CHAPTER ONE
INTRODUCTION

1-1 Introduction:

In the past, clinical liver measurements remained the simplest and most applicable in the developing countries, however this clinical measurement by percussion and palpation can be inaccurate, unreliable with significant inter observer variation. Also, palpability below right costal margin is not a good index of hepatic size especially when there is upward enlargement or downward displacement of the liver.

Ultrasound is the first line investigation for enormous variety of abdominal symptoms because of its non-invasive and comparatively accessible nature. It is depending upon numerous factors, the most important of which is the skill of the operator and machine facility (resolution, contrast, sensitivity, etc.).

1-2 Problem of the Study:

The measurements of the liver are different from one to other symmetrical in all body habits, in Sudan the upper limit of measurement of liver span is 16 cm, that is confuse diagnosis of hepatomegaly in patient whose normal liver span is 14cm, because liver enlargement not exceed than 1 cm, it become 15 cm and according to standard it is normal.

1-3Objectives of the Study:

1-3-1 General Objective:

The study aims to assess the normal measurement of liver span in adult Sudanese population.

1-3-2 Specific Objectives:

To obtain body characteristics including age, gender, height, weight and residence.

To measure normal liver span.

To correlate normal liver span measurement with body characteristics.

1-4 Important of the Study:

The liver is normally variable in size (mainly the left lobe) according to age, sex, height, weight and residence that would confuse the diagnosis of pathology if we don't know the normal liver size of the patient.

1-5 Overview of the Study:

This study falls in to five chapters, chapter one is an introduction which include problem of the study, objectives of the study and overview of the study, while chapter two includes literature review and previous study, chapter three deals with material used to collect the data and the method of data collection and analysis, chapter four presented the result of the study and finally chapter five includes discussion of the result, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2-1 Liver Anatomy:

The liver is the largest organ in abdomen (weight is about 1500 grams). located intraperitoneal in the right upper quadrant of the abdomen and bounded superiorly by the diaphragm, the posterior surface of right lobe of liver is indented by the right kidney, IVC and hepatic flexure of colon also adjacent to right lobe, the left lobe is highly variable in size and shape at time extend to left upper quadrant while in other barely extend to midline.(Adam, 2009).

Occasionally the right lobe of the liver may be congenitally absent. The left lobe may be small and thin, particularly in older patients. Rare congenital absence of the left lobe inferior margin of left lobe lies close to the stomach pancreas and splenic vessels. The size and shape are highly variable.

2-1-1 Liver Segments:

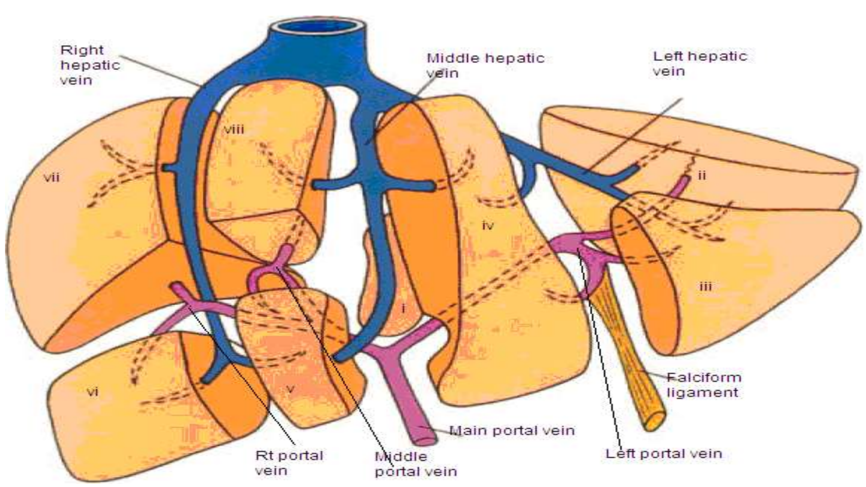

Figure (1) Liver segments, portal and hepatic veins copied from Abdominal US book.

The segmental anatomy system, proposed by Couinaud in 1954, divides the liver into eight segments, numbered in a clockwise direction. They are divided by the portal and hepatic veins and the system are used by surgeons today when planning surgical procedures. This system is also used when localizing lesions with CT and MRI.(Bates et al, 2004).

Identifying the different segments on ultrasound requires the operator to form a mental three dimensional image of the liver. The dynamic nature of ultrasound, together with the variation in alones of scan makes this more difficult to do than for CT or MRI.(Bates et al, 2004).

2-1-2 Traditional Segment Anatomy of the Liver:

Liver divided into three lobes:

1. The right lobe which is divided into anterior and posterior segments.
2. The left lobe which has medial and lateral segments.
3. The caudate lobe is considered separately, since it receives portal venous and hepatic artery blood from both the right and left systems.

2-1-3 Liver Ligaments:

Ligaments attach the liver to the diaphragm, stomach, anterior abdominal wall and retro peritoneum. Liver ligaments consist of:

Falciform ligament: parietal peritoneal, anterior posterior fold that attaches the pare area of the liver to the right recto muscle of the anterior abdominal wall .it extends from the diaphragm to the umbilicus, running to the liver's anterior surface it continuous with the ligamentum teres, which is anatomical divider of the right and left lobe of liver.(Gilani,2005).

Ligamentum teres: fibrous, round ligament formed by obliterated left umbilical vein, arises from umbilicus and courses within the falciform ligament to the umbilical notch on the anterior surface of the liver caursing along the inferior surface it continuous as the ligamentum venosum (obliterated ductus venosus) running posterior to the inferior vena cava.

Coronary ligament: parietal peritoneal, bifold layer that attaches the liver's posterior surface to the diaphragm, anterior and posterior layer are continuous anteriorly with the falciform ligament and laterally with the triangular ligament.

Right and left triangular ligament: formed by continuous of the coronary ligament, triangular extensions from the far right border of the bare area of the diaphragm and superior surface of left lobe to just anterior of the esophageal opening in the diaphragm.

Gastrohepatic ligament: visceral peritoneal bifold layer also known as lesser omentum, from the undersurface of the liver it continuous with ligamentumvenosum. Ascending it attaches the undersurface of the liver with lesser curvature of the stomach and the first portion of the duodenum.

Hepatoduodinalligament: portion of the lesser omentum that is located on the right free edge of the gastrohepaticligament, extend to the duodenum and right hepatic flexure and forms the ventral portion of the foramen of winslow or the epiploic foramen surround the portal tried immediately adjacent to the portahepatis. (Gilani, 2005).

2-1-4 Main Hepatic Fissures:

-The main lobar fissure divides the liver into right and left lobes,it is found in line joining gallbladder fossa with the inferior vena cava. Both these structures are easily seen on ultrasonogram .one portion of the main lobar fissure is visible between the gallbladder neck and the origin of the right portal vein or terminus of the main portal vein. The middle hepatic vein courses in the cephalic portion of the main lobar fissure.

On transverse scans it well be apparent that the main lobar fissure separates specially the medial segment of the left lobe from the anterior segment of the right lobe.

The right intersegmental fissure divides the anterior and posterior segments of the right lobe. The anterior and posterior divisions of the right portal vein course centrally within these segments. Along branch of the right hepatic vein, which is commonly observed on both transverse and longitudinal sonograms, courses within the right segmental fissure.

