



**Sudan University of Science and Technology**  
**College of Graduate Studies**



## **Study of Hepatobiliary Diseases using Magnetic Resonance Cholangiopancreatography (MRCP)**

**دراسة أمراض الجهاز الكبدى المرارى باستخدام الرنين المغناطيسى**

**A Thesis Submitted for Partial Fulfillment of the Requirements of M.Sc Degree in Diagnostic Radiologic Technology**

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**2017**

## الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال تعالى (الله لا إله إلا هو الحي القيوم لا تأخذه سنة ولا نوم له ما في السموات وما في الأرض من ذا الذي يشفع عنده إلا بإذنه يعلم ما بين أيديهم وما خلفهم ولا يحيطون بشيء من علمه إلا بما شاء وسع كرسيه السموات والأرض ولا يؤوده حفظهما وهو العلي العظيم). صدق الله العظيم

الآية 255 من سورة البقرة.

## **Dedication**

To our Parents

To anyone who taught us a letter

To brothers and sisters

To our Friends

To everyone whom gave us a bit of wise advice

## **Acknowledgements**

First and foremost, we would like to Thank ALLAH for granting us the ability to complete this research. We would to express our deepest thankful to **Prof. Hussein Ahmed Hassan** for her support and guidance. We also would like to thank Antalia Hospital, Al Aml hospital staff and Al Ribat hospital for their help.

Finally, we would like to sincerely our families for their consistent mental support, great thanks for them.

## **Abstract**

Hepato-biliary system abnormalities, especially cholelithiasis and different types of tumors those need accurate diagnoses help to eliminate side effects, and complications of those diseases that may affect other body parts.

Objective of this research was to study Hepato-biliary by using MRCP.

The study was carried out in Al-Amal Al-watany hospital, Al-Rebat hospital, MRI department with general electric and Philip 1.5 Tesla, and Antalia diagnostic center, MRI department GE 1.5 Tesla. The study was performed from November 2016 to February 2017.

The data were collected from (50) patients and all patients have history of hepato-biliary system abnormalities, with age range (21-80) years old, and weight rang (50-93) kg.

The result showed 58% of patients were female, the 42% male also showed that the range of the most affected weight was (50-60) kg and almost of the abnormalities was gall stones (52%).

The result of this study also show that the MRCP detected (98%) from studying population affected by hepato-biliary disease, where the ultrasound detected (44%) from studying group.

The study concludes that the Magnetic Resonance imaging is the best modality in detecting the hepato-biliary diseases.

## المستخلص

الإزدياد المستمر لأمراض الجهاز الكبدي المراري ، خاصة الحصاوي والأورام يحتاج إلى تشخيص دقيق، ذلك لأن التشخيص المبكر يقلل من الأعراض الجانبية ومن نسبة مضاعفات هذه الأمراض وتأثيرها على بقية أجزاء الجسم .

تهدف هذه الدراسة إلى تقييم دور التصوير بالرنين المغناطيسي لأمراض الجهاز الكبدي المراري ومقارنتها بالفحوصات الإشعاعية الأخرى. أجريت الدراسة بمستشفى الأمل الوطني والرباط الوطني قسم التصوير بالرنين المغناطيسي، ماركة فيليبس 1.5 تسلا، ومركز أنطاليا للتشخيص ماركة جي إي 1.5 تسلا.

أجريت الدراسة في الفترة من نوفمبر 2016 حتى فبراير 2017 . تم جمع بيانات الدراسة من (50) مريضا، وتتراوح أعمار المرضى ما بين 21-80 سنة ، والأوزان ما بين 50-90 كجم، وتمت الدراسة وفقا للسن والوزن ونتائج الرنين المغناطيسي والموجات فوق الصوتية.

وخلصت الدراسة بأن الأكثر إصابة من عينة الدراسة هن الإناث بنسبة (58%) وأن الأوزان الأكثر إصابة تتراوح ما بين 50-60 كجم، وأن أكثر أمراض الجهاز الكبدي المراري شيوعا حصاوي الحويصلة الصفراوية بنسبة (52%).

من نتائج هذه الدراسة أنه وجد أن التصوير بالرنين المغناطيسي كشفت عن (98%) من عينة الدراسة مصابة بأمراض مختلفة في الجهاز الكبدي المراري، وكانت نسبة الإصابة التي تم تشخيصها عند الكشف باستخدام الموجات فوق الصوتية (44%).

وخلصت الدراسة إلى أن تقنية الرنين المغناطيسي هي أهم تقنية تشخيصية تساعد في الكشف عن أمراض الجهاز الكبدي المراري.

## List of Abbreviations

<b>Abbreviation</b>	<b>The term</b>
<b>CBD</b>	Common Bile Duct
<b>CD</b>	Compact Disc
<b>CCK</b>	Cholecystokinin
<b>CT</b>	Computed Tomography
<b>DWI</b>	Diffuse Weighted Image
<b>ERCP</b>	Endoscopic Retrograde Cholangiopancreatography
<b>FRFSE</b>	Fast Recovery Fast Spin Echo
<b>FSE</b>	Fast Spin Echo
<b>GRE</b>	Gradient Echo
<b>HASTE</b>	Half Fourier Acquisition Signal _shot Turbo spin Echo
<b>HBS</b>	Hepato-Biliary Scintigraphy
<b>MRCP</b>	Magnetic Resonance Cholangiopancreatography
<b>MRI</b>	Magnetic Resonance Imaging
<b>MPR</b>	Multiple Reconstruction Planer
<b>OCG</b>	Oral Cholecystography
<b>PTC</b>	Percutaneous Transhepatic Cholangiography
<b>RARE</b>	Rapid Acquisition Rapid Enhancement
<b>SE</b>	Spin Echo
<b>SO</b>	Sphincter of Oddi
<b>TE</b>	Time to Echo

<b>U/S</b>	Ultrasound
<b>2D</b>	Two Dimensions
<b>3D</b>	Three Dimensions



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# Chapter One

## General Introduction

### 1.1 Introduction:

Magnetic resonance cholangiopancreatography (MRCP) is an abdominal magnetic resonance imaging method that allows non-invasive visualization of the Pancreatobiliary tree and requires no administration of contrast agent. (Adamek 1998).

MRCP is increasingly being used as a non-invasive alternative to ERCP and a high percentage of the diagnostic results of MRCP are comparable with those from ERCP for various hepatobiliary pathologies. (Vogl 2006).

It has been exactly two decades since magnetic resonance cholangiopancreatography (MRCP) was first described. Over this time, the technique has evolved considerably, aided by improvements in spatial resolution and speed of acquisition. It has now an established role in the investigation of many biliary disorders, serving as a non-invasive alternative to endoscopic retrograde cholangiopancreatography (ERCP). It makes use of heavily T2-weighted pulse sequences, thus exploiting the inherent differences in the T2-weighted contrast between stationary fluid-filled structures in the abdomen (which have a long T2 relaxation time) and adjacent soft tissue (which has a much shorter T2 relaxation time). Static or slow moving fluids within the biliary tree and pancreatic duct appear of high signal intensity on MRCP, whilst surrounding tissue is of reduced signal intensity. (WallnerBK 1991).

Heavily T2-weighted images were originally achieved using a gradient-echo (GRE) balanced steady-state free precession technique. A fast spin-echo (FSE) pulse sequence with a long echo time (TE) was then introduced shortly after, with the advantages of a higher signal-to-noise ratio and contrast-to-noise ratio, and a lower sensitivity to motion and susceptibility artefacts. (Morimoto K 1992).

Modified FSE sequences have been described, including rapid acquisition with rapid enhancement (RARE), half-Fourier acquisition single-shot turbo spin-echo (HASTE), and fast-recovery fast spin-echo (FRFSE) sequences. Both breath-hold (using a single shot approach) and non-breath-hold techniques (with respiratory triggering) have been used, with images obtained either as a two-dimensional (2D) or three-dimensional (3D) acquisition. A 3D technique provides a higher signal to noise ratio, which is traded off for thinner contiguous slices. (Takehara 1994).

A 3D technique provides a higher signal to noise ratio, which is traded off for thinner contiguous slices. Acquiring images with near isotropic voxels allows improved post-processing manipulation of the images with multi-planar reconstruction, maximum intensity projection (MIP) and volume rendering. (Barish MA 1995).

The introduction of faster gradients and a parallel acquisition technique has resulted in even greater spatial resolution and faster acquisition times. More recently, functional assessment of biliary excretion and pancreatic exocrine function has become possible with the use of hepatobiliary contrast media and secretin respectively. (Fayad LM 2003).

MRCP is currently gaining wider use as a non-invasive alternative to ERCP. The techniques are comparable with respect to diagnostic accuracy but MRCP offers the advantages of 3D imaging and imaging reformatting, as well as having no morbidity and mortality. MRCP is non-invasive and well tolerated, and in cases where it is not possible to carry out interventional endoscopy, MRCP should be the first choice of diagnostic tool. (Fayad LM 2003).

## **1.2 Problem of study:**

Most of the imaging modalities fail to show the causes, level, and size of the obstruction at the same time mainly in the early stage and then if the hepatobiliary diseases diagnosed in late stage then leads to many complications and many imaging procedures cause risks due to contrast media use, and using ionizing radiation.

