بسم الله الرحمن الرحيم

Sudan University of Sciences and Technology

Faculty of Graduate Studies

Measurements of Normal Hepatic Veins in Sudanese using Ultrasonography

قياسات الاوردة الكبدية الطبيعية لدى السودانيين باستخدام الموجات فوق الصوتية

A thesis Submitted for Partial Fulfillment for the Requirement of M.Sc. Degree in Medical Diagnostic Ultrasound

by:

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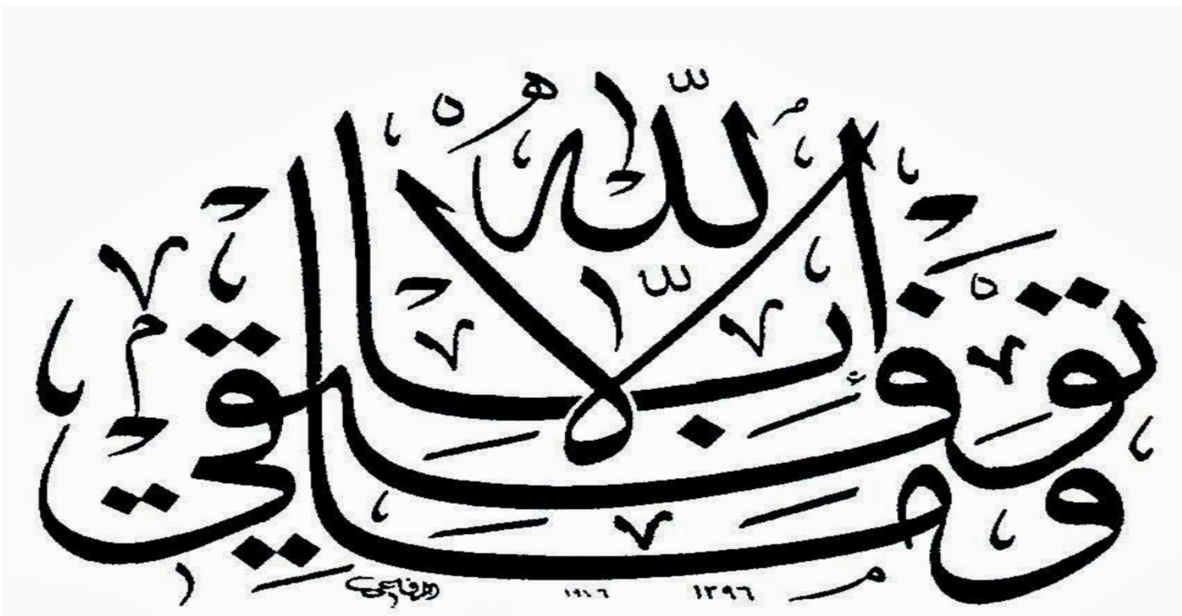
الايه



صدق الله العظيم

سورة هود (88)

Dedication

To my mother ..to my father

To my brothers ..

My husband and my daughter

{Retal}

Acknowledgement

I thank almighty God for giving me the strength, courage and determination in conducting this study, despite all difficulties.

Phrases may not cover what I mean to show, but a word must be penned to those who helped me and guided me through the way and to those who intended to help me accomplish this work ,It’s because of their patience and splendid character I reached this far.

I would like to thank gratefully my supervisor Dr. Ahmed Mostafa Abukonna

Abstract

This descriptive study was conducted to assess the hepatic veins diameter in Sudanese population in Khartoum state . 50 subjects (female 26 and male 24) were enrolled in the study, their age ranged between 18-65 years old. Abdominal ultrasound was performed with real time ultrasound machine using a 3.5 MHz transducer.

The result of the study showed that the overall mean diameter of hepatic veins was [8.60 ± 0.92] mm. with minimum diameter [7mm] and maximum diameter [10mm]. Right hepatic vein (HV) diameter to inferior vena cava (IVC) was [4.72 ± 0.96] mm with minimum diameter [3mm] and maximum diameter [6mm]. Middle hepatic vein proximal (MHVP) to IVC was [8.44 ± 0.86] mm. with minimum diameter [7mm] and maximum diameter was [10mm], Middle hepatic vein distal (MHVD) to IVC was [4.66 ± 0.96]mm with minimum diameter [3mm] and maximum diameter [6mm] and left HVP to IVC was [8.34 ± 0.48] mm. with minimum diameter [7mm] and maximum diameter [10mm], Left HV distal to IVC was [4.74 ± 1.49]mm with minimum diameter [2mm] and maximum diameter [5mm] .

There is a strong correlation between hepatic veins diameter and age and BMI; as age and BMI increases the hepatic veins diameter increase.

Hepatic sonography is frequently unavoidable, particularly in critically ill patients, and the results are essential for defining diagnostic and therapeutic strategies.

The study recommended further studies with larger sample size should be conducted to correlate the hepatic veins diameter with respiratory phases for furtherer evaluations.

ملخص الدراسه

لقد أجريت هذه الدراسة الوصفيه لمعرفة متوسط قطر الأوردة الكبدية لدي السودانيين في ولاية الخرطوم. تم إجراء فحص موجات فوق الصوتية للبطن لعدد خمسين فرد في الفترة من شهرسبتمبر الي نوفمبر للعام 2016 ، تتراوح أعمارهم بين 18-65 عاما.كان عدد النساء 26 والرجال 24.

تم المسح باستخدام جهاز موجات فوق الصوتية (مع خاصية الزمن الحقيقي) المتاح تجاريا باستخدام محول 3.5 ميغاهيرتز.

أظهرت الدراسه ان متوسط قطر الأوردة الكبدية في عدد 50 مريض (الوريد الكبدي اليمين الجزء العلوي من الوريد الاجوف السفلي [8.60 ± 0.92] ملم مع الحد الأدنى 7 ملم والأقصى 10 ملم والجزء البعيد منه [4.72 ± 0.97] ملم مع الحد الأدنى 3 ملم والاقصى 6 ملم) , (الوريد الكبدي الوسط الجزء العلوي من الوريد الاجوف السفلي [8.44 ± 0.86] ملم مع الحد الأدنى 7 ملم والأقصى 10 ملم والجزء البعيد منه [4.66 ± 0.96] ملم مع الحد الأدنى 3 ملم والأقصى 6 ملم و (الوريد الكبدي الايسر الجزء العلوي من الوريد الاجوف السفلي [8.34 ± 0.48] ملم مع الحد الأدنى 7 ملم والأقصى 10 ملم والجزء البعيد منه [4.74 ± 1.49]ملم مع الحد الأدنى2ملم والأقصى 5ملم). وجدت الدراسه بأن هنالك علاقة قوية بين قطر الأوردة الكبدية والعمرو مؤشر كتلة الجسم (علاقة طردية)

فحص الكبد بالموجات فوق الصوتية في كثير من الأحيان لا يمكن تجنبه، وبخاصة في المرضى ذوي الحالات الحرجة، والنتائج هي أساسية في تحديد الاستراتيجيات التشخيصية والعلاجية.

وقد أوصت الدراسة بعمل دراسات أخرى في هذا الاتجاه بزيادة العينات لدراسه واعادة تقييم العلاقة بين قطر أوردة الكبد مع التغيرات التنفسيه.

List of contents

List of figures

List of tables

List of abbreviations

Abbreviation	Full meaning
BMI	Body mass index
CT	Computed tomography
HV	Hepatic vein
IVC	Inferior vena cava
KHz	kilohertz
LT HV P	Left hepatic vein proximal
LT HV D	Left hepatic vein distal
M HV P	Middle hepatic vein proximal
M HV D	Middle hepatic vein distal
MHz	Mega hertz
PW	Pulse waves
RT HV P	Right hepatic vein proximal
RT HV D	Right hepatic vein distal
2D	Two dimensional

Chapter one

Introduction

1.1 Introduction

Liver diseases are most common in the world and one of the important causes of death. Hepatic venous congestion is liver dysfunction, lead to dilatation of hepatic veins, hepatomegaly and fibrosis. (Giallourakis CC, *et al* 2002)

Hepatic venous congestion is a well-studied result of acute or chronic right heart failure, lead to elevated hepatic venous pressure and decrease in hepatic venous flow causes hypoxia in hepatic parenchyma, finally results in diffuse hepatocyte death and diffuse fibrosis.the end of this chain is micronodular cirrhosis, cirrhosis lead to compressed hepatic veins. (Giallourakis CC, *et al* 2002)

Because of many disease affect hepatic vein manifested as dilated or compressed hepatic vein, So by measuring the diameter of the hepatic vein by real time sonography in Sudanese population, can estimate reference value in different age group, gender and BMI.

Several studies have shown the normal diameter of hepatic vein 5.6 to 6.2 mm , mean diameter 8.8 mm in patients with passive congestion and increase up to 13 mm in patients with pericardial effusion and others studies have shown the hepatic veins diameter under 6mm for peripheral hepatic veins, under 10mm before entering the IVC. (Wanless et.al, 1982)

Hepatic veins diameter is important in diagnosis of hepatic venous congestion and cirrhosis. This study was conducted to find out the correlation of hepatic veins diameter in Sudanese population with different age group, gender and BMI.