The left intersegmental fissure divides the left lobe into medial and lateral segments. It can be considered as having cranial, middle and caudal thirds, the left hepatic vein courses within the cranial aspect of the left intersegmental fissure, dividing the cephalic portions of the medial and lateral segments of the left hepatic lobe.

The fissure of the ligamentumvenosum contains the gastrohepatic ligament and separates the left lobe and caudate lobe.

The ligamentumtereshepatis or round ligament of the liver divides the caudal portions of the medial and lateral left hepatic segments , It run in the inferior or free edge of the falciform ligament ,and is frequently noted on scanning the round ligament is obliterated left umbilical vein and is seen on transverse scans as around structure generating high amplitude echoes and often an acoustic shadowing , The round ligament can be reliably distinguished from tumor because it is linear shape in the longitudinal plane .

2-1-5 Hepatic Vasculature:

The portal veins originate from portahepatis, where the main portal vein (MPV) enters the liver. They are encased by hyperechoic, fibrous walls of the portal tracts, which make them, stand out from the rest of the parenchyma. Also contained in the portal tracts are the branch of hepatic artery and biliary duct radical. These latter vessels are too small to detect by ultrasound in the peripheral parts of the liver, but can readily be demonstrated in the larger, proximal branches.

At the porta, the hepatic artery generally crosses the anterior aspect of the portal vein, with the common duct anterior to this .in the common variation the artery lies anteriorly to the duct. Peripherally, the relationship between the vessels in the portal tracts is variable.

The three main hepatic veins, right middle and left, can be traced into inferior vena cava (IVC) at the superior margin of the liver, their course runs,therefore, approximately perpendicular to the portal vessels, so a section of liver with a longitudinal image of a hepatic vein is likely to contain a transverse section through a portal vein and vice versa.Unlike the portal tracts, the hepatic veins do not have a fibrous sheath and their walls therefore less reflective. Maximum reflectivity of the vessel walls occurs with the beam perpendicular.

The anatomy of the hepatic venous confluence varies. in most cases the single, main right hepatic vein (RHV) flows directly into IVC, and the middle and left have a common trunk. In 15%- 35% of patients the left hepatic vein and middle hepatic vein are separate. This usually has no significance to the operator, however, it may be significant factor in planning and performing hepatic surgery, especially tumor resection, as the surgeon attempts to retain as much viable hepatic tissue as possible with intact venous outflow.(Bates, et al 2004).

2-2 Liver Physiology:

The liver performs numerous functions; includes:

2-2-1 Production of Bile:

Bile is a fluid that contains bile salts, cholesterol and small amounts of bilirubin (a waste product from destruction of red blood cells (RBCs). Mature RBCs have a 120 days' life span. Old RBCs are engulfed by phagocytes in the spleen and liver, the iron is the hemeis stored in the liver. The globin is broken down into amino acids and reused and the pigment part of heme (which is the waste product bilirubin) well be excreted by the liver as part of the bile.

Bile makes the duodenal contents alkaline so that the pancreatic enzymes will be efficient; it also mixes with the feces and will ultimately be eliminated from the body.

Bilirubin obtained from the breakdown of RBCs by the spleen is called indirect, unconjugated or fat soluble. It is taken to the liver where, along with the liver's form. Bilirubin must be in the water soluble form to work with the bile salts and enable absorption of fats.

2-2-2 Metabolic Functions:

Fibrinogen, Prothrombin and Heparin Synthesis:

The liver manufactures the clot proteins fibrinogen and prothrombin and also the anticoagulant heparin. (Heparin is also found is several other organs of the body).people with liver disease will have longer clotting times because the clot process is slower due to the lack of fibrinogen and prothrombin.

Albumin Synthesis:

The liver manufactures albumin which is a large molecule found in the blood. Its rule is to remain within the capillary and attract back into the vessel the same amount of fluid that left the vessel. Therefore, plasma (the fluid component of blood) leaves the capillary to become interstitial fluid. Albumin will attract into the vessel the correct amount of interstitial fluid to replenish the plasma lost. Albumin plays a significant role in maintaining the body's fluid balance.

Correct fluid balance means the total amount of body fluid is correct and it is distributed throughout the body's fluid compartments in the correct amount. The cytoplasm of the cell, the interstitial fluid and the blood plasma are the three fluid compartments.

Should the hepatic cells secrete too little albumin then the fluid will collect outside the blood vessels resulting in ascites (free fluid within the peritoneal cavity), edema (an excess of interstitial fluid) or a pleural effusion (excess fluid within the pleural cavity).

Amino acid synthesis:

Many of the liver functions are achieved through enzymes, which it also manufactures. Enzymes called transaminases are stored in the liver and are used by the liver to move amino groups around from protein to protein as different amino acids are made.

Aspartate aminotransferase (AST) and alanine aminotransferases (ALT) are two important enzymes that will back up into the bloodstreem whenever there is acute hepatic cell damage or death.Therefore, marked elevations of these transaminases in the serum are indicators of an acute hepatic disorder. It is important to note though that marked elevations of AST and ALT are nonspecific indicators of an acute hepatic disorder in that these can be elevated for a variety of causes.

Protein Metabolism:

Ammonia is formed from the breakdown of the protein, the liver removes this from the blood and it then becomes a principal part of the urea. Urea is thin excreted from the liver back into the blood. The kidneys remove urea from the blood and excrete it as part of the urea.

Carbohydrate Metabolism:

The pancreatic hormones insulin and glucagon work in conjunction with glucose regulation by the liver.

Fat Metabolism:

The liver removes fatty acids from the blood and changes them into lipoproteins which are more readily used by the body.

2-2-3 Storage:

The liver stores glycogen, fats, amino acids, iron, and several vitamins (A, D, B complex and K). The liver utilizes vitamin K to form Prothrombin, therefore the people with liver disease will have longer clotting times.

2-2-4 Detoxification of Blood:

The liver detoxifies alcohol, drugs and steroid hormones. Therefore, prolonged abuse of alcohol and certain drugs can eventually destroy the hepatic cells.

The sex hormones are inactivated and metabolized by the liver. Once the liver is impaired, as with alcoholic cirrhosis, these hormones build up in the blood and can result in breast development in the male (gynecomastia), and testicular atrophy. Sex hormone arecontinuing to be manufactured by the adrenal cortex).

2-2-5 Reticuloendothelial Functions:

Since the liver contains phagocytic cells (Kupffer cells) it can be classified as part of the Reticuloendothelial system. These cells remove foreign materials and also remove worn out red blood cells. The iron is stored and the pigments, which are a waste, will be excreted as a bilirubin protein of bile.

These cells also remove the Technetium Sulfur Colloid from the blood and are the basis of a nuclear medicine examination using this substance.

2-3 Normal Sonographic Appearance:

The liver is homogenous ,medium level echo(mid gray) ,It is interrupted only by vessels and ligaments,it has same or slightly increased echogenicity when compare with renal cortex and hypoechoic if compared with pancreas , blood vessels and bile ducts have anechoic lumen , major portal vein branches are surrounded by highly reflective walls (fibro fatty tissue) smaller portal vein branches may lack these surrounding echoes,hyperechoic walls may also surrounding the larger hepatic vein tributaries,highly reflective or echogenic ligaments and fissures. It is surrounding by thin hyperechoic capsule, also known as Glasson's capsule if the sound beam strikes it perpendicular.