### **1.3 Objectives:**

#### **1.3.1 General Objectives:**

Study of hepatobiliary diseases using the Magnetic resonance cholangiopancreatography (MRCP).

### **1.3.2 Specific Objectives:**

To detect or diagnose the hepatobiliary diseases by MRCP.

To compare between the MRCP and ultrasound in detecting the hepatobiliary diseases.

### **1.4 Overview of the study:**

This study contains five chapters named as follow chapter one the introduction, chapter two the literature review, chapter three the methodology, chapter four results and chapter five the discussion, conclusion and recommendations.

## Chapter Two

### Literature review & previous studies

#### 2.1 The anatomy of the hepatobiliary system:

##### 2.1.1 Liver:

The liver is divided macroscopically into the right and left lobe by the falciform ligament anteriorly. Inferiorly, this corresponds to the round ligament and umbilical fissure. The right lobe is further divided by the gallbladder fossa into the right hemiliver to the right of the gallbladder and the quadrate lobe to the left. The fourth lobe (caudate) is posterior and surrounds the inferior vena cava. Hence, anatomically the liver is divided into two main lobes and two accessory lobes. (Gross anatomy 1989).

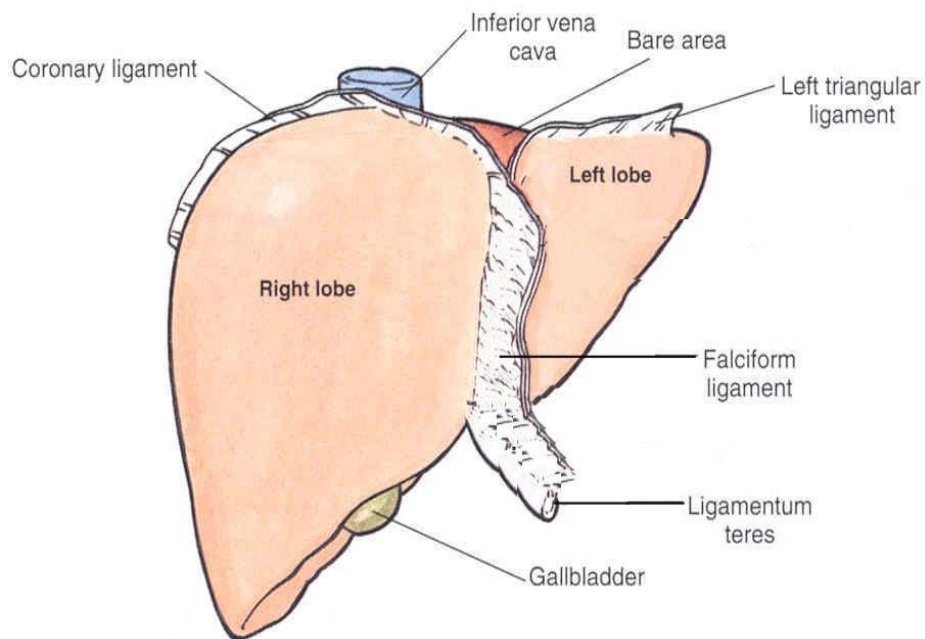


Fig.2.1 anatomy of hepatobiliary system (google/images 2004).



### 2.1.2. Intrahepatic bile ducts:

There are more than 2 km of bile ductules and ducts in the adult human liver. These structures are far from being inert channels, and are capable of significantly modifying biliary flow and composition in response to hormonal secretion. (Michels NA, 1957).

### 2.1.3. Extrahepatic bile ducts:

The joining of the right and left hepatic ducts forms the common hepatic duct. The accessory biliary apparatus, composed of the gallbladder and cystic duct, joins the common hepatic duct to form the common bile duct that drains bile into the second part of duodenum. (Michels NA, 1957).

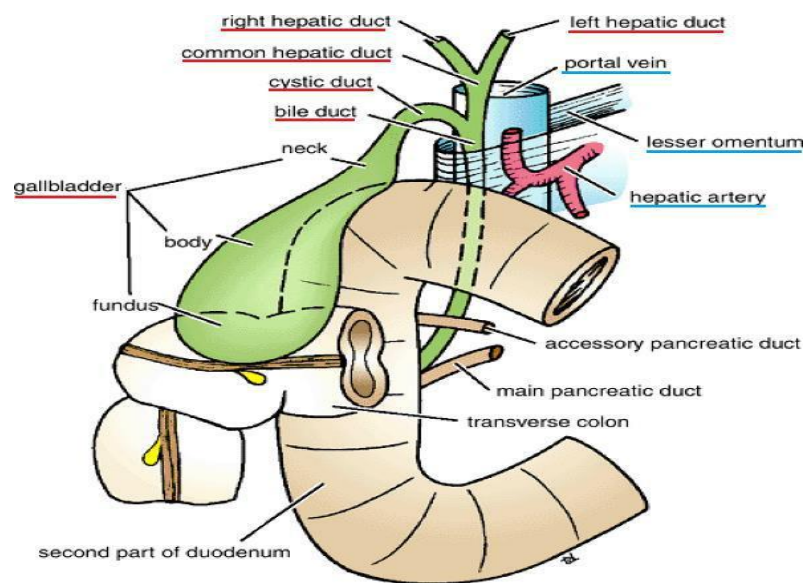


Fig 2.2 biliary ducts. (google/images 1989).

### 2.1.4 Gallbladder and cystic duct:

The gallbladder is a reservoir of bile in the shape of a piriform sac partly contained in a fossa on the inferior surface of the right hepatic lobe. It extends from the right extremity of the porta hepatic to the inferior border of the liver. It is 7 to 10 cm long and 3 to 4 cm broad at its widest part, and can hold from 30 to 50 ml. The gallbladder

is divided into a fundus, body, infundibulum and neck. The fundus extends about 1 cm beyond the free edge of the liver. The body is the largest segment. The infundibulum is the transitional area between the body and the neck. The neck is the tapered segment of the infundibulum that is narrow and joins the cystic duct.

hepatis to the inferior border of the liver. It is 7 to 10 cm long and 3 to 4 cm broad at its widest part, and can hold from 30 to 50 ml. The gallbladder is divided into a fundus, body, infundibulum and neck. The fundus extends about 1 cm beyond the free edge of the liver. The body is the largest segment. The infundibulum is the transitional area between the body and the neck. The neck is the tapered segment of the infundibulum that is narrow and joins the cystic duct. The cystic duct is 3 to 4 cm long and passes posteriorly inferior and to the left from the neck of the gallbladder to join the common hepatic duct to form the common bile duct (CBD). The mucosa of the cystic duct is arranged with spiral folds known as the valves of Heister (Wood D.1979).

#### **2.1.5 The duct of Luschka:**

The duct of Luschka is a small bile duct, running in the bed of the gallbladder, outside the wall. It is present in 50% of individuals (Kune GA.1969).

#### **2.1.6 The Common bile duct:**

The common bile duct (CBD) forms by the junction of the cystic duct with the common hepatic duct. Its course is divided into supra duodenal, retro duodenal, pancreatic and intra duodenal (joins the main pancreatic duct to form the sphincter of Oddi). The supra duodenal segment usually lies in the free border of the hepatoduodenal ligament. It runs to the right of the hepatic artery and anterior to the

portal vein. The retroduodenal segment descends posterior to the first part of the duodenum and slightly obliquely from right to left. The pancreatic segment is related to the head of the pancreas; it can run entirely retropancreatic or travel through its parenchyma. The diameter of the common bile duct is often used as an indication of biliary pathology. Its “normal” size varies depending on the modality used to measure it, and a range of 4 to 13 mm has been reported. (Dowdy GS.1962).

### **2.1.7 Sphincter of Oddi:**

The common bile duct enters the duodenum approximately 8 cm from the pylorus in the second part of the duodenum. The site entry is marked by a papilla (major papilla). Its position can be variable; in approximately 13% of individuals it can be located at the junction of the second and third part of the duodenum, or even more distally. A transverse fold of mucosa usually covers the papilla. The main pancreatic duct of Wirsung joins the common bile duct and forms a common channel in approximately 85% of individuals. In 15%, they open either separately or as a V junction with the duodenal mucosa. (Lindner HH.1976).

### **2.2 Physiology of the biliary system:**

The biliary tract is functionally integrated with the digestive tract by neurohormonal mechanisms in the fasting and digestive phases [W. J. Dodds et al 1989].

The liver secretes bile continuously into the intrahepatic ducts flowing into the extra hepatic ducts. The gallbladder is filled with the aid of the sphincter of Oddi (SO) where the bile is stored and concentrated in the fasting state and emptied during all three phases of the digestive periods. [W. J. Dodds 1989].

In the inter digestive period about 10% of the hepatic bile can drain into the duodenum occurring during intervals between the phasic contractions of the sphincter of Oddi (diastolic periods) when the secreted bile raises the ductal

pressures above the sphincter of Oddi basal pressures [J. Behar and P. Biancani1989].