1.2 Problem of study:

Liver diseases are most common in the world and one of the important causes of death. Some of these diseases affect hepatic vein manifested as dilated (in hepatic venous congestion) or compressed hepatic vein (in cirrhosis). So by measuring the diameter of the hepatic vein by real time sonography in Sudanese population, can estimate reference value in different age group, gender and BMI.

1.3 Objectives of the study:

1.3.1 General objective:

Measurements the diameter of the hepatic vein by real time sonography in Sudanese population.

1.3.2 Specific objective:

- To measure the mean diameter of hepatic vein.
- To estimate reference value of hepatic vein diameter for Sudanese.
- To correlate the mean diameter of hepatic vein with age.
- To correlate the mean hepatic vein diameter with gender.
- To correlate the mean hepatic vein diameter with body mass index.

1.4 Over view of study :

This study consisted of five chapters, with chapter one is an introduction which includes; problem of the study and objectives of study. Chapter two well present comprehensive literature review about different measurement studies, while chapter three is a methodology which include material used to collect the data and method of data acquisition and analysis. Chapter four includes presentation of the result using tables and figures, finally chapter five included discussion, conclusion and recommendations.

Chapter two

Literature review

2.1 Hepatic vein anatomy

The hepatic veins are three large veins which drain the hepatic parenchyma into the IVC, named the right hepatic vein, middle hepatic vein and left hepatic vein . The veins are important landmarks, running in between and hence defining the segments of the liver. There are separate smaller veins draining the caudate lobe of the liver. (http://radiopaedia.org)

2.1.1 Right hepatic vein

The right hepatic vein runs at the right hepatic fissure and drains segments V, VI,VII,VIII. The plane of right hepatic vein separate the segments VI and VII (which are posterior to this plane). (http://radiopaedia.org)

2.1.2 Variants

It is single dominant vein in~ 70% (range 60- 78%) of individuals. There may be early bifurcation, early trifurcation or even multiple right hepatic veins entering IVC. This may make it difficult to deduce segmental anatomy of the liver. (http://radiopaedia.org)

2.1.3 Middle hepatic vein

The middle hepatic vein runs at the middle hepatic fissure and drains segment IV, V and VIII. The plane of middle hepatic vein separates the segments VIII, and V (which are posterolateral to this plane) from segment IV (which is located anteromedial to this plane. (http://radiopaedia.org)

2.1.4 Left hepatic vein

The left hepatic vein runs partially at the fissure for the ligamentum teres and at the left hepatic fissure. It drains segments II, III, and IV. It is always anterior to the portal vein and its plane separate segments II and III. (http://radiopaedia.org)

2.1.5 Caudate lobe veins

The caudate lobe veins (or single vessel) drain directly into the IVC. (http://radiopaedia.org)

2.2 Structure of hepatic vein

The hepatic veins are divided into an upper and lower group. The upper three drain the central veins from the right, middle and left region of the liver and are larger than the lower group of veins.

The lower group of from six to twenty smaller hepatic veins come from right lobe and the caudate lobe, are in contact with hepatic tissue, and are valveless. All the veins empty into the inferior vena cava at the back of the liver. (Albert, *Daniel* 2012)

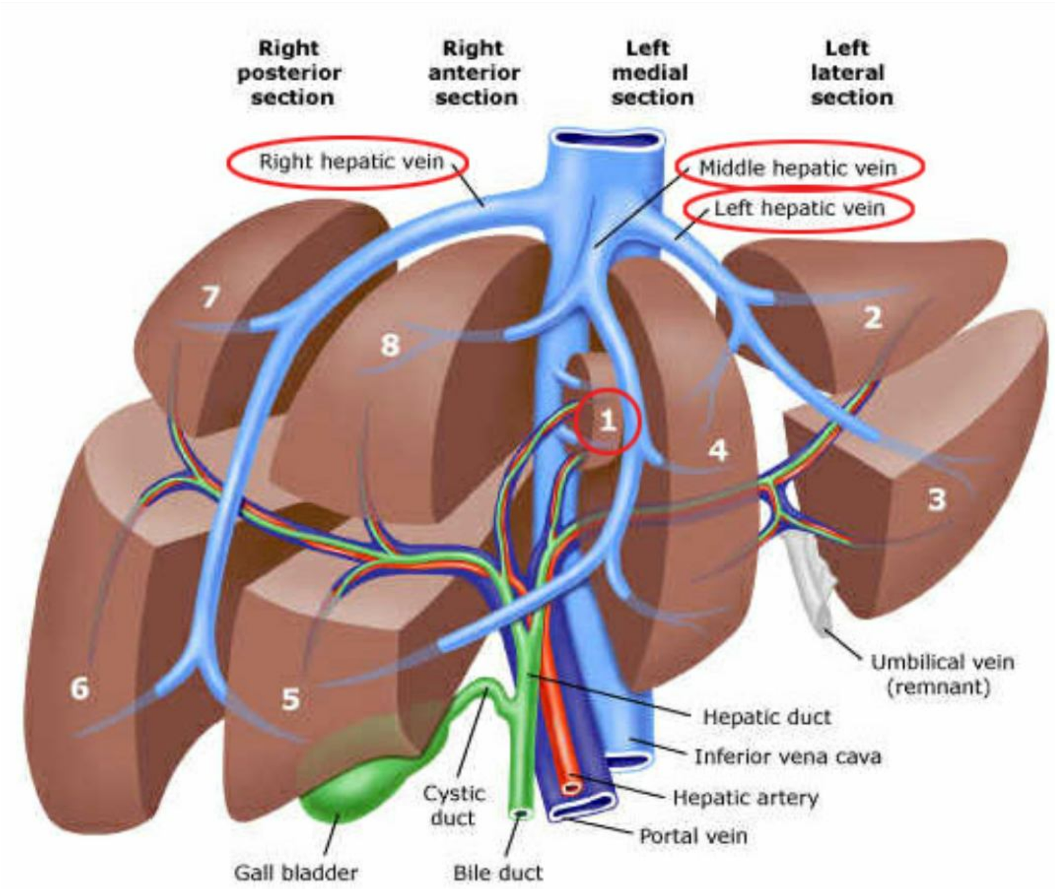


Figure (2.1): The Hepatic veins and its tributaries. (www.google.com)

2.3 Hepatic vein function

The hepatic vein carries oxygen-depleted blood from the liver to the inferior vena cava. They also transport blood that has been drained from the colon, pancreas, small intestine, and the stomach, and cleaned by the liver. (www.healthline.com)

2.4 Hepatic portal system

In human anatomy, the hepatic portal system is the system of veins comprising the hepatic portal vein and its tributaries. It is also called the portal venous system, although it is not the only example of a portal venous system, and splanchnic veins, which is not synonymous with hepatic portal system and is imprecise (as it means visceral veins and not necessarily the veins of the abdominal viscera). (http://cancerweb.ncl.ac.uk)

2.4.1 Function

The portal venous system is responsible for directing blood from parts of the gastrointestinal tract to the liver. Substances absorbed in the small intestine travel first to the liver for processing before continuing to the heart. Not all of the gastrointestinal tract is part of this system. The system extends from about the lower portion of the esophagus to the upper part of the anal canal. It also includes venous drainage from the spleen and pancreas. (http://cancerweb.ncl.ac.uk)

Many drugs that are absorbed through the GI tract are substantially metabolized by the liver before reaching general circulation. This is known as the first pass effect. As a consequence, certain drugs can only be taken via certain routes. For example, nitroglycerin cannot be swallowed because the liver would inactivate the medication, but it can be taken under the tongue or transdermal (through the skin) and thus is absorbed in a way that bypasses the portal venous system. Inversely, dextromethorphan, a cough suppressor, is best taken orally because it needs to be metabolised by the liver into dextrorphan in order to be effective. (http://cancerweb.ncl.ac.uk)

This latter principle is that of most prodrugs. The use of suppositories is a way to by-pass partially the portal vein: the upper 1/3 of the rectum is drained into the portal vein while the lower 2/3 are drained into the internal iliac vein that goes directly in the inferior vena cava (thus by-passing the liver). (http://cancerweb.ncl.ac.uk)

Blood flow to the liver is unique in that it receives both oxygenated and (partially) deoxygenated blood. As a result, the partial gas pressure of oxygen (pO_2) and perfusion pressure of portal blood are lower than in other organs of the body. (http://cancerweb.ncl.ac.uk)

Blood passes from branches of the portal vein through cavities between "plates" of hepatocytes called sinusoids. Blood also flows from branches of the hepatic artery and mixes in the sinusoids to supply the hepatocytes with oxygen. This mixture percolates through the sinusoids and collects in a central vein which drains into the hepatic vein. (http://cancerweb.ncl.ac.uk)

The hepatic vein subsequently drains into the inferior vena cava. The hepatic artery provides 30 to 40% of the oxygen to the liver, while only accounting for 25% of the total liver blood flow. The rest comes from the partially deoxygenated blood from the portal vein. The liver consumes about 20% of the total body oxygen when at rest. That is why the total liver blood flow is quite high, at about 1 liter a minute and up to two liters a minute. That is on average one fourth of the average cardiac output at rest. (http://cancerweb.ncl.ac.uk)