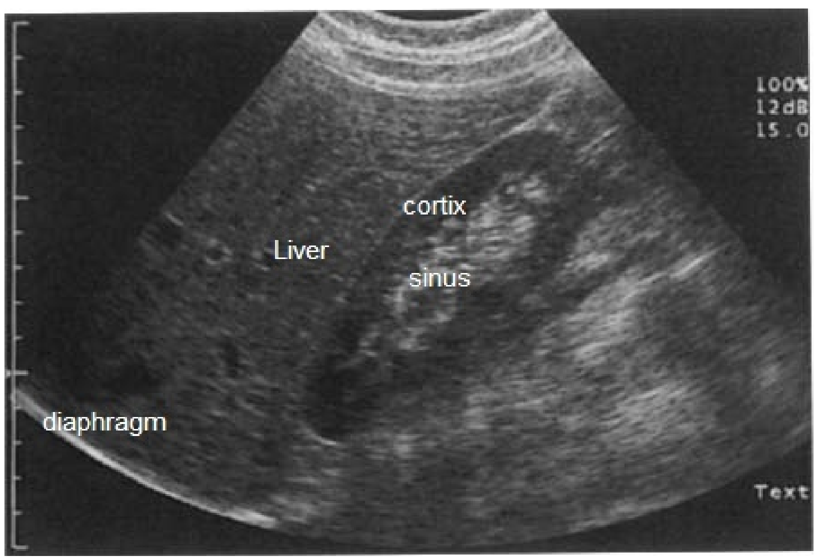

Figure (2-3) Longitudinal section (LS) through the right lobe of the liver. The renal cortex is slightly less echogenic than the liver parenchyma and renal sinus.

2-4 Liver Size:

The size of the liver is difficult to quantify, as there is such a large variation in shape between normal subjects and direct measurements are notoriously inaccurate. Size is therefore assessed subjectively. Look particularly in the inferior margin of the right lobe which should come to a point anterior to the lower pole of the right kidney. A relatively common variation of this is the Reidel's lobe, an inferior elongation of segment VI on the right. This is an extension of the right lobe over the lower pole of the kidney, with a rounded margin, and is worth remembering as a possible cause of a palpable right upper quadrant mass.

To distinguish mild enlargement from a Reidel's lobe, look at the left lobe. If this also looks bulky, with rounded inferior edge, the liver is enlarged. A Reidel's lobe is usually accompanied by a smaller, less accessible left lobe.

Liver size decreases with increase in age and varies with patient height and weight (Gilani, 2005).

2-5 Liver Scanning Technique:

It includes Preparation of patient byFasting for 8 to 12 hours, this guarantees normal gallbladder and biliary tract dilatation and reduces the stomach and bowel gas anterior to the pancreas. Fluid is essential to prevent dehydration only water should be given.

Transducers used are 3.5 MHz for thin patients, 5 MHz for obese patients.

Also sitting the correct gain should allow the diaphragm to be clean seen; the liver should be homogenous throughout its depth.

Patient position is supine, left posterior oblique, left lateral decubitus, sitting semi erect to erect or prone as needed.

Scans are usually done in longitudinal and transverse or transverse –oblique planes. The transducer is placed in a subcostal location and scanning is usually performed with the patient in deep suspended inspiration in order to lower the liver, the best images of the diaphragmatic portion of the liver are usually obtained with steep cephalad angulation of the transducer.

Intercostal scanning may be necessary if the patient is too full of gas or if the liver small and too high for adequate subcostal scanning, moving the patient from the supine to the left posterior oblique or left lateral decubitus positions may cause the liver to fall to lower position and it often rearranges the gas thereby enhancing the scanning procedure. Intercostal scanning provides scan in the coronal plane.

A real time transducer with a small footprint and a wide field of view is generally the preferred equipment. This enables easy subcostal and intercostal scanning. As the liver is a large organ, the optimal transducer should provide focusing from near to far field.

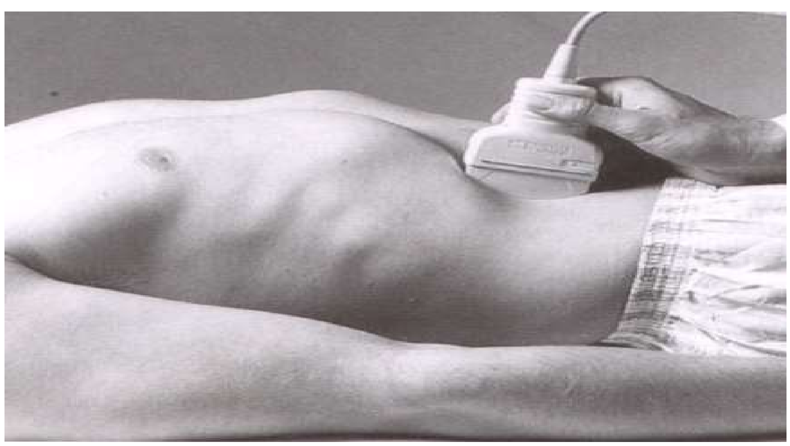

Figure (2-5)Picture discusses how the probe placed to scan liver span.

2-6 Previous Studies:

There are many previous studies determined the relations of liver span measurements in Sudanese, Arabian and international population.

The correlation of liver size and body habitues in adult Sudanese population (Yassir Hegazi Abdoon) 2009-2010.the study available in Alzaeem Alazhari library (number255) concluded the assessment of liver size by ultrasound scanning is more accurate, rapid and safe. In this study the measurement of liver in adult Sudanese population is taken and compound with their body mass indices (BMI). The researcher found that there is significant correlation between right lobe AP and Body Mass Indices and inverse significant relationship with the left lobe AP caudate lobe AP and (BMI).He recommended mainly ultrasound staff should training in liver measurement and do it for all patients.

Emad S T, Azmy M Hadidy, Azmy A Haroun, radiology department ,Jordan university hospital ,Jordan ,J med J ,2009 , vol 43(3) page 197- 204.ultrasound measurement of liver span in Jordanian adults; aimed to measurement liver span in Jordanian adults by ultrasound , to investigate the liver span and several factors (age, gender, weight , height , BMI , BSA and to standardize ultrasound mean of liver span .methods : study carried in 2007 on nonselective population sample of 242 male and 275 female from (18-76years old) age test the relation between liver span and several anthropometric factors including age, sex, weight , height , BMI , BSA.

Results: all variables contributed highly to variation in females liver span, the same factors, however, withexception of BMI significantly contributed to the variation in male liver span. Conclusion: height and BSA the best determinations of liver span in males and females respectively.

Mitta L R, Chowdhary D S ,department of anatomy J N medical college data megha institute of medical science university 2010-volume 4- issue 4- page 2733-2 , A pilot study of the normal measurement of the liver and the spleen by ultrasound in the rajasthani population . aimed to determine the normal standard of liver and spleen in rajasthani population in India .method: 200 subjects (100 male -100 female) from population were evaluated ,the subject divided into 5 groups according to their age (11-70 years) ,results: the average longitudinal diameter of right lobe of liver was 12,99+/-0.76cm (male) 12.66+/-1.07cm (female) and of left lobe was 9.28+/-0.81cm (male) and 9.17+/-1.03cm (female).conclusion: this study will be very important in the daily practice in radiology clinics.