The remaining 90% of bile is redirected toward the cystic duct to be stored in the gallbladder. The remaining 90% of bile is redirected toward the cystic duct to be stored in the gallbladder. The main neuro hormonal mechanisms regulating the motility of the gallbladder are the vagus and splanchnic nerves and the hormone CCK [K. Sonobe 1995].

The vagus nerve contains afferent and efferent fibers. Stimulation of the efferent fibers of the vagus nerve contracts the gallbladder. During the fasting period the gallbladder maintains a moderate tonic contraction that is superimposed with non-propulsive and propulsive contractions [H. Abiru 1994].

These contractions are responsible for the additional albeit small discharge of gallbladder bile in the duodenum that takes place during this period. In the digestive period strong gallbladder contractions and sphincter of Oddi relaxation lead to the high rates of bile discharge flowing into the common bile duct and duodenum. During this period, the gallbladder motor activity like the rest of the gastrointestinal tract is influenced by the three phases of digestive process: cephalic, antral, and duodenal [I. Takahashi 1986].

The cephalic phase is initiated by stimuli that activate the central nervous system, as individuals are exposed to olfactory, visual, and the taste of food. Once food reaches the stomach it triggers an antral-gallbladder reflex also mediated by vagal fibers. The gallbladder empties most of its remaining contents during the intestinal phase induced by the release of CCK from the duodenum and proximal jejunum. In conclusion the Functions of the biliary system to drain waste products from the liver into the duodenum and to help digestion with the controlled release of bile. Bile is the greenish-yellow fluid (consisting of waste products, cholesterol, and bile salts) that is secreted by the liver cells to carry away waste and to break down fats during

digestion Bile salt is the actual component which helps break down and absorb fats. Bile, which is excreted from the body in the form of feces, is what gives feces its dark brown color. [I. Takahashi 1986].

### **2.2.1 Blood supply and venous drainage of the liver:**

The arterial supply to the liver in early gestation life is from three main sources: the left hepatic artery from the left gastric artery; the middle hepatic artery (common hepatic artery) from the celiac trunk; and the right hepatic artery from the superior mesenteric artery. With further development, the blood supply assumes the adult pattern, with atrophy of both the right and left hepatic arteries and the common hepatic artery (middle hepatic) supplying the whole liver. The venous drainage of the liver is into the inferior vena cava through the right, middle and left hepatic veins. (Jones AL 1980).

The arterial supply to the gallbladder is from the cystic artery. The gallbladder is innervated by the vagus nerve through its hepatic branch from the anterior vagal trunk. The venous drainage is through the cystic vein, which drains into the portal vein. There are also some small veins that drain directly into the liver to the hepatic veins. The gall- bladder is also innervated by the sympathetic nervous system through the celiac plexus. The blood supply to the common bile duct is also divided into three segments. The supra duodenal segment of the duct essentially has an axial blood supply. The blood supply originates from the retro duodenal artery, right hepatic artery, cystic artery, gastroduodenal artery and the retro portal artery. The veins draining the bile duct correspond to the described arteries. The nerve supply to the extrahepatic bile duct is from extrinsic and intrinsic nerves. (Northover 1978).

## **2.3 Pathology of the Biliary System:**

### **2.3.1 Cholelithiasis:**

Cholelithiasis is the medical name for hard deposits (gallstones) that may form in the gallbladder. The cause of cholelithiasis is not completely understood. The most

common type of gallstones form in cholelithiasis, called a cholesterol stone, results from the presence of too much cholesterol in the bile. Another type of stone, called a pigment stone, is formed from excess bilirubin, a waste product created by the breakdown of the red blood cells in the liver. The size and number of gallstones varies in cholelithiasis. The gallbladder can form many small stones or one large stone. (Kahan S, 2009).

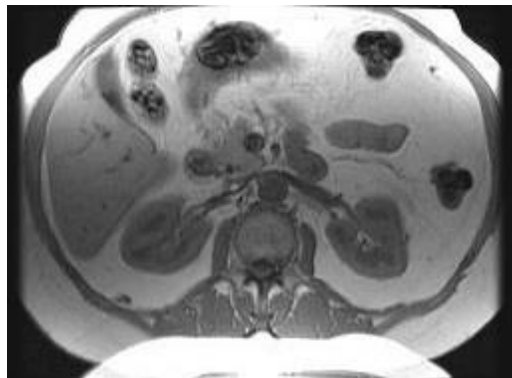
Cholelithiasis can lead to cholecystitis, inflammation of the gallbladder. Acute gallstone attacks may be managed with intravenous medications. Chronic (long-standing) cholelithiasis is treated by surgical removal of the gallbladder. (Hermann RE.1989).



(Fig.2.3) Cholelithiasis. Ultrasound image obtained with a 4-MHz transducer demonstrates a stone in the gallbladder neck with typical acoustic shadow. (Radiopaedia 2008).



(fig.2.4) Cholelithiasis. A non-calcified filling defect is present in the gallbladder on this contrast-enhanced CT. Ultrasound examination confirmed a mobile stone and excluded the other possible diagnoses of polyp or tumor. (Radiopaedia 2002).

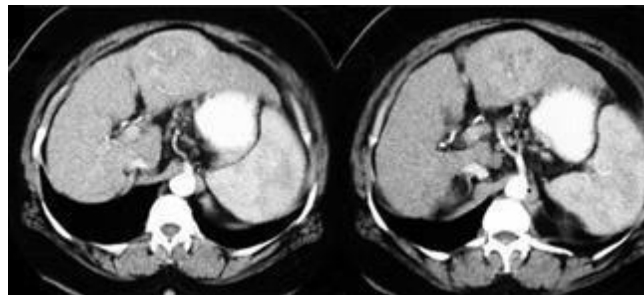


(fig.2.5) Cholelithiasis. Multiple tiny gallstones appear as signal void-filling defects in the gallbladder on this T1-weighted spoiled gradient-echo sequence. (Radiopaedia 2011).

### **2.3.2 Hepatocellular carcinoma:**

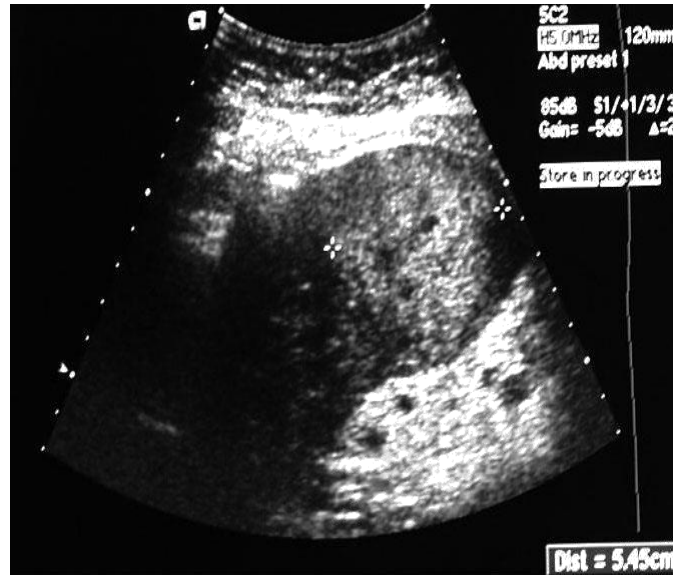
Hepatocellular carcinoma is the cancer of the liver. It is also called “hepatoma”.

Hepatocellular carcinoma is commonly seen in people at the age of 50 to 60 years old. Hepatocellular carcinoma is the liver cancer that arises from the liver itself. It is not the same as the metastatic liver cancer which is a cancer that comes from the other organs of the body and spread to the liver. The most common cause of the hepatocellular carcinoma is the scarring of the liver due to alcohol abuse, hepatitis B, hemochromatosis or iron overload, autoimmune diseases, as well as diseases that causes inflammation of the liver. This type of liver cancer is more often seen in men. This is probably because men are more prone to alcohol abuse. People with hepatitis B and C are also at higher risk of this liver cancer. Here are the most common symptoms of hepatocellular carcinoma. (Khan SA 2002).



(fig 2.6) CT scan in the hepatic arterial phase of contrast enhancement showing neovascularity in a low-density hepatic mass. (Radiopaedia 2009).





(Fig 2.7) Ultrasound image showing hyper echoic mass representing hepatocellular carcinoma. (Radiopaedia 1995).

### **2.3.3 Gall Stones:**

Gallstones form in the gallbladder, a small organ located under the liver. Gallstones are pieces of solid material that form in the gallbladder. These stones develop because cholesterol and pigments in bile sometimes form hard particles. (Hermann RE.1989).