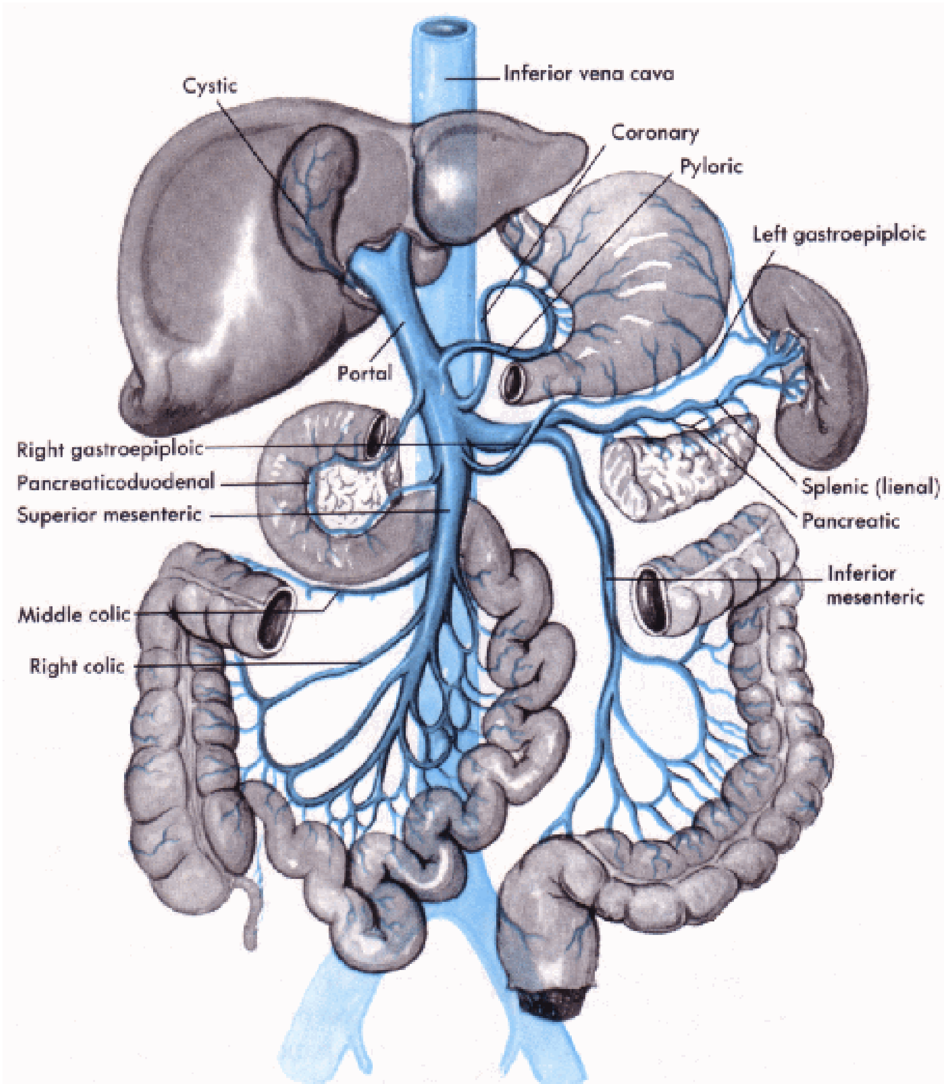


Figure (2.2): The portal vein and its tributaries. (http://www.daviddarling.info)

2.5 Portal vein anatomy

The portal vein or hepatic portal vein is a blood vessel that carries blood from the gastrointestinal tract and spleen to the liver. This blood is rich in nutrients that have been extracted from food, and the liver processes these nutrients; it also filters toxins that may have been ingested with the food. 75% of total liver blood flow is through the portal vein, with the remainder coming from the hepatic artery proper. The blood leaves the liver to the heart in the hepatic veins. (Henry Gray 1901)

The portal vein is not a true vein, because it conducts blood to capillary beds in the liver and not directly to the heart. It is a major component of the hepatic portal system, one of only two portal venous systems in the body – with the hypophyseal portal system being the other. (Henry Gray 1901)

The portal vein is usually formed by the confluence of the superior mesenteric and splenic veins and also receives blood from the inferior mesenteric, gastric, and cystic veins. (Henry Gray 1901)

Conditions involving the portal vein cause considerable illness and death. An important example of such a condition is elevated blood pressure in the portal vein. This condition, called portal hypertension, is a major complication of cirrhosis. (Henry Gray 1901)

2.6 Structure of portal vein

Measuring approximately 8 cm (3 inches) in adults, the portal vein is located in the right upper quadrant of the abdomen, originating behind the neck of the pancreas. (Harold M, et al 2008)

In most individuals, the portal vein is formed by the union of the superior mesenteric vein and the splenic vein. For this reason, the portal vein is occasionally called the splenic-mesenteric confluence. Occasionally, the portal vein also directly communicates with the inferior mesenteric vein, although this is highly variable. Other tributaries of the portal vein include the cystic and gastric veins. (Plinio Rossi, L.Broglia 2000) (Benjamin L, et al 2008)

Immediately before reaching the liver, the portal vein divides into right and left. It ramifies further, forming smaller venous branches and ultimately portal venules.

Each portal venule courses alongside a hepatic arteriole and the two vessels form the vascular components of the portal triad. These vessels ultimately empty into the hepatic sinusoids to supply blood to the liver. (Henry Gray et al 1901)

2.7 Portal vein function

The portal vein and hepatic arteries form the liver's dual blood supply. Approximately 75% of hepatic blood flow is derived from the portal vein, while the remainder is from the hepatic arteries. (Plinio Rossi, L.Broglia 2000)

Unlike most veins, the portal vein does not drain into the heart. Rather, it is part of a portal venous system that delivers venous blood into another capillary system, the hepatic sinusoids of the liver. In carrying venous blood from the gastrointestinal tract to the liver, the portal vein accomplishes two tasks: it supplies the liver with metabolic substrates and it ensures that substances ingested are first processed by the liver before reaching the systemic circulation. (Plinio Rossi, L.Broglia 2000)

This accomplishes two things. First, possible toxins that may be ingested can be detoxified by the hepatocytes before they are released into the systemic circulation. Second, the liver is the first organ to absorb nutrients just taken in by the intestines. After draining into the liver sinusoids, blood from the liver is drained by the hepatic vein. (Plinio Rossi, L.Broglia 2000) .

2.8 Pathology

2.8.1 Passive hepatic congestion

Passive hepatic congestion or congested liver in cardiac disease is stasis of blood in hepatic parenchyma, due to impaired hepatic vein drainage which leads to widening and splaying of central hepatic veins and hepatomegaly. Passive hepatic congestion is a well-studied result of acute or chronic right heart failure, lead to elevated hepatic venous pressure and decrease in hepatic venous flow causes hypoxia in hepatic parenchyma, finally results in diffuse hepatocyte death and diffuse fibrosis.the end of this chain is micronodular cirrhosis, cirrhosis lead to compressed hepatic veins. (www.radiopedia.org)

In ultrasound, early in the course of disease the main abnormality is enlargement of the right hepatic lobe .Normally right hepatic vein measures less than 6 mm and in these patients its mean is about 9mm , appears as dilated hepatic veins. The diameter of hepatic vein increases up to 13mm with pericardial effusion. (www.radiopedia.org)

2.8.2 Cirrhosis

In cirrhosis, increased intrahepatic vascular resistance is thought to be located mainly in the hepatic sinusoids. Recent studies have demonstrated that in addition to the increased resistance caused by the morphologic changes of chronic liver diseases, a dynamic component of increased resistance (resulting from the active contraction of vascular smooth muscle cells, myofibroblasts, and hepatic stellate cells) is also present. In ultrasound, appear as enlarged liver and compressed hepatic veins. (www.radiopedia.org)

2.9 Ultrasound

Ultrasounds are sound waves with frequencies higher than the upper audible limit of human hearing. Ultrasound is no different from 'normal' (audible) sound in its physical properties, except in that humans cannot hear it. This limit varies from person to person and is approximately 20 kilohertz (20,000 hertz) in healthy, young adults. Ultrasound devices operate with frequencies from 20 kHz up to several gigahertz. (Novelline, Robert 1997)

Ultrasound is used in many different fields. Ultrasonic devices are used to detect objects and measure distances. Ultrasound imaging or sonography is often used in medicine. In the nondestructive testing of products and structures, ultrasound is used to detect invisible flaws. Industrially, ultrasound is used for cleaning, mixing, and to accelerate chemical processes. Animals such as bats and porpoises use ultrasound for locating prey and obstacles. (Novelline, Robert 1997)

2.9.1 Modes of sonography

Several modes of ultrasound are used in medical imaging. These are:

A-mode: A-mode (amplitude mode) is the simplest type of ultrasound. A single transducer scans a line through the body with the echoes plotted on screen as a function of depth. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy. (Cobbold, Richard S. C. 2007)

B-mode or 2D mode: In B-mode (brightness mode) ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen. More commonly known as 2D mode now. (Cobbold, Richard S. C. 2007)