CHAPTER THREE

MATERIALS AND METHODS

3-1 Type of Study:

This is descriptive case study done in normal Sonographic measurements of liver span amongadult Sudanese population.

3-2 Area of Study:

This study was done in Different hospitals and centers include ultrasound department in Khartoum and Gazira states.

3-3 Duration of Study:

Study was beginning in July up to November 2019.

3-4 Variables of Study:

The variables of study are anthropometric factors includes age, gender, weight, height and residence.

3-5 Population of Study Selected:

Healthy Sudanese Population with different age, sex, obesity, height, Tribes and comes from different areas of Sudan.

3-6 Sampling and Sample Size:

There was 70 of normal Sudanese population selected the technique of non - probability method (quota).

3-7 Data Collection:

Data was collected by data collection sheet (in this sheet we sure normal liver history ,that is no history of hepatic or biliary disease ,alcohol consumption , diabetes mellitus , upper abdominal surgery , no hepatitis B& C , no congestive heart failure and all subjects is normal liver pattern without evidence of fatty or focal hepatic abnormality) and ultrasound images, the procedure done by Esaote machine, Honda HS2000in Omdurman, and Wad madani Military

Hospitals. I was scan the liver span one time and recorded in collected sheet with patient's age, gender, weight, height, residence, measurements and other factor written in the sheet.

3-8 Data Analysis:

Data was analyzed by software programmer (Statistic Package for Social Sciences (SPSS) using one sample T test, independent sample T test, Microsoft Excel2007 and Microsoft word2007.

3-9 Data Presentation:

Datawas presented by Tables, Figures and Diagrams

3-10 Ethical Concern:

The Researcher waspreservedall special data of the populationof study and all data written in data collecting sheets by their agreements.

CHAPTER FOUR

RESULTS

4 Results:

About the 70 cases of normal ultrasound measurement of theliver span in adult Sudanese population werestudied prospectively in order to measure the liver span.The following tables and figures showed the normal measurements of the liver span:

Table (4.1) frequency distribution of age \years:

Age \years	Frequency	Percent	Valid Percent	Cumulative Percent
17-31	23	32.9	32.9	32.9
32-46	12	17.1	17.1	50.0
47-61	22	31.4	31.4	81.4
62-76	11	15.7	15.7	97.1
77-82	2	2.9	2.9	100.0
Total	70	100.0	100.0	

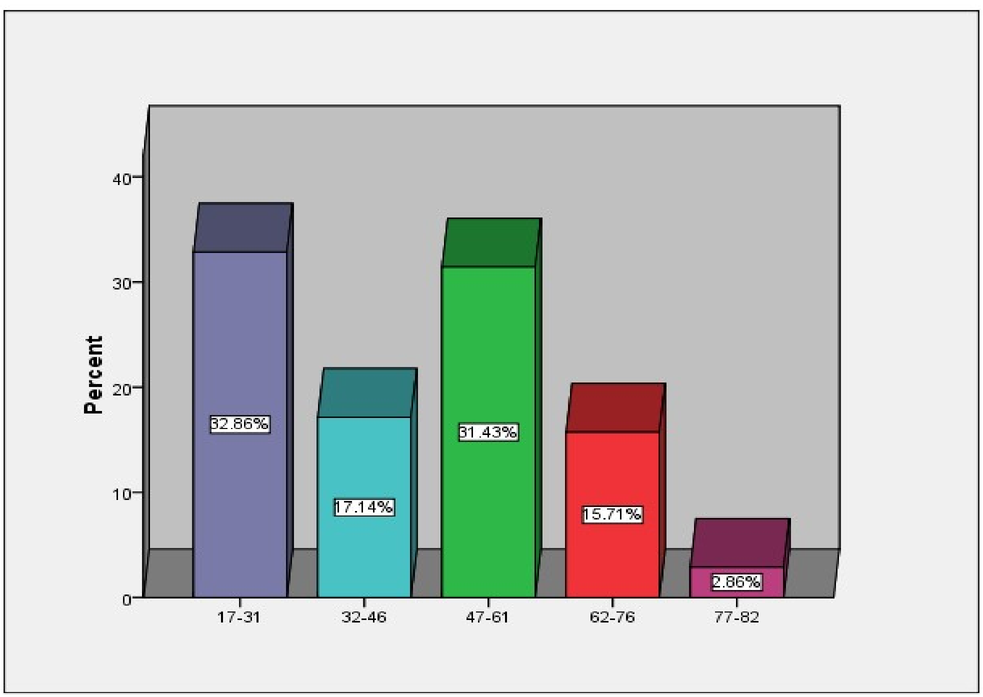

Figure (4.1) frequency distribution of age \years

Table (4.2) frequency distribution of gender:

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	48	68.6	68.6	68.6
Male	22	31.4	31.4	100.0
Total	70	100.0	100.0	

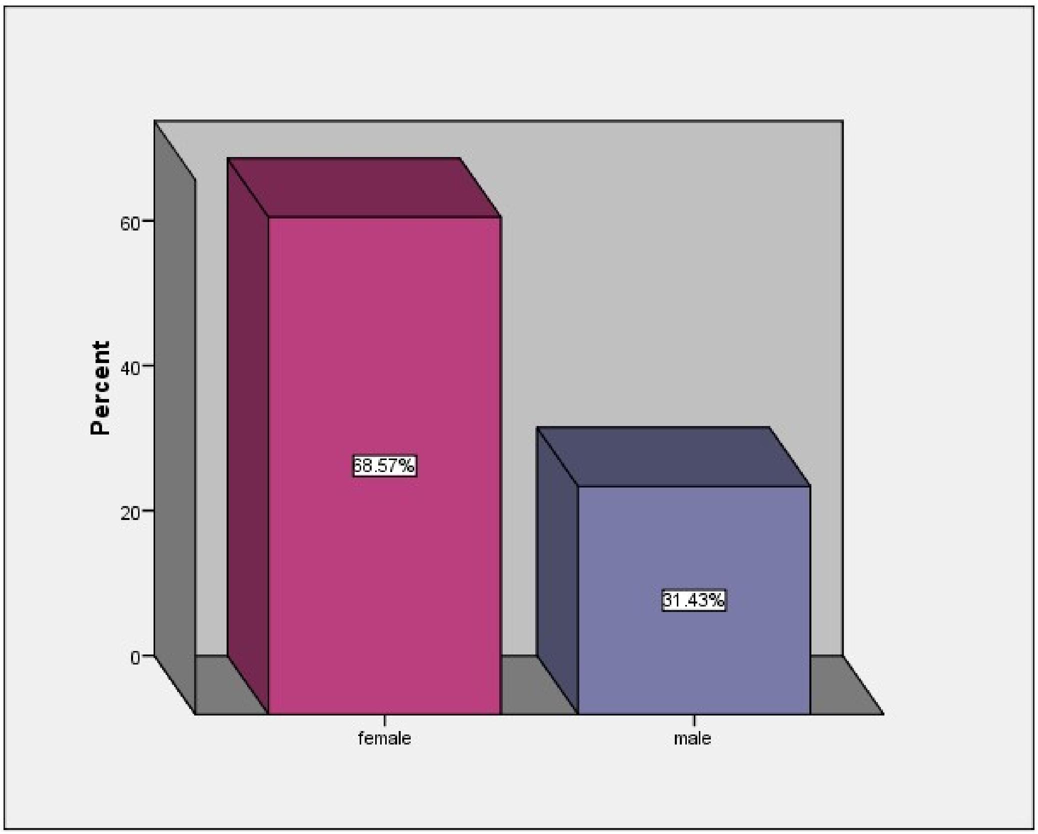

Figure (4.2) frequency distribution of gender.