#### **2.3.3.1 The two main types of gallstones are:**

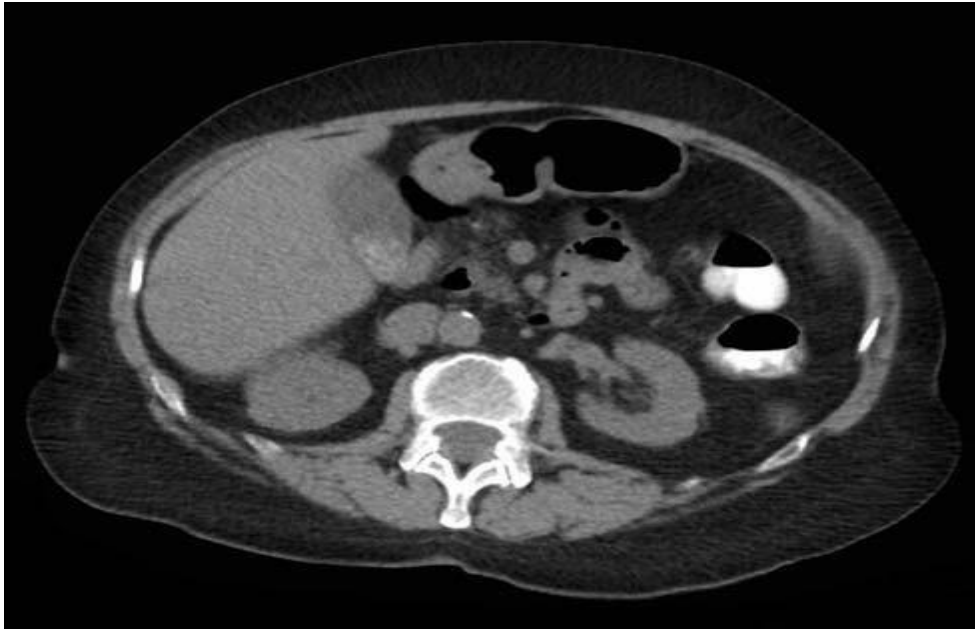
##### **2.3.3.1.1 Cholesterol stones:**

Usually yellow-green in color, approximately 80% of gallstones are cholesterol stones. (Hermann RE.1989).

##### **2.3.3.1.2 Pigment stones:**

These stones are smaller and darker and are made up of bilirubin. Pigment stones are more common in people with certain medical conditions, such as cirrhosis (a liver disease in which scar tissue replaces healthy liver tissue) or blood diseases such as sickle cell anemia. (Hermann RE.1989).

### 2.3.3.2 Feature of gall stone in different modalities: :



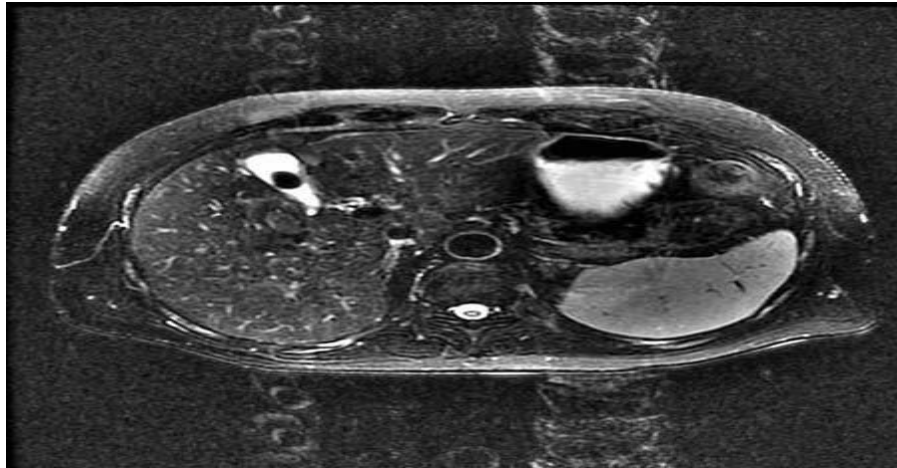
(Fig 2.8) gall stone appearance in ct image  
(Radiopaedia 2005).

Ultrasound produces pictures of the gallbladder and bile ducts. It shows signs of inflammation or indications that there is blockage of bile flow. Ultrasound is the most common test performed to evaluate gallbladder abnormalities. (Varghese JC,2002).



(Fig 2.9) Ultrasound image of a patient's gallbladder showing a gallstone (arrow).  
(Radiopaedia 2004).

### 2.3.3.2.3 Gall stone in MRI Images:



(Fig 2.10) MRI of a patient's abdomen showing a gallstone. (Radiopaedia 2012).

### 2.3.3 Common bile duct stones:

(choledocholithiasis): are gallstones that are present in the bile ducts, sometimes within the cystic duct of the gallbladder but more frequently in the common bile duct. Most gallstones are formed in the gallbladder and if small enough, it will pass out into the cystic duct and then into the common bile duct (CBD) along with the flow of bile. These stones may lodge in the duct and become impacted thereby causing a blockage of the duct. Most small stones, however, will pass out with the bile into the duodenum of the small intestine. Less frequently, a stone may originate within the hepatic or common bile duct and this is referred to as a primary bile duct stone. There are two different types of gallstones – cholesterol and pigment stones. (Balfe DM 2000).

Ultrasonography laparoscopic is used in detecting common bile duct stones during laparoscopic cholecystectomy. The aim of this study is to describe The laparoscopic ultrasonographic appearance of the common bile duct mucosa in patients with choledocholithiasis. (Varghese JC 2002).

### **2.3.4 Obstructive jaundice:**

Obstructive jaundice is a condition in which there is blockage of the flow of bile out of the liver. Any type of obstruction that blocks the flow of bile from the liver can cause obstructive jaundice. Most commonly, gallstones create the blockage. Other causes of obstruction include inflammation, tumors, trauma, pancreatic cancer, narrowing of the bile ducts, and structural abnormalities present at birth. (Bope ET, 2012.)

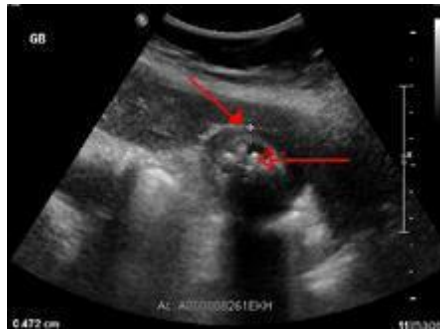
### **2.3.5 Biliary colic or chronic cholecystitis:**

The commonest presentation of gallstone disease is biliary pain. The pain starts suddenly in the epigastrium or right upper quadrant and may radiate round to the back in the interscapular region. (Hermann RE.1989).

Ultrasound is paramount in differential diagnosis. Ultrasound findings suggestive of acute cholecystitis include pericholecystic fluid, >4 mm gallbladder wall thickening, and Murphy's sign. Visualization of gallstones on ultrasound helps confirm the diagnosis of cholecystitis. Computed tomography (CT) scan, magnetic resonance imaging (MRI), and hepatobiliary scintigraphy (HBS) are also useful in the detection of cholecystitis. Endoscopic retrograde cholangiopancreatography (ERCP) may be useful to visualize the anatomy. (Varghese JC 2002).

### **2.3.6 Acute cholecystitis:**

When obstruction of the cystic duct persists, an acute inflammatory response may develop with a mild fever. Irritation of the adjacent parietal peritoneum causes localised tenderness in the right upper quadrant. As well as gall stones, ultrasonography may show a tender, thick walled, oedematous gall bladder with an abnormal amount of adjacent fluid. Liver enzyme activities are often mildly abnormal. (Varghese JC 2002).



(Fig 2.11) Acute cholecystitis as seen on ultrasound. Closed arrow points to gall bladder wall thickening. Open arrow points to stones in the GB. (Radiopaedia 2002).

### **2.3.7 Pancreatic Diseases:**

#### **2.3.7.1 Pancreatic cancer:**

Is when cancer cells develop from the pancreas, a glandular organ located behind the stomach. By the time of diagnosis, the cancer has usually spread to other parts of the body. (Ryan ME 1994).

#### **2.3.7.2 Pancreatitis:**

This happens when digestive enzymes start digesting the pancreas itself. (Ryan ME 1994).

#### **2.3.7.3 Cystic fibrosis:**

A genetic disorder in which thick, sticky mucus can also block tubes in the pancreas. (Ryan ME 1994).



(Fig 2.12) Axial CT image with iv. contrast. Macro cystic adenocarcinoma of the pancreatic head. (Radiopaedia 2005).

### **2.3.8 Liver Disorders:**

Liver disease (hepatic disease) is a type of damage to or disease of the liver. (Balfe DM 2000).

There are more than a hundred kinds of liver disease but the most widely spread are as follows:

#### **2.3.8.1 Hepatitis:**

Inflammation of the liver, is caused mainly by various viruses (viral hepatitis) but also by some liver toxins (e.g. alcoholic hepatitis), autoimmunity (autoimmune hepatitis) or hereditary conditions. (Khan SA 2002).

#### **2.3.8.2 Alcoholic liver disease:**

Is any hepatic manifestation of alcohol overconsumption, including fatty liver disease, alcoholic hepatitis, and cirrhosis. Analogous terms such as "drug-induced" or "toxic" liver disease are also used to refer to the range of disorders caused by various drugs and environmental chemicals. (Khan SA 2002).

#### **2.3.8.3 Fatty liver disease (hepatic steatosis):**

Is a reversible condition where large vacuoles of triglyceride fat accumulate in liver cells. Non-alcoholic fatty liver disease is a spectrum of disease associated with obesity and metabolic syndrome, among other causes. Fatty liver may lead to inflammatory disease (i.e. steato hepatitis) and, eventually, cirrhosis. (Khan SA 2002).