C-mode: A C-mode image is formed in a plane normal to a B-mode image. A gate that selects data from a specific depth from an A-mode line is used; then the transducer is moved in the 2D plane to sample the entire region at this fixed depth. When the transducer traverses the area in a spiral, an area of 100 cm2 can be scanned in around 10 seconds. (Cobbold, Richard S. C. 2007)

M-mode: In M-mode (motion mode) ultrasound, pulses are emitted in quick succession – each time, either an A-mode or B-mode image is taken. Over time, this is analogous to recording a video in ultrasound. As the organ boundaries that produce reflections move relative to the probe, this can be used to determine the velocity of specific organ structures. (Cobbold, Richard S. C. 2007)

Doppler mode: This mode makes use of the Doppler Effect in measuring and visualizing blood flow

Color Doppler: Velocity information is presented as a color-coded overlay on top of a B-mode image

Continuous Doppler: Doppler information is sampled along a line through the body, and all velocities detected at each time point are presented (on a time line)

Pulsed wave (PW) Doppler: Doppler information is sampled from only a small sample volume (defined in 2D image), and presented on a timeline

Duplex is a common name for the simultaneous presentation of 2D and (usually) PW Doppler information. (Using modern ultrasound machines, color Doppler is almost always also used; hence the alternative name Triplex. (Cobbold, Richard S. C. 2007)

2.9.2 Abdominal ultrasonography

Abdominal ultrasonography (also called abdominal ultrasound imaging or abdominal sonography) is a form of medical ultrasonography (medical application of ultrasound technology) to visualise abdominal anatomical structures. (Bisset 2008)

It uses transmission and reflection of ultrasound waves to visualise internal organs through the abdominal wall (with the help of gel which helps transmission of the sound waves). For this reason, the procedure is also called a transabdominal ultrasound, in contrast with endoscopic ultrasound, the latter combining ultrasound with endoscopy through visualize internal structures from within hollow organs. (Bisset 2008)

Abdominal ultrasound examinations are performed by gastroenterologists or certain other specialists in internal medicine, radiologists or sonographers trained for this procedure. (Bisset 2008)

2.10 Hepatic veins

The diameter of hepatic veins , under 6mm for peripheral hepatic veins, under 10mm before entering the inferior vena cava. (http://www.stefajir.cz)

On sonogram, hepatic veins appear anechoic tubular structures coursing toward the inferior vena cava caliber increases closer to IVC and smooth wall margins. On Doppler appear multiphasic hepatofugal blood flow pattern.(Susanna Ovel 2014)

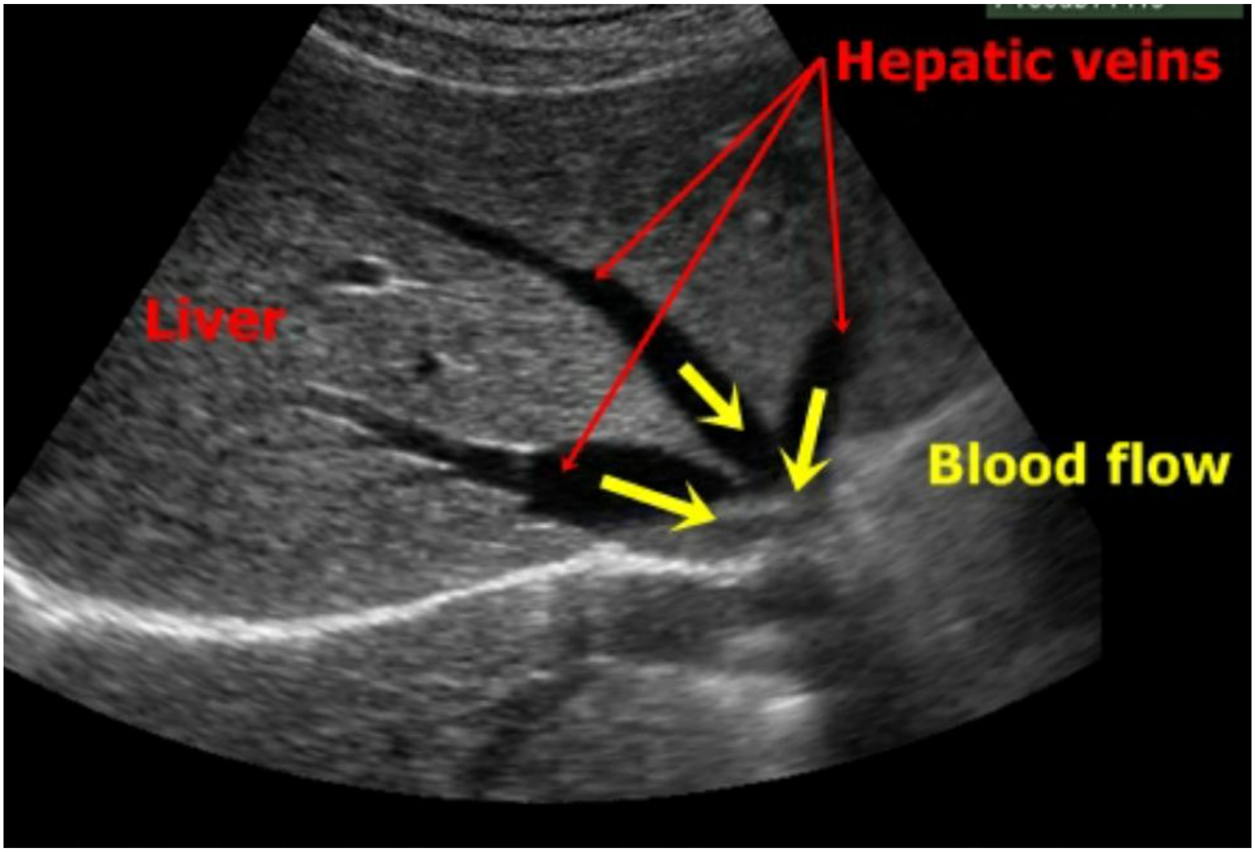


Figure (2.3):Hepatic veins entering the liver.{http://www.stefajir.cz}

2.10.1 Hepatic veins diameter measurement

The hepatic veins drainage the blood from the liver into IVC, can be visualized using transverse, subcostal approach by place the probe just below the level of the xiphoid with steep angulation toward the diaghragm. (Sandra L, 2011)

In normal individuals, the hepatic vein diameter 5.6 to 6.2 mm in quiet respiration.

Respiration and patient position greatly affect the size of the hepatic veins therefore, diagnostic measurements must be standardized by examining the patient in the supine position and in a state of quiet respiration. (Sandra L, 2011)