Table (4.3) frequency distribution of residence:

Residence	Frequency	Percent	Valid Percent	Cumulative Percent
Center	42	60.0	60.0	60.0
East	6	8.6	8.6	68.6
North	4	5.7	5.7	74.3
South	3	4.3	4.3	78.6
West	15	21.4	21.4	100.0
Total	70	100.0	100.0	

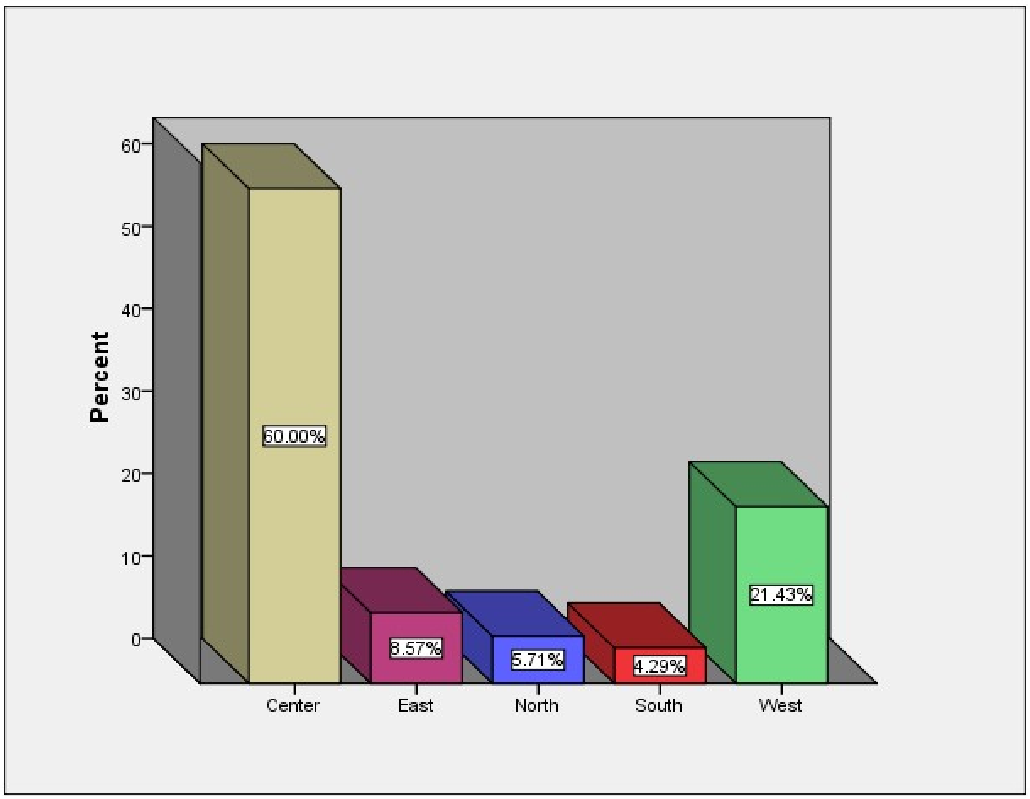

Figure (4.3) frequency distribution of residence

Table (4.4) Descriptive statistic age, weight, height, BMI and liver span:

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	70	17	82	43.76	17.950
Weight	70	42	170	67.11	17.090
Height	70	150	185	164.41	8.438
BMI	70	16.38	54.26	24.7720	5.48372
Liver span	70	10.5	15.7	12.886	1.0892
Valid N (list wise)	70				

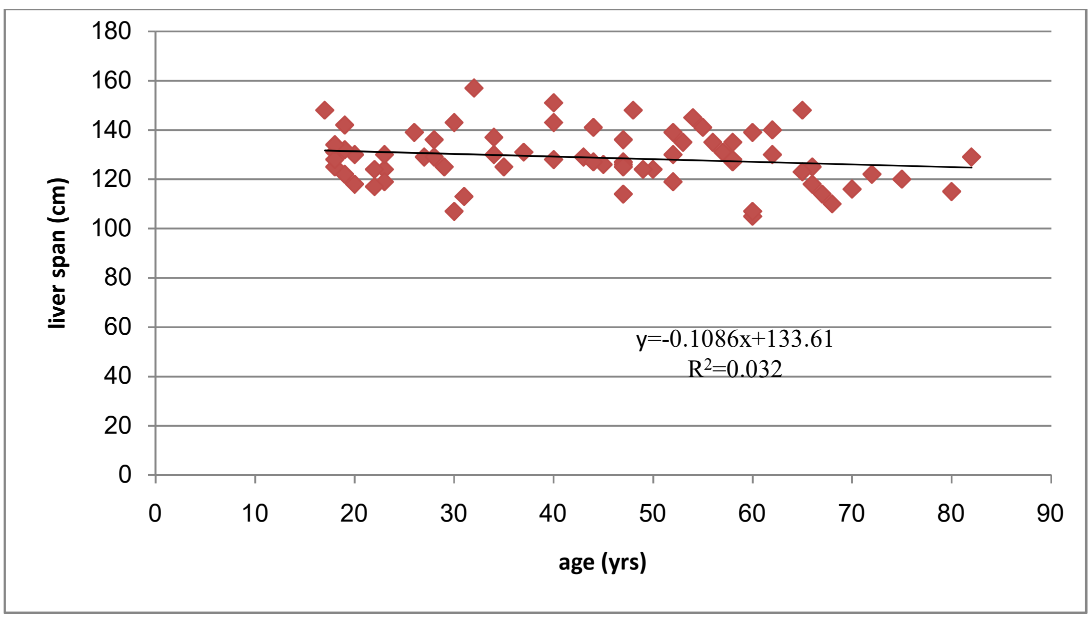

Figure (4.4) scatter plot shows relationship between age and liver span.

Table (4.5) Compare mean liver span in different age group:

Age		age	Weight	Height	BMI	liver span
17-31	Mean	22.96	66.48	162.57	25.0128	12.804
	N	23	23	23	23	23
	Std. Deviation	4.656	2.4670	.9365	7.65683	0.9842
32-46	Mean	39.00	71.42	164.92	26.0423	13.542
	N	12	12	12	12	12
	Std. Deviation	4.513	1.6395	8.284	4.97827	1.0501
47-61	Mean	53.05	66.73	163.32	25.0182	12.909
	N	22	22	22	22	22
	Std. Deviation	4.806	11.076	8.109	3.82950	1.1109
62-76	Mean	67.09	65.09	169.00	22.8491	12.418
	N	11	11	11	11	11
	Std. Deviation	3.986	9.481	6.450	3.59181	1.1339
77-82	Mean	81.00	64.00	169.50	22.2493	12.200
	N	2	2	2	2	2
	Std. Deviation	1.414	5.657	6.364	.29802	0.9899
Total	Mean	43.76	67.11	164.41	24.7720	12.886
	N	70	70	70	70	70
	Std. Deviation	17.950	17.090	8.438	5.48372	1.0892
P value			0.912	0.242	0.655	0.117