#### **2.3.8.4 Cirrhosis:**

Is the formation of fibrous tissue (fibrosis) in the place of liver cells that have died due to a variety of causes, including viral hepatitis, alcohol overconsumption, and other forms of liver toxicity. Cirrhosis causes chronic liver failure. (Khan SA 2002).

#### **2.3.8.5 Primary liver cancer:**

Most commonly manifests as hepatocellular carcinoma and/or cholangiocarcinoma; rarer forms include angiosarcoma and hemangiosarcoma of the liver. (Many liver

malignancies are secondary lesions that have metastasized from primary cancers in the gastrointestinal tract and other organs, such as the kidneys, lungs, breast, or prostate.). (Khan SA 2002).

#### **2.3.8.6 Primary biliary cirrhosis:**

Is a serious autoimmune disease of the bile capillaries. (Khan SA 2002).

#### **2.3.8.7 Primary sclerosing cholangitis:**

Is a serious chronic inflammatory disease of the bile duct, which is believed to be autoimmune in origin. (Khan SA 2002).

#### **2.3.8.8 Hereditary disease:**

That cause damage to the liver include hemochromatosis, involving accumulation of iron in the body, and Wilson's disease, which causes the body to retain copper. Liver damage is also a clinical feature of alpha 1-antitrypsin deficiency and glycogen storage disease type II. (Khan SA 2002).

### **2.4 Radiographic procedure:**

#### **2.4.1 Plain abdomen x-ray radiograph:**

X-ray is a form an electromagnetic wave of high energy and very short wave length (ionizing radiation) which is able to pass through many materials opaque to light. plain radiograph of the biliary system may be taken to demonstrate opacities, including calcifications in the region of gall bladder and biliary tree. The gall bladder and biliary ducts blend in with other abdominal soft tissue and in most cases cannot be visualized without the additional of contrast media examination. (Bontrager 2006).

#### **2.4.2 Oral cholecystography (OCG):**

It is a radiographic contract media examination in which the contrast ingested orally to study the anatomy and function of biliary system. The patient fast at least 8hr before the exam and the evening meal before the exam should be light and should not contain fats. (Bontrager 2006).

Patient ingest four to six tablets or capsules during the evening before exam. Scout radiograph (first radiograph) is taken with the patient prone .it checked to determine the presence or absence of opacified gall bladder. Right posterior oblique projection taken to demonstrate the biliary duct system drainage into duodenum and right lateral decubitus position demonstrate the opacified gall bladder is project away from the vertebral column. Many projections may be taken after administer fatty meal which stimulate the duodenum mucosa to produce CCK which is will turn the gall bladder to contract to assessment the contracting ability of the gall bladder. The number of OCG is being ordered has decreased generally because of increase used of sonography. (Bontrager 2006).

#### **2.4.3 Diagnostic Ultrasound (sonography):**

Sonography is a noninvasive imaging method that uses high frequency sound waves (above to audible sound) so called ultrasound- to produce relatively precise images of structures within the body. Ultrasound is first imaging investigation of choice for the jaundiced patient it is able to detect small calculi in the gall bladder and biliary ducts that generally are not visualized during OCG also ultrasound excellent in distinguish between the dilated and non-dilated ducts, common bile duct measurements are graded as follows: normal <6. equivocal 6-8 mm dilated > 8. the site and cause of obstruction are defined only 25 percent of causes as overlying duodenal gas often obscure the lower end of common bile duct depending on the finding of US other more definitive imaging of the biliary system may be done. (Bontrager 2006).

#### **2.4.4 Operative cholangiography:**

Operative cholangiogram involves the injection of radiopaque dye into the ducts of the biliary tract during gall bladder surgery. X-ray then reveal clear images of biliary tract. This is test is used occasionally when other less invasive test does not provide enough information. The primary purpose of operative cholangiography are: to



reveal any cholelithiasis (stones) not previously detected, determine the function of hepato pancreatic ampulla, and demonstrate small lesions, strictures or dilatation in biliary ducts. (Bontrager 2006).

#### **2.4.5 Postoperative (T tube or delayed) cholangiography:**

Delayed cholangiogram usually performed in radiology department following a cholecystectomy. The surgeon may be concerned about the residual stones in the biliary ducts that went undetected during the surgery. The surgeon will place a special tube catheter into the common bile duct. The catheter extends to the outside of the body and is clamped off, because the T-tube catheter has been clamped off drainage of excess bile is performed at the beginning of the procedure, after duct drainage and under fluoroscopic control the iodinated contrast media is injected fractionally and fluoroscopic spot films are taken. (Bontrager 2006).

#### **2.4.6 PTC (Percutaneous transhepatic cholangiography):**

It is another type of cholangiography that demonstrate the biliary duct, it is more invasive than other form of cholangiography. PTC involve direct puncture of biliary duct with a needle passing through the liver once within duct, iodinated contrast media is injected under fluoroscopic control. Fluoroscopic spot films and conventional radiographs are taken during the procedure. PTC Is indicated for assessment of high biliary obstruction at the level of porta and where biliary obstruction is unable to outlined by ERCP due to previous biliary diversion surgery. (Bontrager 2006).

#### **2.4.7 ERCP (Endoscopic retrograde cholangiopancreatography):**

In which small cannula is passed into the ampulla of vater under the direct endoscopic visualization. Then contrast media is injected into the biliary and pancreatic ducts and image acquired. ERCP is used to assess biliary obstruction diagnosed on ultrasound or computed tomography. ERCP is the investigation of choice for suspected distal biliary obstruction that may require investigation such as

sphincterotomy, basket retrieval of stones, biliary biopsy or biliary stent placement. (Bontrager 2006).

#### **2.4.8 Nuclear medicine:**

A hepato-biliary or HIDA scan is a scan of the gall bladder and biliary system. Patients with a history of the abdominal pain, nausea, and vomiting, or chest pain resulting from gall bladder or biliary diseases are candidates for this procedure.

Patients are injected with radio-active isotope and images are taken approximately 1 to 2 hours after injection. After the completion of the examination, another procedure may be performed to indicate the response of the gall bladder to hormonal stimulation. It requires a second injection. Liver and spleen nuclear medicine scans evaluate functional liver disorders that include cirrhosis, hepatitis, and metabolic disorders. (Bontrager 2006).

#### **2.4.9 Computer tomography (CT):**

Computer tomography mean using of rotating x-ray tube detector to produce cross section image for only selected layer this layer is free from superimposition of other organ and tissue. CT Cholangiography is a reasonable reliable method of imaging the biliary system Involve a slow intravenous contrast infusion of an iodine containing choleangiographic agent (biliscopin) to opacity the bile duct. (Bontrager 2006).

#### **2.4.10 MRI:**

Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, and virtually all other internal body structures. The images can then be examined on a computer monitor, transmitted electronically, printed or copied to a CD. MRI does not use ionizing radiation (x-rays). (Radiologyinfo 2011).

#### **2.4.10.1 MRCP:**

Magnetic resonance cholangiopancreatography is uses heavily T2 weighted image that show stationary fluids such as high signal with moving fluids and solids as low signal. The bile ducts and gallbladder are there for seen as bright structures on a dark background. MRCP has largely replaced by diagnostic ERCP, as the investigation of choice for imaging of the biliary system including assessment of jaundice patients with dilated bile duct on Ultra sound. MRCP is commonly used prior to laparoscopiccholecystectomy to diagnose bile duct calculi and bile duct variants and to avoid of intraoperative exploration of common bile duct. (Catherine 2008).

#### **2.4.10.2 MRCP Protocol:**

Coronal breath –hold incoherent (spoiled) GRE –SET1 Act as a localizer if three plan localization is unavailable, or as diagnostic sequence / Thick slices. gap is prescribed relative to the vertical alignment light, from the posterior abdominal muscles to the anterior abdominal wall. The area from the pubis symphysis to the diaphragm is included in the image. Axial SE/ FSE /incoherent (spoiled) GRE T1 - /+in and out of phase as for coronal T1, except prescribe slices from the inferior margin of the liver to the diaphragm. (Catherine Westbrook 2008).

#### **2.4.10.3. Additional sequences:**

##### **2.4.10.3.1 SS-FSE (MRP):**

This is sequence provides images in which only fluid –filled spaces such as the gall bladder and biliary ducts return signal .it is necessary to use very long TEs and TRs to effectively nullify the signal from all tissues except those have long T2 Decay times. TEs in excess of 200 ms and TRs of more than 10 s as required. If SS-FSE is unavailable, then an FSE sequence may be substituted. (Catherine Westbrook 2008).

##### **2.4.10.3.2 SS-FSE/GRE-EPI /Diffusion imaging:**

The use of real time imaging has application in the liver and biliary system. This includes biopsies and thermal ablations of liver lesion under real time MR control.in

addition, diffusion and perfusion techniques of the liver have been developed that may negate the use of contrast agent in the further. DWI images are overlaid onto T1 weighted acquisition provides pathology information, whereas the T1 weighted acquisition provide anatomical data. The images produced are not dissimilar to a PET/CT scan. In addition diffusion tensor imaging use in conjunction with parallel imaging techniques enables differentiation of benign from malignant hepatic lesions and may also assist in the quantification of hepatic fibrosis. (Catherine Westbrook 2008).