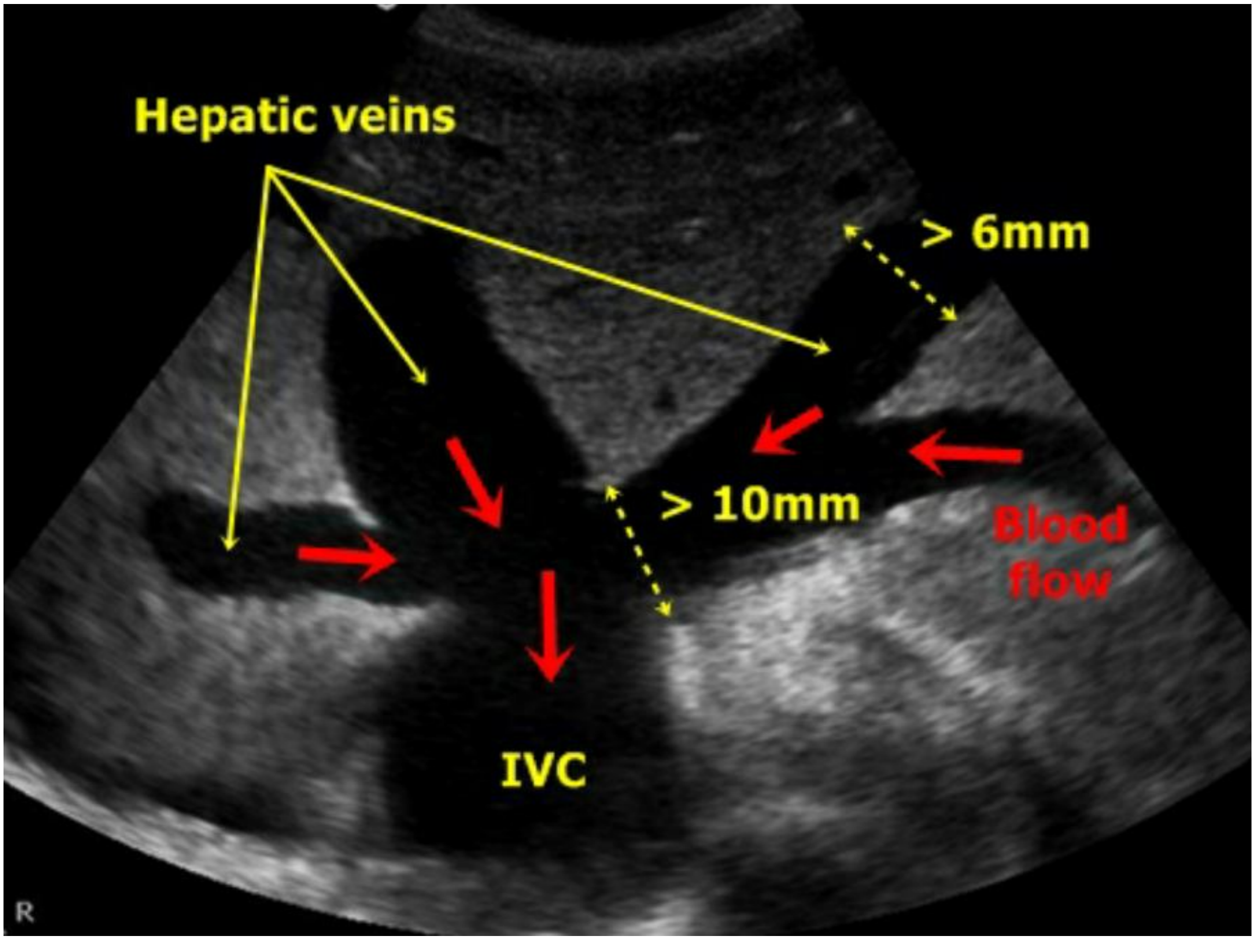


Figure (2.4): Dilated hepatic veins –Peripheral veins are border than 6mm, veins near influx into IVC are wider than 10mm.the measurement at the peripheral and the influx into IVC. .{http://www.stefajir.cz}

2.10.2 Hepatic veins Doppler

The normal hepatic vein waveform, despite commonly being described as triphasic, has four components: a retrograde A wave, an antegrade S wave, a transitional V wave (which may be antegrade, retrograde, or neutral), and an antegrade D wave. These waves are created by the blood flow through the hepatic veins related to the cardiac cycle. (http://www.rsna.org)

The A wave corresponds to atrial contraction. With the tricuspid valve open, blood is propelled in two directions: antegrade toward the right ventricle and retrograde toward the IVC and into the hepatic veins. At the end of atrial systole, peak retrograde velocity away from the heart is achieved. As ventricular systole commences, the tricuspid valve closes and the retrograde velocity toward the hepatic veins begins to decrease and approach the baseline. There is conflicting literature as to whether a normal hepatic vein Awave must be retrograde with the spectral tracing peaking above the baseline. Bolondi et al reported that the A wave must be retrograde in normal patients, whereas Pedersen et al showed that an A wave that remains below the baseline may also be found in normal people. During ventricular systole, not only do the ventricular walls contract to propel blood into the right ventricular outflow tract, but there is also movement of the tricuspid valve annulus toward the cardiac apex. These actions create arelative negative pressure in the atrium, causing antegrade blood flow out of the liver and into the heart during the S wave. In the normal heart, the largest amount of antegrade blood flow is during this phase . The V wave corresponds to atrial overfilling. As the ventricular contraction becomes less intense and the closed tricuspid valve begins to return to its original position, the atrium fills and blood flow velocity toward the heart decreases. The peak of the V wave may be below, at, or above the baseline, depending on whether there is antegrade flow throughout, transient equilibrium with no flow, or transient retrograde flow, respectively. Note that the term triphasic does not include the V wave, perhaps because this wave represents only a transitional phase. (http://www.rsna.org)

The D wave begins as the tricuspid valve opens. During cardiac diastole, the right atrium and ventricle fill passively, with antegrade flow of blood from the liver into the heart. In the normal patient, the velocity of this passive flow is almost always lower in magnitude than the velocity during the S wave. A normal variant, termed the C wave, can cause a small retrograde spike following the A wave. As atrial systole ends and ventricular systole commences, the tricuspid valve closes. The tricuspid annulus begins to move toward the cardiac apex and the retrograde velocity of flow toward the liver begins to decrease. (http://www.rsna.org)

Abnormal (pathologic) wave form manifested as dampened wave form,Dampening is indicative of relative venous outflow obstruction, which may be due to fatty infiltration of the liver , cirrhosis , or metastatic infiltration. (http://www.rsna.org)

2.11 Previous study

Dr Henry knipe and Dr Bruno Di Muzio et al, were found the normal diameter of hepatic vein 5.6 to 6.2 mm, mean diameter 8.8 mm in patients with passive congestion and increase up to 13 mm in patients with pericardial effusion.

Other study shows the hepatic veins diameter less than 6mm for peripheral hepatic veins, under 10mm before entering the IVC. Considered dilated hepatic veins when peripheral HVs are broader than 6mm, wider than 10mm near influx into IVC. (Wanless et.al, 1982)

Chapter three

Materials and Methods

3.1 Materials

3.1.1 Subjects:

This is a descriptive and analytical study conducted in Khartoum state. 50 subjects (female 26 and male 24) were enrolled in the study, their age ranged between 18-65 years old. Or normal individuals aged between 18-65 years old. Patient with biliary, liver, vascular and cardiac diseases as well as Hypertensive and diabetic subjects were excluded.

3.1.2 Machines used

The study was conducted in Khartoum state, including the following hospitals:

1. Alakadimy teaching hospital. Toshiba xario 100 (USA 2011).
2. Rebat hospital.Simense
3. Turkey hospital. . Mindary DP 10
4. Balsam medical center. Mindary DP 10

All machines used with 3.5 MHz curvilinear transducer.

3.2 Methods

3.2.1 Technique used:

Ultrasound was performed with commercially available real time machine using a 3.5 MHz transducer. The hepatic veins were scanned in transverse, subcostal approach by place the probe just below the level of the xiphoid with steep angulation toward the diaghragm. The patients were scanned in the supine position and in a state of quiet respiration.

3.2.2 Data collection & Analysis:

Data were collected randomly using data collection sheet and statistical analysis was performed Statistical Package for Social Sciences (SPSS), where mean, minimum and maximum value was obtained, student t-test and correlation were also performed.

3.2.3 Ethical Consideration

Informed consent obtained by patients for purpose of research and chief of radiology department for each hospital.

Chapter four

Results

Table 4.1 show statistical parameters for all patients

	Min	*Max*	*Mean*	*SD*
Age	18	65	38.84	14.39
Weight	48	85	70.24	9.29
Height	150	181	168.02	6.89
BMI	19.2	28.4	24.78	2.12
IVC diameter	16	19	17.58	0.95
Liver diameter	10	15	13.46	1.11
R HV diameter P	7	10	8.60	0.926
R HV diameter D	3	6	4.72	0.970
M HV diameter P	7	10	8.44	0.861
M HV diameter D	3	6	4.66	0.961
L HV diameter P	7	10	8.34	0.484
L HV diameter D	2	5	4.74	1.49