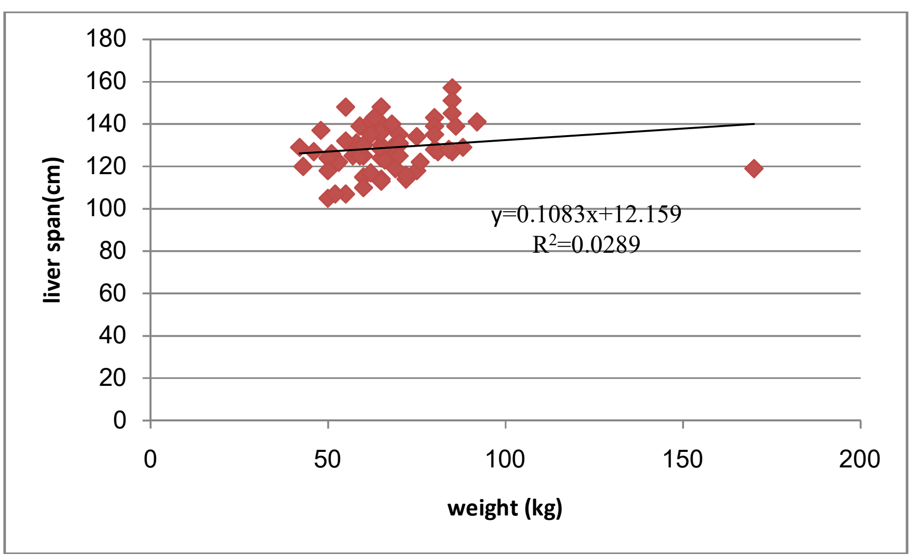

Figure (4.5) scatterplot shows relationship between weight and liver span.

Table (4.6) Independent sample t-test to shows mean different in liver span in both genders:

a. Means

Gender	N	Mean	Std. Deviation	Std. Error Mean
Male	22	12.641	.9287	1.980
Female	48	12.998	1.1470	1.656

b. t-test

	t-test for Equality of Means						
Liver span	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
	-1.279-	68	.205	-3.570-	2.792	-9.141-	2.000
	-1.383-	49.758	.173	-3.570-	2.581	-8.755-	1.615

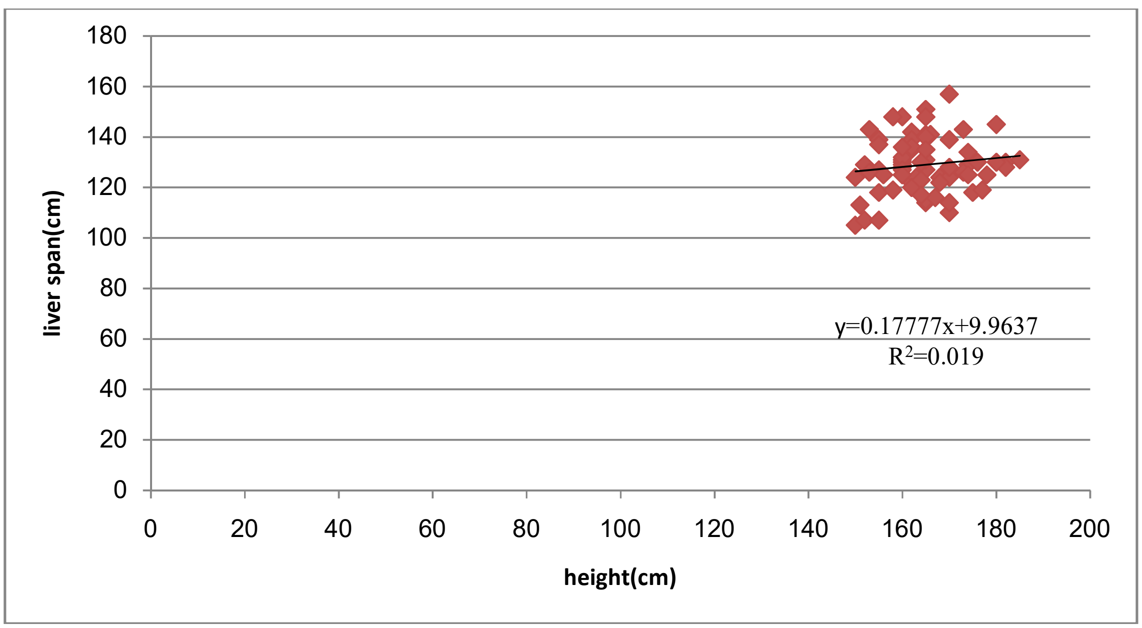

Figure (4.6) scatterplot shows relationship between height and liver span.

Table (4.7) Correlation age, weight .height ,BMI and liver span:

		age	Weight	Height	BMI
liver span	Pearson Correlation	-.179	.170	.138	.144
	Sig. (2-tailed)	.138	.160	.256	.235
	N	70	70	70	70

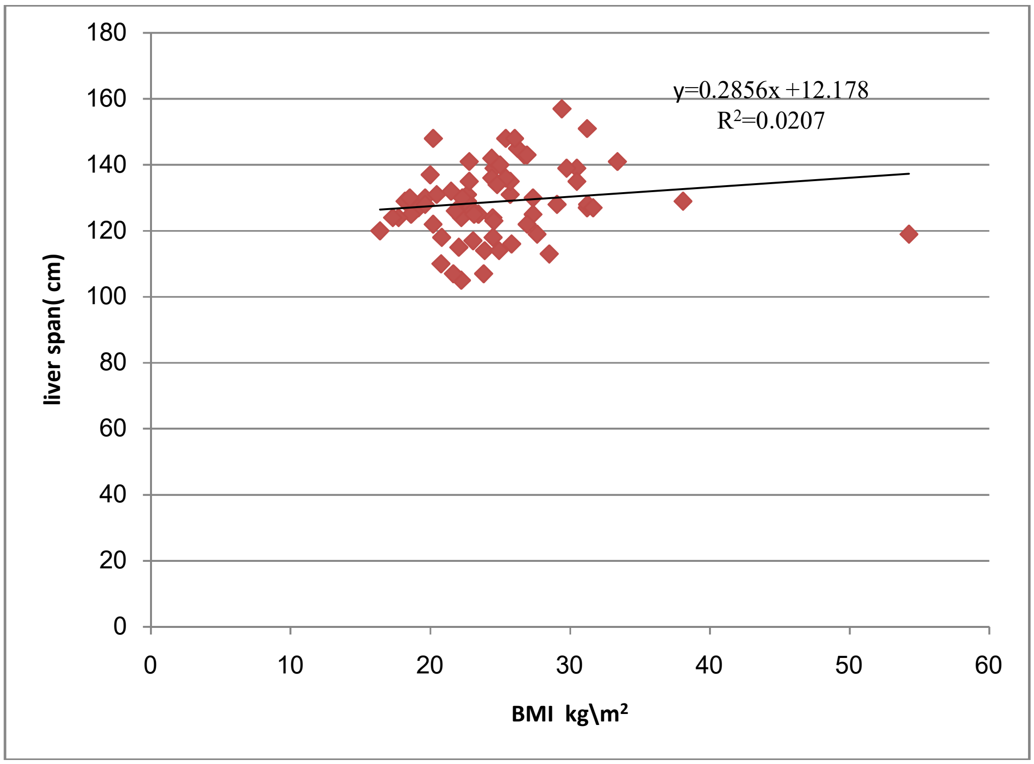

Figure (4.7) scatterplot shows relationship between BMI and liver span.