#### **2.4.10.4 Magnetic resonance Imaging (MRI):**

Is a noninvasive technique for evaluating the intrahepatic and extra hepatic bile ducts and the pancreatic duct. (Catherine Westbrook 2008).

#### **2.4.10.5 MRI Equipment.**

The MRI equipment consists of following components:

##### **2.4.10.5.1 The magnet generates the magnetic field:**

The magnet is three types are Permanent, Resistive and Superconductive. (Thomas S.R 1992).

##### **2.4.10.5.2. Shim coils:**

Make the magnetic field homogeneous. The uniform field achieved by shimming also has a role in ensuring accurate slice thickness and profile, slice location, and geometric fidelity for all imaging. Shimming is typically achieved by some combination of four methods Passive Shimming, Resistive Shimming, Superconductive Shimming and Gradient Offset Shimming. (Thomas S.R.1992)

##### **2.4.10.5.3. Radiofrequency coils:**

Transmit the radio signal into the body part being imaged. All excitation energy is provided by magnetic fields rotating in the X-Y plane, at the Larmor frequency of Hydrogen (42.58 Mhz/T). These rotating magnetic fields are created by passing RF

alternating current, generated by the RF transmitter, through suitably shaped and orientated conductors known as the RF coils. This energy realigns the nuclear magnetic fields of the subject into the transverse plane and bring the nuclei fields into phase coherence by acting as a fixed magnetic field in the rotating frame. The nuclear magnetic fields rotating coherently in the transverse plane induce RF currents (MR signal) in the receive coil which are detected and analyzed in the receiver system. (Thomas S.R.1992).

#### **2.4.10.5.4. Receiver coils:**

Detect the returning radio signals. (Thomas S.R.1992)

##### **2.4.10.5.4.1. Linear Array Coil:**

A receiver coil with more than one segment, which can be utilized as a single or a multiple segment coil. (Thomas S.R.1992)

##### **2.4.10.5.4.2 Surface Coil:**

A surface coil is essentially a loop of conducting material, such as copper tubing. This type of receiver coil is placed directly on or over the region of interest for increased magnetic sensitivity. The loop may form various shapes and be bent slightly to conform to the imaged body part. (Thomas S.R.1992)

##### **2.4.10.5.4.3 Antenna:**

A device that enables the sending and/or receiving of electromagnetic waves. (Thomas S.R.1992)

##### **2.4.8.10.4.4. Body Coil:**

The body coil is installed in the magnet and functions both as transmit than also as a receiver coil. This coil has a large measurement field, but does not have the high SNR of special coils. When specific receiver only coils are used (the most surface coils), the body coil serves as the transmit coil. (Thomas S.R.1992)

#### **2.4.10.5.5 Gradient coils:**

Provide spatial localization of the signals. Current carrying gradient coils with reduced gradient fringe field inside of the magnet cryostat structures like cryo shields and He-vessel. (Thomas S.R.1992)

#### **2.4.10.5.6 Shielding coils:**

Produce a magnetic field that cancels the field from primary coils in regions where it is not desired. (Thomas S.R.1992)

##### **2.4.10.5.6.1 Cry shielding:**

##### **2.4.10.5.6.2 Room Shielding:**

Magnetic shielding through the use of high permeability material in the walls (plus floor and ceiling) of the magnet room. Room shielding can be complete (e.g., six sides of a box, Faraday cage), or partial if the fringe field is to be reduced only in certain areas. (Mr-tip 2013).

##### **2.4.10.5.6.3 Self-Shielding:**

Magnetic shielding by attaching a high permeability yoke to the magnet (passive shielding) or by incorporating additional magnetic field-generating coils designed to reduce the external field (active shielding). (Mr-tip 2013).

##### **2.4.10.5.6.4 Active Shielding:**

Magnetic shielding through the use of secondary shielding coils designed to produce a magnetic field that cancels the field from primary coils in regions where it is not desired. These coils may be inside the magnet cryostat. Active shielding can be applied to the main magnet or to the gradient magnetic fields. (Thomas S.R.1992)

## **2.5 previous studies**

Taylor (1991) research about MR cholangiopancreatography (MRCP) at 0.5 T: technique optimization and preliminary results ametoevaluated the accuracy of magnetic resonance cholangiopancreatography (MRCP) in 129 patients with suspected biliary tract disease who were referred for ERCP. MRCP results were

interpreted by an expert in hepatobiliary imaging who was blinded to ERCP findings. Forty-six patients had choledocholithiasis, and 12 had biliary strictures. Compared with ERCP as the gold standard, the sensitivity, specificity, positive predictive value, and negative predictive value of MRCP for diagnosing stones were 98%, 89%, 83%, and 99%, respectively. Of the 14 patients with small calculi (1-5 mm in diameter) diagnosed at ERCP, 13 were detected on MRCP (sensitivity, 93%), but there were 9 false-positive MRCP results. All 12 biliary strictures were diagnosed by MRCP (sensitivity, specificity, positive predictive value, and negative predictive value; 100%, 99%, 92%, and 100%, respectively).

American Journal of Gastroenterology (2005) The study about Detection of Bile Duct Stones in Suspected Biliary Pancreatitis: Comparison of MRCP, ERCP, and Intra ductal US reported on The aim to evaluate of the ability of MRCP to detect choledocholithiasis in patients with acute biliary pancreatitis.in addition, we investigated whether intra ductal US (IDUS) could help manage these patients. The study done on Thirty-two patients with suspected biliary pancreatitis were studied prospectively. MRCP was performed immediately before ERCP by separate blinded examiners within 24 h of admission. Wire-guided IDUS was performed during ERCP within 72 h of admission, regardless of the results of MRCP. The sensitivity of US, CT, MRCP, ERCP, and IDUS for identifying choledocholithiasis was 20.0%, 40.0%, 80.0%, 90.0%, and 95.0%, respectively. The sensitivity of MRCP for detecting choledocholithiasis decreased with dilated bile ducts (bile duct diameter > 10 mm, 72.7% vs 88.9%). In conclusion MRCP can be used to select patients with biliary pancreatitis who require ERCP. IDUS may be applied in the management of biliary pancreatitis if ERCP is performed.

Kim JH, Kim MJ (2002) research about MRCP compared to diagnostic ERCP for diagnosis when biliary obstruction is suspected aim to compare MRCP to diagnostic ERCP in patients with suspected biliary obstruction was conducted. The study

contain 25 studies were identified reporting several conditions including choledocholithiasis (18 studies), malignancy (four studies), obstruction (three studies), stricture (two studies) and dilatation (five studies). Three of the 18 studies reporting choledocholithiasis were excluded from the analysis due to lack of data, or differences in study design. The sensitivity for the 15 studies of choledocholithiasis ranged from 0.50 to 1.00 while specificity ranged from 0.83 to 1.00. The positive likelihood ratio ranged: from 5.44–47.72 and the negative likelihood ratio for the 15 studies ranged from 0.00–0.51. For malignancy, sensitivity ranged from 0.81 to 0.94 and specificity from 0.92 to 1.00. Positive likelihood ratios ranged from 10.12 to 43 and negative likelihood ratios ranged from 0.15 to 0.21, although these estimates were less reliable. In conclusion MRCP is a comparable diagnostic investigation in comparison to ERCP for diagnosing biliary obstruction.



## Chapter Three

### Materials and Method

#### 3.1. Materials:

##### 3.1.1 Machine use:

Use MR Machine Produced by Philips Company with 1.5 tesla, made in German and GE MR Machine 1.5 tesla, made in U.S.A



(Fig 3.1) Philips MRI scanner. (Healthcare.philips 2001).



(Fig3.2) MRI Scanner made by G.C Company. ([Cancerresearchuk](#) 2015).

### **3.1.2 Study Population:**

Patient seen during that period were 50 patients included 21 male and 29 female, with different ages and different weights.

### **3.1.3 Area of The Study:**

Al Amal Hospital (khartoum - Sudan), Alribat Hospital (khartoum - Sudan) and Antalia Diagnostic Center.

### **3.1.4 Duration of The Study:**

The Study Started at November 2016 to February 2017.

## **3.2 Methods:**

### **3.2.1. protocol used:**

Patient fast for 4 hours before the exam, ensured there is not ferromagnetic substance such as implanted medical device e. g: pedicle screws and pacemaker. Immediately before the scan the patient wear gown and ensure there is no external metallic objects. Full explanation the procedure to the patient and how long should he /she remain still to avoid motion.

Patient spine head first, arms elevated above his /her head and immobilized in this position

Instruct the patient to take deep breath to obtain an image for specific section to avoid image artifacts.

coronal plan as localizer to obtain axial section T2 weighted image with used sat for fat suppression and take coronal from axial plan 3D format.

### **3.2.2 Image interpretation:**

The collected images were diagnosed by a referred radiologist who report the final diagnoses and we collected the data from those reports.