Table (4.2): Show frequency of male and female

Gender	**frequency**
Male	24
Female	26
Total	50

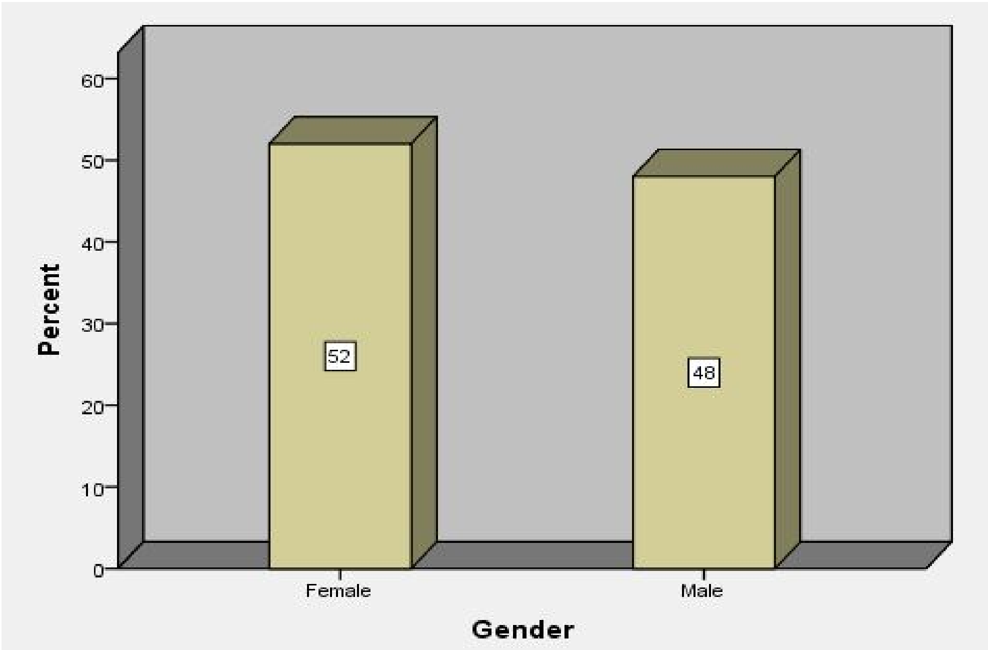


Figure (4.1): Show distribution of males and females

Table (4.3): Show statistical information for males

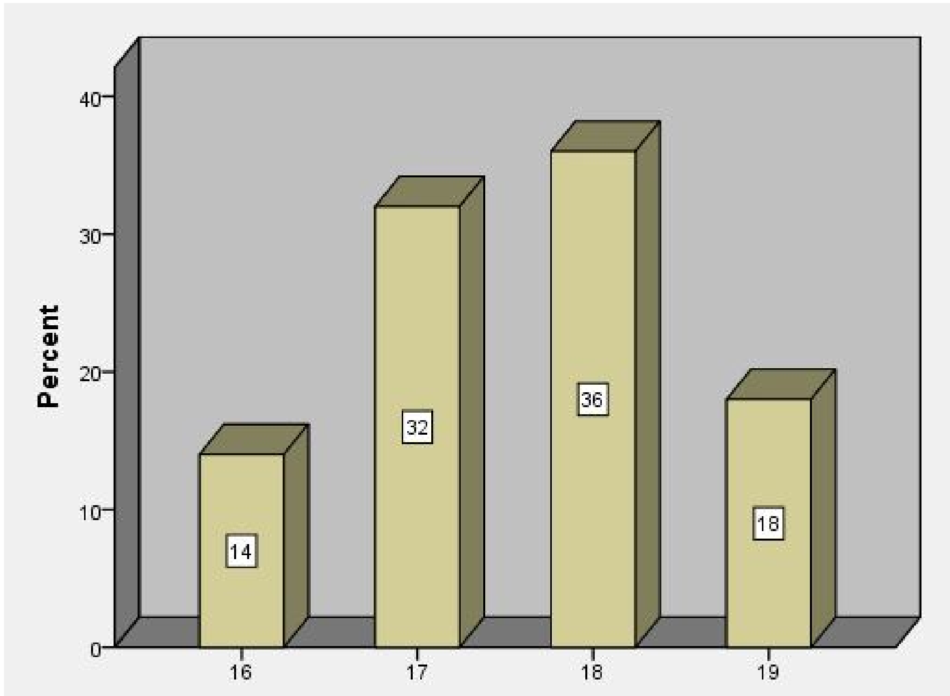
	Min	*Max*	*Mean*	*SD*
Age	18	65	39.46	15.45
Weight	55	83	71.21	8.03
High	153	181	170.17	7.02
BMI	21.1	27.7	24.53	1.69
IVC diameter	16	19	17.15	0.944
Liver diameter	11	15	13.63	1.13
R HV diameter P	7	10	8.75	0.926
R HV diameter D	3	6	4.88	0.94
M HV diameter P	7	10	8.63	0.92
M HV diameter D	3	6	4.83	0.963
L HV diameter P	7	10	8.5	0.88
L HV diameter D	3	6	4.92	1.47

Table (4.4): statistical information for females

	Min	*Max*	*Mean*	*SD*
Age	18	62	38.27	13.61
Weight	48	85	69.35	10.39
High	150	175	166.04	6.26
BMI	19.2	28.4	25.02	2.46
IVC diameter	16	19	17.42	0.945
Liver diameter	10	15	13.31	1.08
R HV diameter P	7	10	8.46	0.905
R HV diameter D	3	6	4.58	0.987
M HV diameter P	7	10	8.27	0.778
M HV diameter D	3	6	4.5	0.949
L HV diameter P	7	10	8.19	0.801
L HV diameter D	2	5	4.58	1.52

Table (4.5): Show frequency of age groups

Age group(yrs)	**Frequency**
18-25	12
26-33	8
34-41	10
42-49	7
50-57	6
58-65	7
Total	50



IVC diameter

Figure (4.2): Show distribution of IVC diameter for all pt.

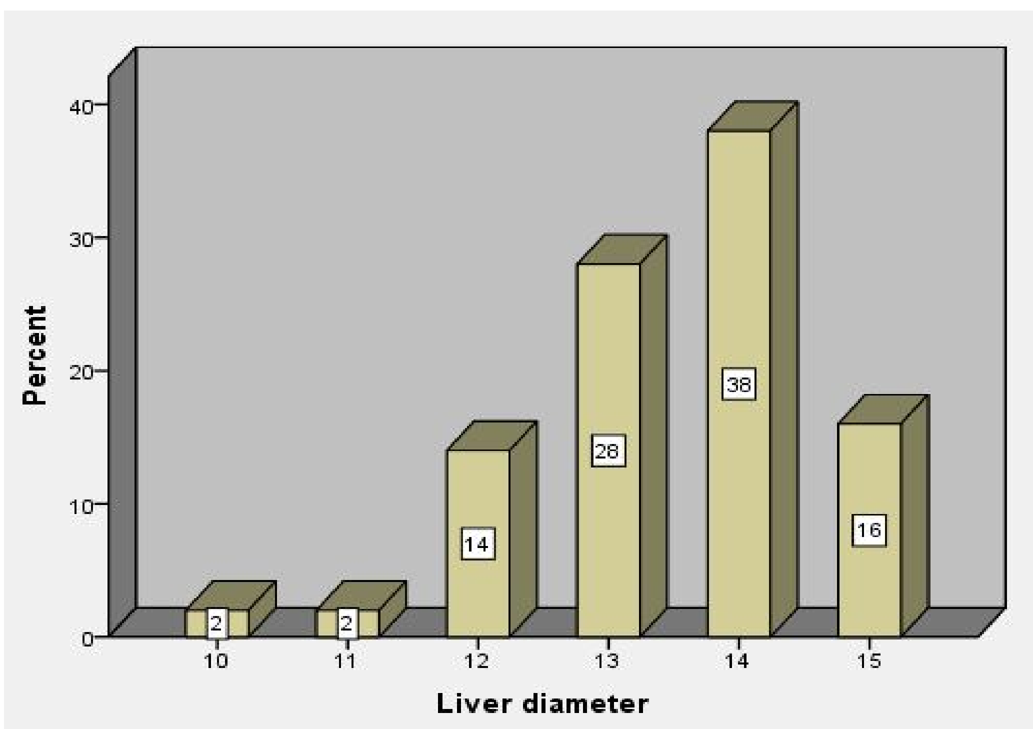
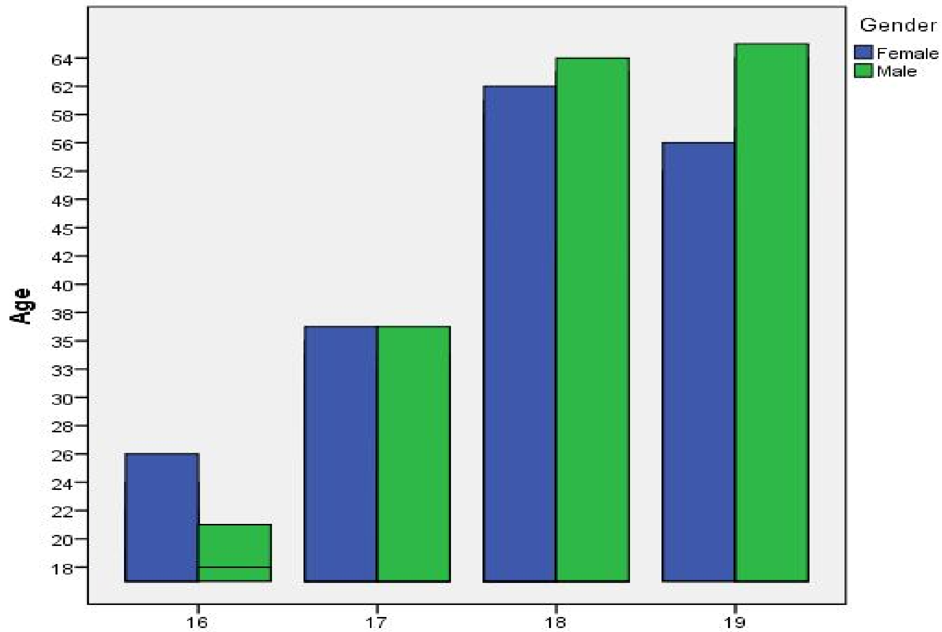


Figure (4.3): Show distribution of liver diameter for all pt.