Table (4.8) Compare mean liver span with different residence:

liver span				
residence	Mean	N	Std. Deviation	P value
Center	12.874	42	1.1544	0.843
East	12.950	6	1.3635	
North	12.450	4	1.6543	
South	12.533	3	0.9452	
West	13.080	15	0.6657	
Total	12.886	70	1.0892	

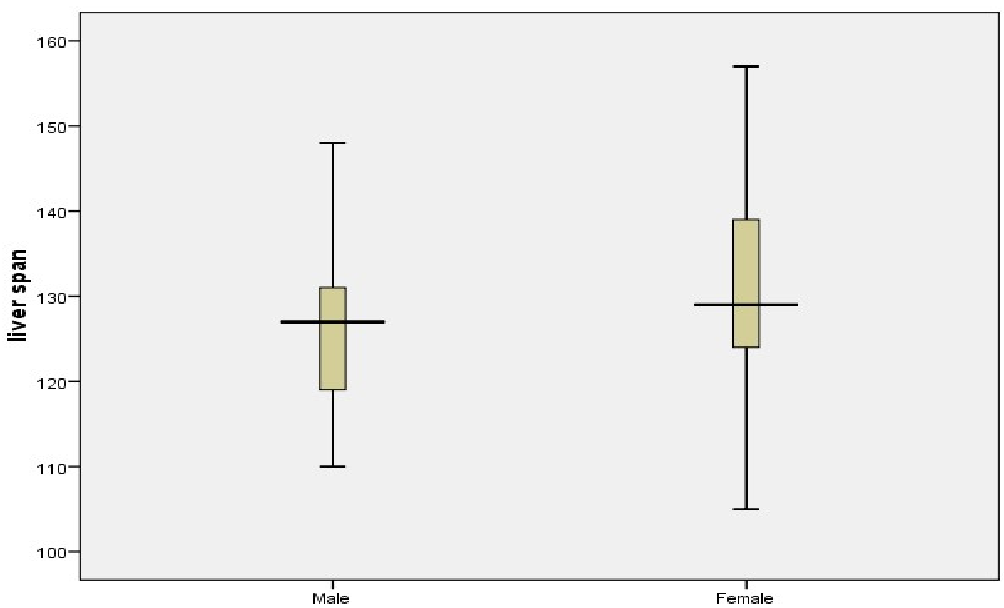

Figure (4.8) plot box shows mean liver span in male and female.

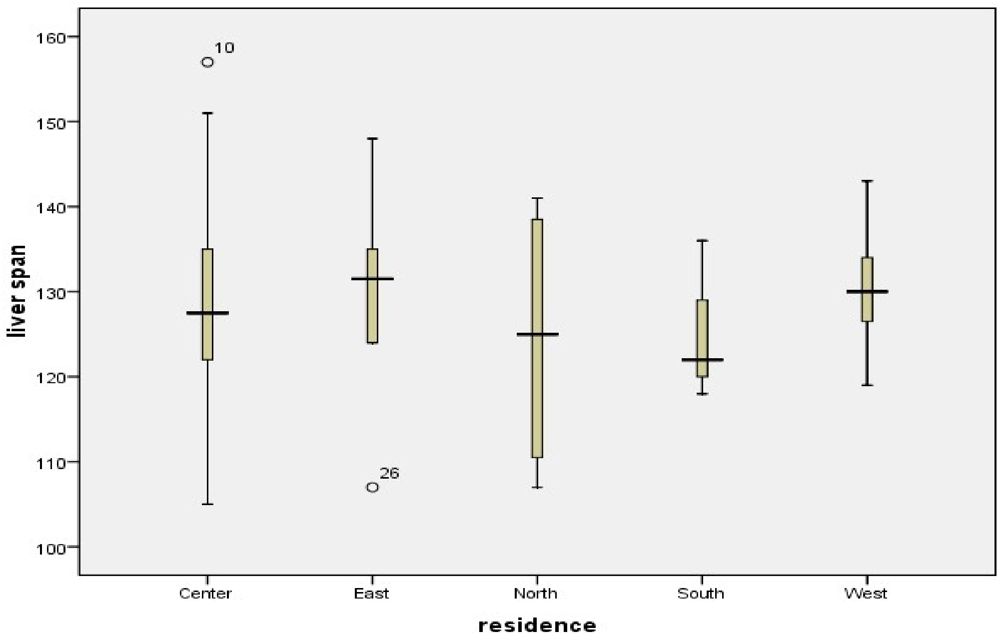

Figure (4.9) plot box shows mean liver span in different residence.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5-1 Discussion:

This was cross sectional study done to assess the liver span in normal Sudanese adult using ultrasound, the data was collected from 70 adults with different age group 32.9% of them in age 17-31 yrs. followed by 31.4% 47-61 years .68.8% were female 60% fromcenter of Sudan and 21% from western Sudan.

The mean age was 43.7± 1.79 yrs. weight 67.11± 1.709 kg, height 164.4±0.843 cm, BMI 24.77±5.48 kg\m^2, the study found liver span means was 12.886±1.089 cm, the study found the mean liver span in age group 17-31yrswas 12.804±0.984 cm, 32-46 yrs was 13.542 ±1.050 cm, 47-61 yrs 12.909±1.110 cm, in 62-76yrs was 12.418± 1.133 cm, while in 77-82 yrs was 12.200 ± 0.989 cm,no significant difference in liver span in different age group, p value >0.05.

Linear regression shows liver span decreased as age increased, it decreased by 0.1 cm for every year age liver span = -0.10 age + 13.361 cm (R2=0.032).

Liver span increased gradually by weight, it increased by 0.1 cm for every 1 kg of weight liver span = 0.10 weight + 12.159 cm (R2= 0.02), Liver span increased gradually by Height, it increased by 0.17 cm for every 1 cm of height liver span = 0.177 height + 9.963 cm (R2= 0.019), Liver span increased gradually by BMI , it increased by 0.28 cm for every 1 kg\cm ^{2} liver span = 0.28 BMI+ 12.178 cm (R^2= 0.02).

No significant difference was found between different genders in liver span, the mean for male was 12.641±0.928 cm which is slightly smaller than female 12.998 ±1.147 cm, p value >0.05 by 95% confidence intervals.
No significant correlation between age, weight, height of individual and liver span p value >0.05.

No significant correlation found between residence and liver span p value >0.05, liver span was slightly larger in west, east, and center than south and north.

CONCLUSION

In conclusion, the study aims to assess the normal measurement of liver span in adult Sudanese population.

There were 70 cases of normal Sudanese population. Data was collected by data collection sheet, analyzed by software programmer (Statistic Package for Social Sciences (SPSS).The procedure was done by Esaote, Honda HS2000machines.

Study was beginning in July up to November 2019, in Omdurman, and Wad madani Military Hospitals.

The study found that liver span means was 12.886±1.089 cm. no significant difference in liver span in different age groups, p value > 0.05.

Liver span decreased as age increased, it decreased by 0.1 cm for every year age.

Liver span increased gradually by weight, it increased by 0.1 cm for every 1 kg of weight.