### **3.2.3 Data Collection:**

Each patient of referred was interviewed and short history taken e.g.: age, gender, weigh, and ultrasound findings.

### **3.2.4 Data Analysis:**

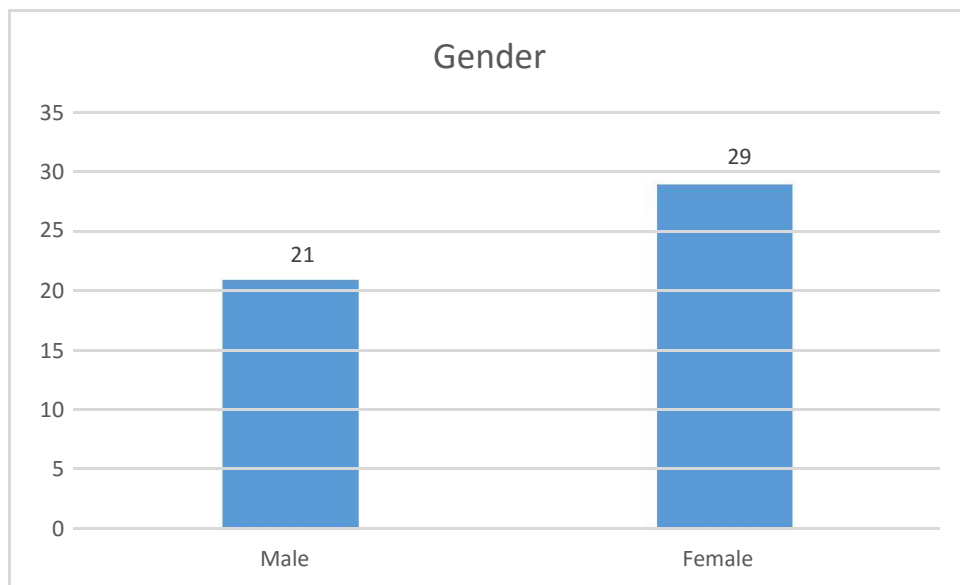
The MRCP images achieved in this study were directly diagnosed by confirmed radiologist and the result was analysis by the statistics computation of this study was performed using excel and manually.

## Chapter Four Results

The following tables and figures present data that obtained from (50) patients whose were examined by MRI for detecting diseases of hepato-biliary system, those patient's variable in gender, age, weight, MRCP and ultrasound findings.

**Table 4-1:** Showed the frequency distribution of gender with their percentages:

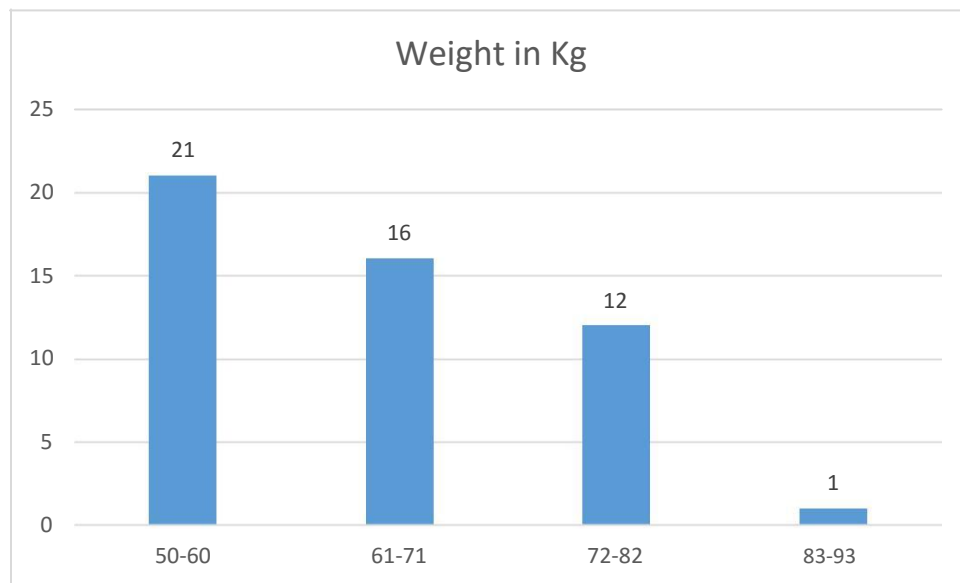
<b>Gender</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
Frequency	21	29	<b>50</b>
Percent	42%	58%	<b>100%</b>



**Figure 4-1:** bar charts demonstrates the frequency of gender.

**Table 4-2:** Showed the frequency distribution of weight with their percentages:

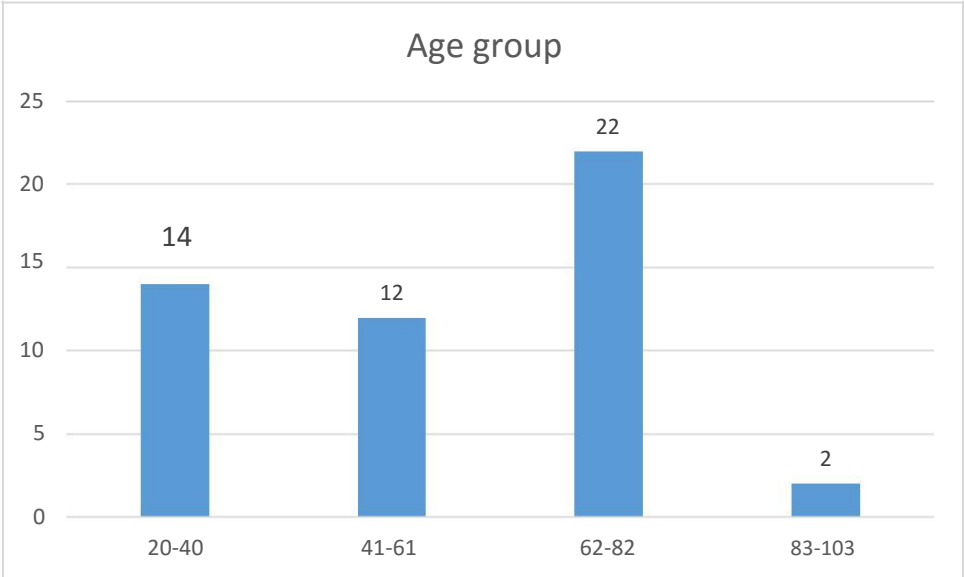
<b>Rang of weight in kg</b>	<b>Frequency</b>	<b>Percent</b>
50-60	21	42%
61-71	16	32%
72-82	12	24%
83-93	1	2%
<b>Total</b>	<b>50</b>	<b>100%</b>



**Figure 4-2:** bar charts demonstrates the frequency of patient's weight.

**Table 4-3:** Showed the frequency distribution of age with their percentages:

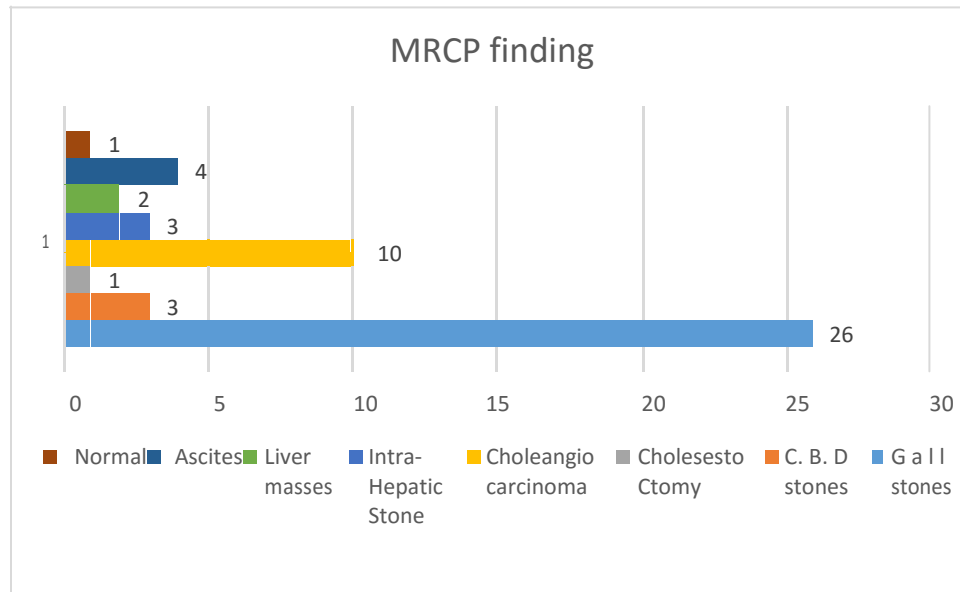
Age group	Frequency	Percent
20-40	14	28%
41-61	12	24%
62-82	22	44%
83-103	2	4%
<b>Total</b>	<b>50</b>	<b>100%</b>