IVC diameter

Figure (4.4): Show mean of IVC diameter for all age groups

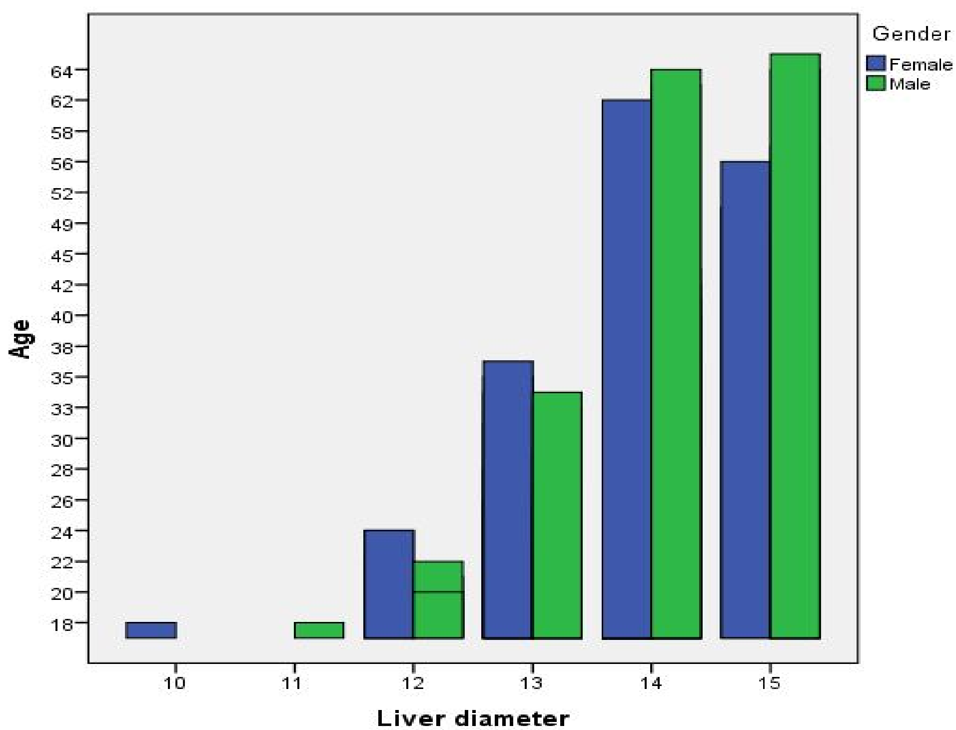


Figure (4.5): Show mean of Liver diameter for all age groups.

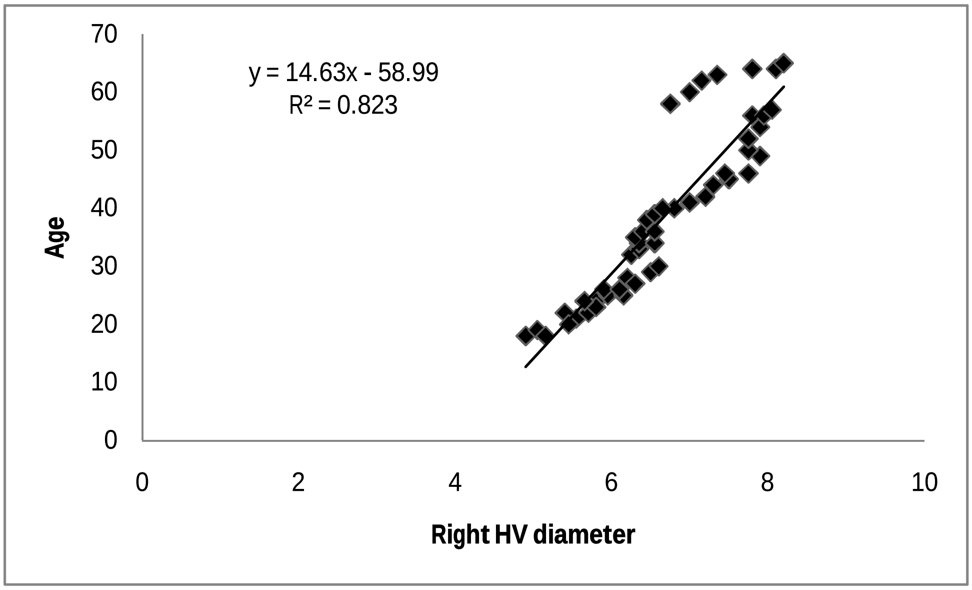


Figure (4.6): Show correlation between age and RT HV diameter.

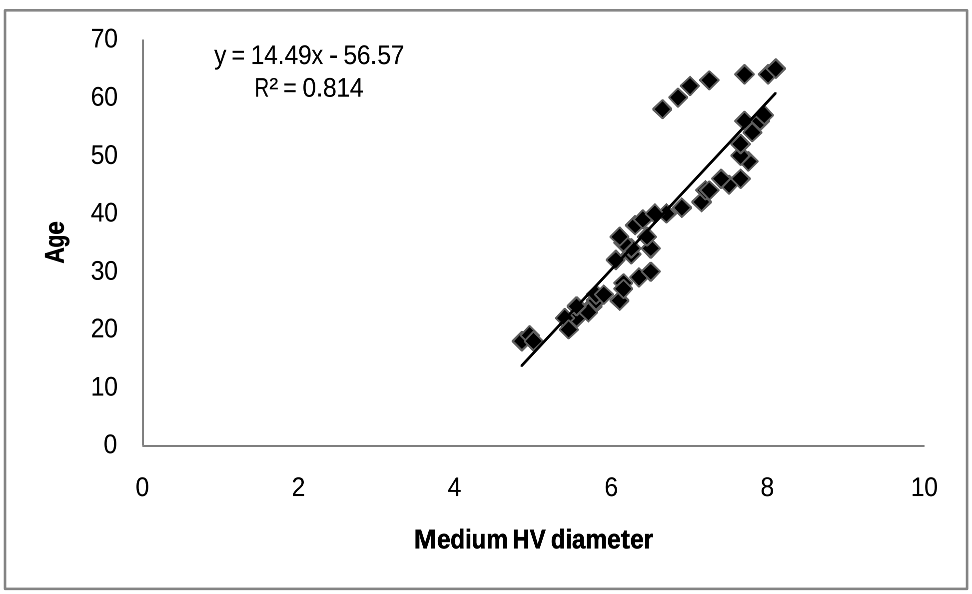


Figure (4.7): Show correlation between age and M HV diameter.

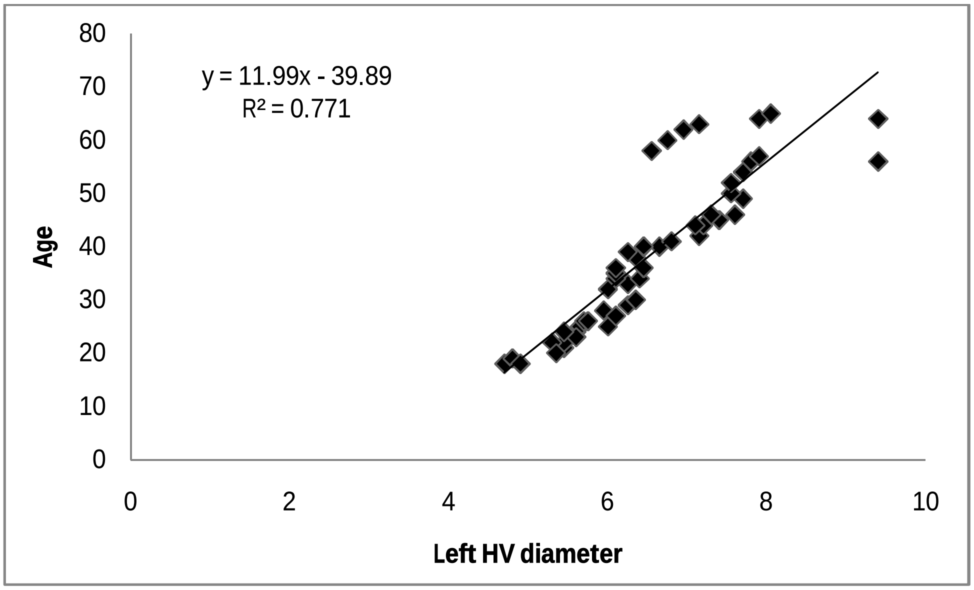


Figure (4.8): Show correlation between age and LT HV diameter.

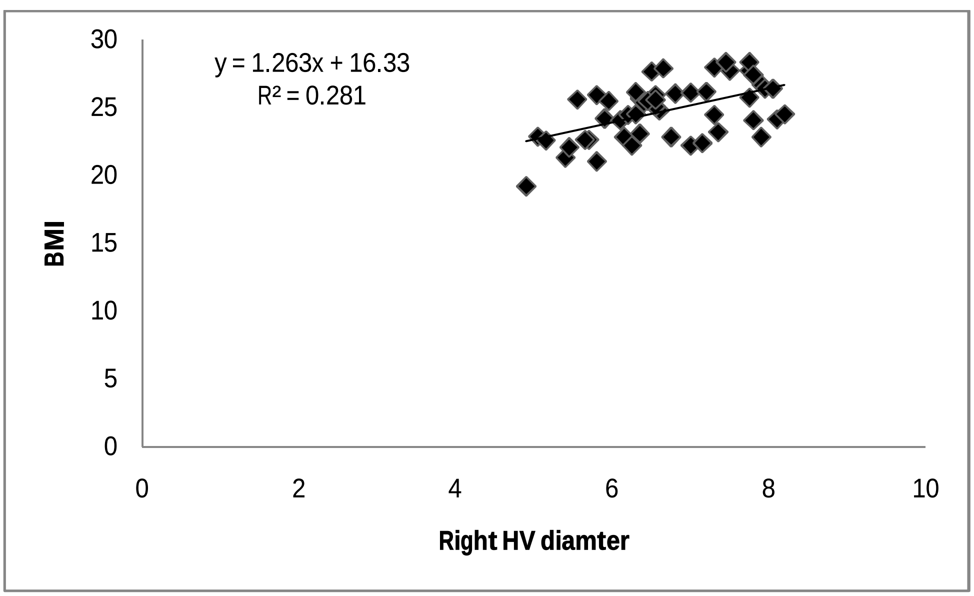


Figure (4.9): Show correlation between BMI and RT HV diameter.

