ranged from 2.0 mm to 7.9mm.

From Table 4.3 The mean weight was (75.44kg) with (SD=11.95 kg) the mean of height was (164.5cm) and the (SD=6.71cm),BMI was calculated from the height and weight measuring the mean of the BMI was(27.88) and the (SD=4.28), the mean of the chest circumference measured at the middle of the chest was (94.07cm) with (SD=15.75cm),the mean of the abdominal circumference was (91.50cm) and the(SD=15.7cm).

In accordance with previous results correlation was done to find out the relation between the different variables, the result revealed out that there was significant correlation at the 0.01 level between the age and the CBD diameter as recorded in Table 4.5 and Figure 4.5 A scatter plot diagram showed age correlation with CBD diameter. The diameter increase by 0.02 from 2.1 for each 20 years of age $y = 0.0444x + 0.9648$, $R^2 = 0.8811$. That agrees with the study done by Nidhi Lal which observed a statistically significant relation of common bile duct with age, along with a linear trend and agree with the study done by Daradkeh S which revealed that the factor found to be significantly affecting the diameter of the common bile duct was age, and agrees with the study done by Perret R which found that there was significant change in size with age.

In order to assess the association between common bile duct diameter and anthropometric measurements, both of which were continuous variables, correlation using Common bile duct diameter was not observed to have statistically significant correlation with any of the anthropometric measurements as recorded in Figure 4.6 and Figure 4.7,$y = -0.0075x + 4.2079$, $R^2 = 0.0028$, $y = 0.0138x + 1.9338$, $R^2 = 0.0301$.same result achieved by Nidhi Lal who found that the common bile duct diameter did not show any statistically significant correlation with any of the anthropometryic measurements

In figure4.8AscatterplotdiagramshowedBMIcorrelationwith.CBD which revealed that there was no correlation, $y = 0.0441x + 1.7473R^2 = 0.0393$, that does not agree with previous study done by Daradkeh S which showed that the factor found to be significantly affecting the diameter of the common bile duct was body mass index.

The common bile duct diameter has positive relationship with age (increase with increasing in age), and has no significant relation with body anthropometry, and no significant correlation with the body mass index.

5.2. Conclusion

This study was conducted in Giad Hospital Gazira State whose general objective was to measure normal common bile duct by using ultrasonography, US machine SIUI Apogee 1200 was used in the study.

The study found that the average diameter of the normal common bile duct is less than 6mm which matches the world level. The study also showed that there was significant correlation of common bile duct diameter with age as it increases by 0.02 from 2.1 for each 20 years of age, and there was no significant association between BMI and anthropometry measurement and the common bile duct diameter.

5.3.Recommendations:

- Ultrasound is a simple, time saving and non-invasive tool for the diagnosis of diseases U/S should be the first investigation to be used to evaluate the normal index for populations.
- Further studies in measurement of common bile duct in different locations with larger sample of population should be used for more accurate results.
- Measurement with different patient body posture for more accuracy and to have limits of normal diameter according to the position of the patient.
- Further studies should be done on other body characteristics.
- Educating and training sonographers and radiologists to perform optimum examination and correct measurements.
- The study should be done on female and male at same age.
- The most profound limitation of the study was the small sample size. So, studies using larger samples is highly recommended.

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Appendix 1

Sudan University of Science and Technology College of Graduate Studies

Data collection Sheet

No	Gender	Age	Height	Weight	BMI	CBD (mm)	Chest cir.(cm)	Abd.cir.(cm)

Appendix 2

Ultrasound Images

Image (1): Ultrasound image of 19 years female shows the CBD relation with portal vein and longitudinal plane of gall bladder, caliber measuring the CBD diameter. (Researcher, 2019)

Image (2): Ultrasound image of 24 years female shows the caliber measuring the CBD diameter (0.23mm). (Researcher, 2019)

Image (3): Ultrasound image of 90 years male shows the caliber measuring the CBD diameter (4.3mm).(Researcher, 2019)

Image (4): Ultrasound image of 69 years male shows the caliber measuring the CBD diameter(4.3mm).(Researcher, 2018)

Image (5): Ultrasound image of female 35 years shows the normal CBD (3.8 mm). (Researcher, 2018)