**Figure 4-3:** bar charts demonstrates the frequency of patients age.

**Table 4-4:** Showed the frequency distribution of MRCP finding with their percentages:

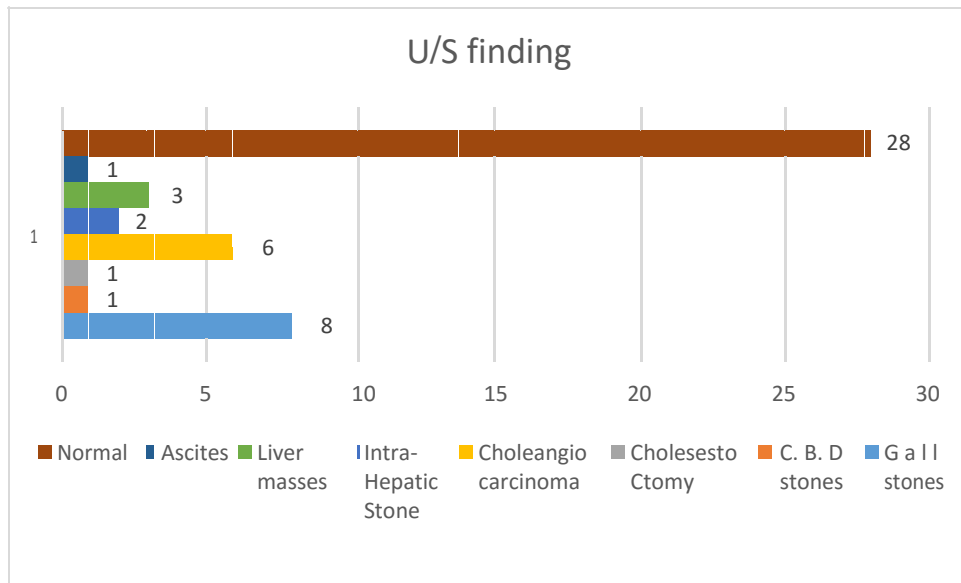
Diseases	G a l l stones	C. B. D stones	Cholesesto Ctomy	Choleangio carcinoma	Intra-Hepatic Stone	Liver masses	Ascites	Normal	Total
Frequency	26	3	1	10	3	2	4	1	<b>50</b>
Percent	52%	6%	2%	20%	6%	4%	8%	2%	<b>100%</b>



**Figure 4-4:** bar charts demonstrates the frequency of MRCP finding.

**Table 4-5:** Showed the frequency distribution of U/S finding with their percentages:

Diseases	G a l l stones	C. B. D stones	Cholesesto Ctomy	Choleangio carcinoma	Intra-Hepatic Stone	Liver masses	Ascites	Normal	Total
Frequency	8	1	1	6	2	3	1	28	50
Percent	16%	2%	2%	12%	4%	6%	2%	56%	100%

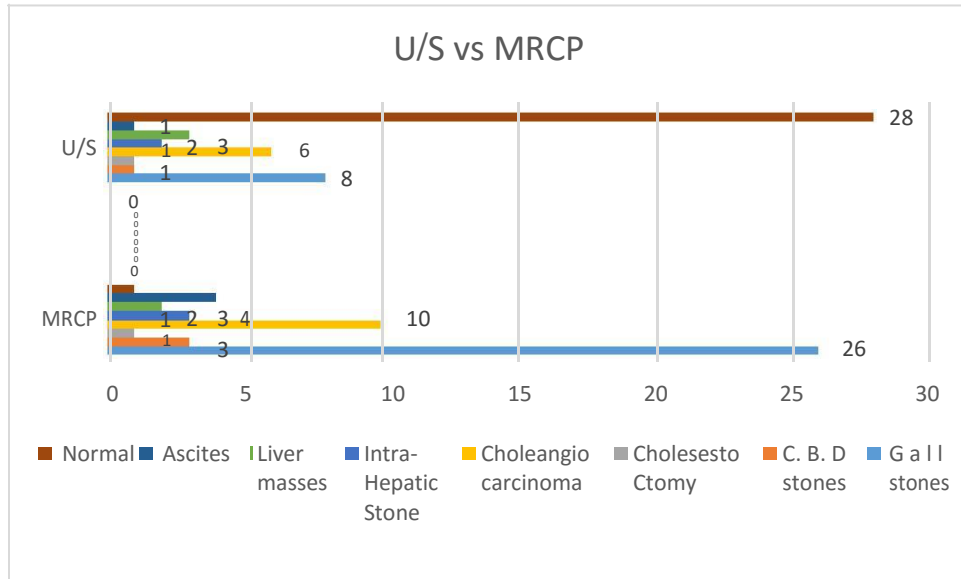


**Figure 4-5:** bar charts demonstrates the frequency of U/S finding.



**Table 4-6:** Showed the similar findings of MRCP and U/S:

Diseases	G a l l stones	C. B. D stones	Cholesesto Ctomy	Choleangio carcinoma	Intra-Hepatic Stone	Liver masses	Ascites	Normal	Total
MRCP	26	3	1	10	3	2	4	1	50
U/S	8	1	1	6	2	3	1	28	50



**Figure 4-6:** bar charts demonstrates the frequency of MRCP vs U/S.

## **Chapter five**

### **Discussion, Conclusion and Recommendations**

#### **5.1 discussion:**

**Showed the female is more affected by( 58%) than male by( 42%) .  
Table (4.1).**

**Showed the most of pathological condition found in  
weight(50\_60kg).Table(4.2).**

**Showed the most affected age range between (62-82  
yrs)by(44%).Table(4.3).**

**Showed the frequency distribution of MRCP detected (52%) of the  
population under study as  
gallstones,cholesectomy(2%),cholangiocarcinoma(20%),liver  
masses(4%),ascites(8%) and normal (2%).Table (4.4).**

**Showed u/s detected (16%) of the population under study as  
gallstones,common bile duct(2%) and cholangiocarcinoma  
(12%),liver masses(6%),ascites(2%) and normal (56%).Table(4.5).**

**Demonstreted the MRCP is more affected in detecting the  
hepatobiliary disease compering with U/S.Table (4.6).**

## **5.2 The conclusion:**

The study concluded that most of hepato-biliary diseases diagnosed by MRCP than other imaging modalities , females are more affected by hepato-biliary diseases more than males. MRCP T2 weighted images are effective procedure in characterization and differentiation of hepato-biliary diseases. The elderly patients are more affected than the younger patients .MRCP is noninvasive procedure and not operator dependent. These feature make MRCP good choice in diagnose the hepato-biliary diseases. The diagnose may need to revised as more details from the patient history, ultrasound result, and compare this with lap investigation histopathology in cases those suspected carcinoma.

MRCP offer new method for detecting the hepato-biliary disease in its early stage, without complication as other invasive procedure.

### **5.3 Recommendations:**

- recommend by more trained for all technicians and radiologists to make full use of MRI technology.
- All government medical centers in hospitals must have MRI machines to offering MRI services for all patients with low cost.
- All colleges of medical and radiology must have MRI machine for well education and researching to investigate new protocols for different diseases same as world.

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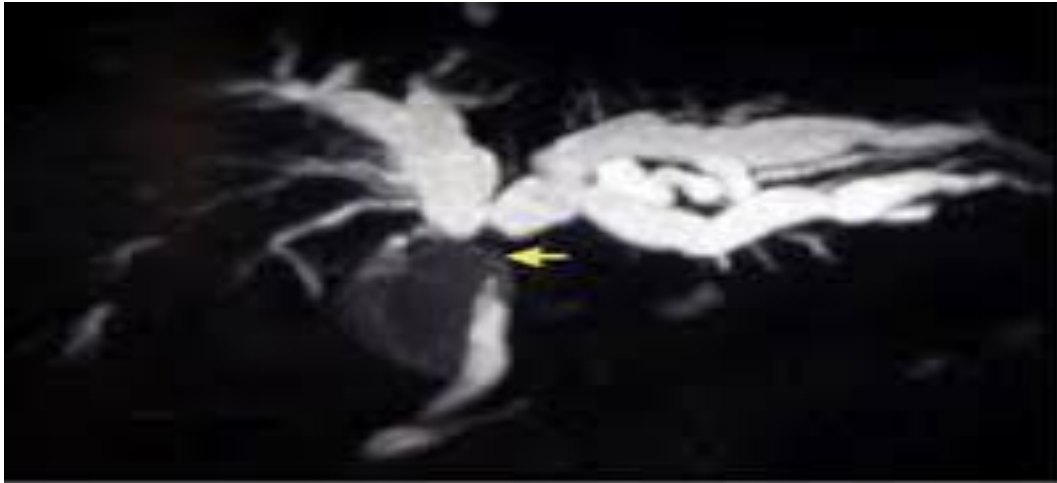
**Appendix (1)**

**Data collection sheet:**

No.	Age	Gender	Weight	MRI finding	US finding	diagnoses
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## Appendix (2)



Shows Hepatic ducts dilation with tumor at the confluence, 64 years' female.



Shows Axial HASTE MRCP image, showing dilated CBD with multiple signal voids within it, suggestive of choledocholithiasis. 70 years male pt. has a severe abdominal pain.



27 years old, female who presents with abdominal pain. MRCP images demonstrate an intrahepatic biliary stone.



72 years old, female with abdominal pain. MRCP showing pancreatic cyst in the head of the organ with dilation of the main and branch pancreatic ducts as well as of the extra- intra hepatic biliary tree.