Liver span increased gradually by Height, it increased by 0.17 cm for every 1 cm of height.Liver span increased gradually by BMI , it increased by 0.28 cm for every 1 $kg\backslash cm^2$.

No significant difference was found between different genders in liver span, the mean for male was 12.641±0.928 cm which is slightly smaller than female 12.998 ±1.147 cm, p value >0.05.

No significant correlation between age, weight, height of individual and liver span p value >0.05.

No significant correlation found between residence and liver span p value >0.05, liver span was slightly larger in west, east, and center than south and north.

RECOMMENDATIONS

During the Abdominal Ultrasound investigation , the patient should be fasting at least eight hours and drinking water previous to investigation liver clearly and to get better visualization.

If the Liver Span measurement more than 14 cm, an enlargement may be considered.

The Hospitals should be supported with highly developed Ultrasound Machines so as to evaluate the Abdomen and especially liver clearly.

Study recommends that further researches must be done to determine normal liver size in Sudan.

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APPENDICES

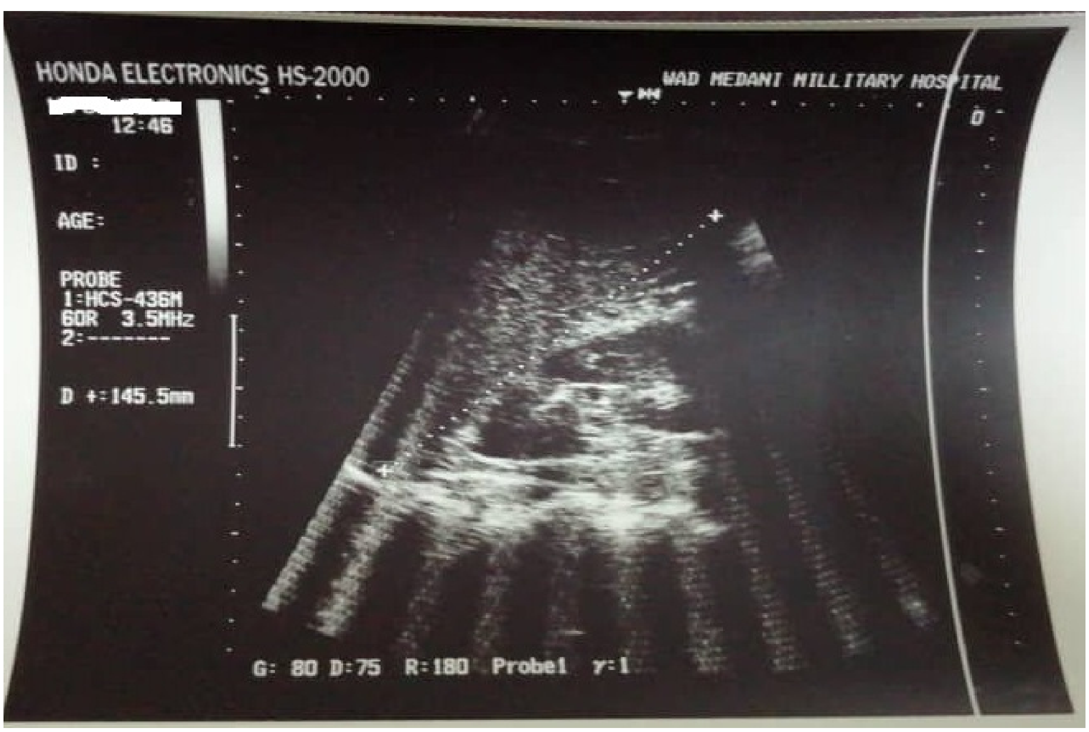
Female, 47 years old, normal liver span US image.

Male, 25 years old, normal liver span US image.

Female, 55 years old, normal liver span US image.

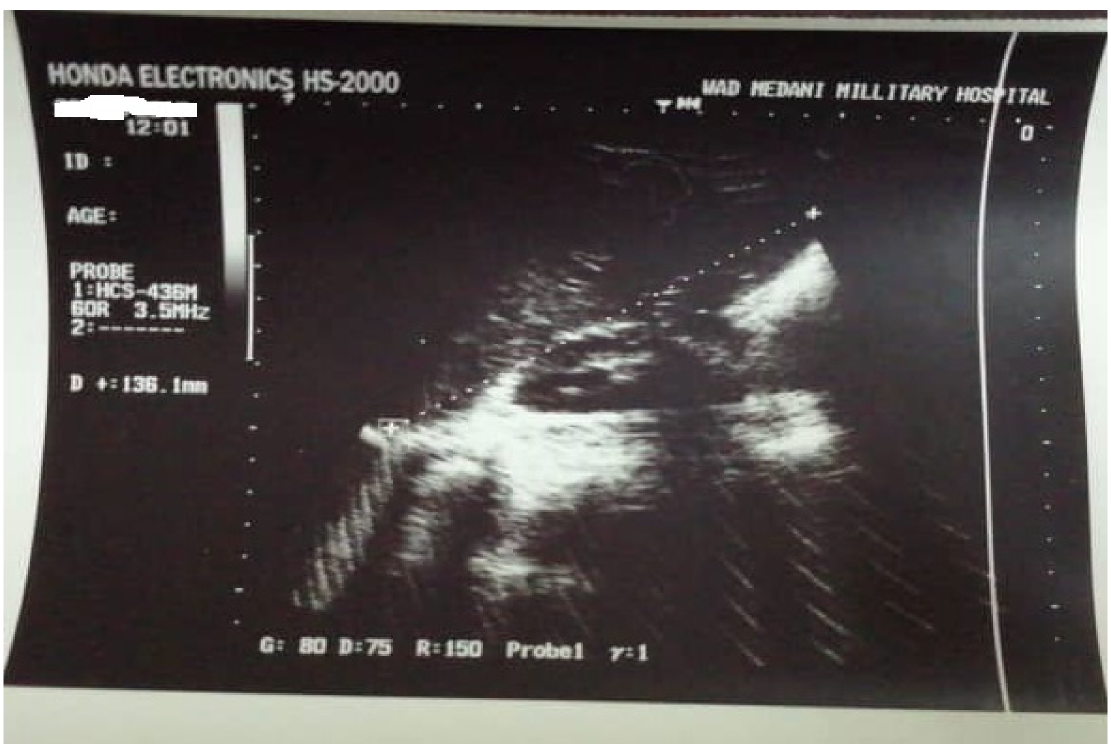
Female, 36 years old, normal liver span US image.

Male, 28 years old, normal liver span US image.



Female, 32 years old, normal liver span US image.

Male, 22 years old, normal liver span US image.



Female, 29 years old, normal liver span US image.

Sudan University of Science and Technology
College of Graduate Studies

Measurement of Normal Liver Span in Adult Sudanese using ultrasonography

Data Collection Sheets

1-Gender:…………

2-Age:…………..…

3-Residence: ……………………….

4-Whole Liver (liver span): ……….cm

5-Echogenecity :

…………………………………………………………….

6-Echotexture :

……………………………………………………………

7- Riedel's Lobe : Yes …….. No ……..

8- Absent Of Left lobe : Yes …….. No ……..

9- Height : ………………… cm

10- Weigh :…………………….kg

11- Comment:…………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………

Sig :……… Date: 2019