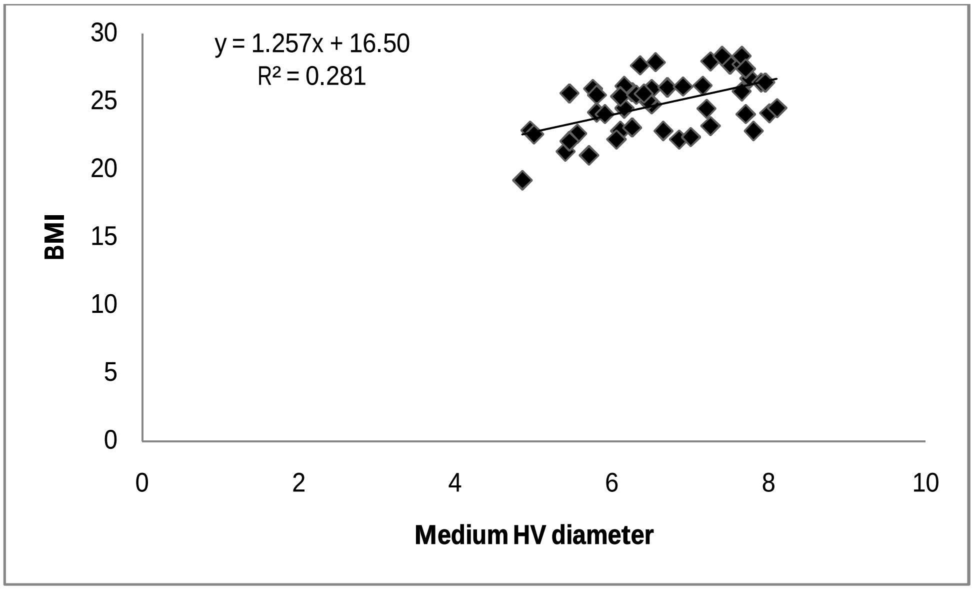


Figure (4.10): Show correlation between BMI and M HV diameter.

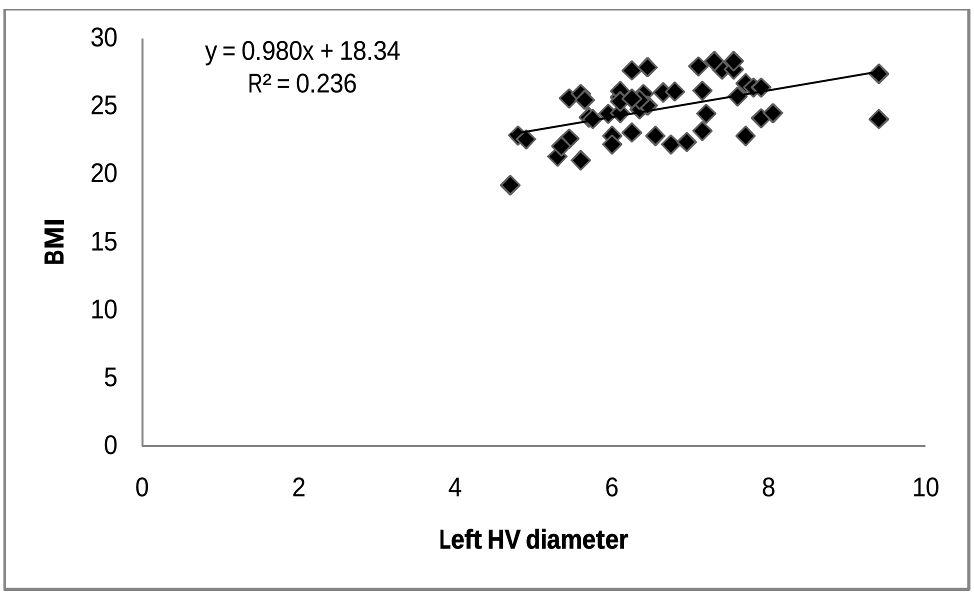


Figure (4.11): Show correlation between BMI and LT HV diameter.

Chapter Five

Discussion, Conclusion and Recommendation

5.1 Discussion

The overall mean diameter of hepatic veins in 50subjects was (RT HVP [8.60 ± 0.92] mm. with minimum diameter [7mm] and maximum diameter [10mm], RT HV D [4.72 ± 0.96]mm with minimum diameter [3mm] and maximum diameter [6mm], MHVP [8.44 ± 0.86] mm. with minimum diameter [7mm] and maximum diameter [10mm], MHV D [4.66 ± 0.96]mm with minimum diameter [3mm] and maximum diameter [6mm] and LT HV P [8.34 ± 0.48] mm. with minimum diameter [7mm] and maximum diameter [10mm], LT HV D [4.74 ± 1.49]mm with minimum diameter [2mm] and maximum diameter [5mm]).

From these results there is a strong correlation between hepatic veins diameter and age, BMI, as age and BMI increases the hepatic veins diameter increase.

The mean hepatic veins diameter for male was (RT HV P [8.75 ± 0.92] mm. with minimum diameter [7mm] and maximum diameter [10mm], RT HV D [4.88 ± 0.94]mm with minimum diameter [3mm] and maximum diameter [6mm], M HV P [8.63 ± 0.92] mm. with minimum diameter [7mm] and maximum diameter [10mm], MHV D [4.83 ± 0.96]mm with minimum diameter [3mm] and maximum diameter [6mm] and LT HV P [8.5 ± 0.88] mm. with minimum diameter [7mm] and maximum diameter [10mm], LT HV D [4.92 ± 1.47]mm with minimum diameter [3mm] and maximum diameter [6mm]).

The mean hepatic veins diameter for female was (RT HVP [8.46 ± 0.90] mm. with minimum diameter [7mm] and maximum diameter [10mm], RT HV D [4.58 ± 0.98]mm with minimum diameter [3mm] and maximum diameter [6mm], M HV P

[8.27 ± 0.77] mm. with minimum diameter [7mm] and maximum diameter [10mm], MHV D [4.5 ± 0.94]mm with minimum diameter [3mm] and maximum diameter [6mm] and LT HV P [8.19 ± 0.8] mm. with minimum diameter [7mm] and maximum diameter [10mm], LT HV D [4.58 ± 1.52]mm with minimum diameter [2mm] and maximum diameter [5mm]). From these results the mean diameter of hepatic veins for males is slightly higher than mean diameter of female hepatic veins.

This study was quite similar to study of ***Wanless ,et al*** in sample size and results.

They were found the hepatic veins diameter less than 6mm for peripheral hepatic veins, under 10mm before entering the IVC. Considered dilated hepatic veins when peripheral HVs are broader than 6mm, wider than 10mm near influx into IVC.

Another study done by ***Henry et.al*** who found that the normal diameter of hepatic vein 5.6 to 6.2 mm , mean diameter 8.8 mm in patients with passive congestion and increase up to 13 mm in patients with pericardial effusion. Actually it differ because we measure at peripheral and proximal hepatic veins but in this previous study measure only at the center.

5.2 Conclusion

This study was conducted to find out the mean hepatic veins in Sudanese population.

The overall mean diameter of hepatic veins in 50pt was (RT HV P [8.60 ± 0.92] mm. with minimum diameter [7mm] and maximum diameter [10mm], RT HV D [4.72 ± 0.96]mm with minimum diameter [3mm] and maximum diameter [6mm], M HV P [8.44 ± 0.86] mm. with minimum diameter [7mm] and maximum diameter [10mm], MHV D [4.66 ± 0.96]mm. with minimum diameter [3mm] and maximum diameter [6mm] and LT HV P [8.34 ± 0.48] mm. with minimum diameter [7mm] and maximum diameter [10mm], LT HV D [4.74 ± 1.49]mm with minimum diameter [2mm] and maximum diameter [5mm]).

There is a strong correlation between hepatic veins diameter and age, BMI, as age and BMI increases the hepatic veins diameter increase.

Also from results was found the mean diameter of hepatic veins for males is slightly higher than mean diameter of hepatic veins of female.

5.3 Recommendations

- The best technique to measure the hepatic veins diameter by ultrasonography when is scanned in transverse, subcostal approach by place the probe just below the level of the xiphoid with steep angulation toward the diaphragm.
- The patients must scan in the supine position and in a state of quiet respiration.
- The age, gender and BMI are important parameters that affect the diameter of hepatic veins.
- Further studies with larger sample size should be conducted to correlate the portal vein diameter with respiratory phases for furtherer evaluations.

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Appendix

- **Data collection:**

Data sheet

# of Case	Age	Gender	Weight	Height	IVC diameter (mm)	Liver Diameter (cm)	Right HV Diameter (mm)		Middle HV diameter (mm)		Left HV Diameter (mm)	
							P	D	P	D	P	D

Transverse ultrasound image of hepatic vein confluence shows the left (L), middle (M), and right (R) hepatic veins as they join the inferior vena cava (IVC).

Transverse view of Rt lobe of liver show right hepatic vein (rhv) and middle hepatic vein (mhv) with diaphragm