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Sonographic Measurement of Normal Liver Span among Sudanese Adults

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Abstract: ***Introduction**: The aim of this study was to identify the normal measurement of liver size for Sudanese adult using ultrasound in order to compare this measurement with international liver measurement studies and to correlate the relationship between somatic parameters and liver measurements with ultrasound in Sudanese adults that have morphologically normal liver. **Methodology**: The method adapted was an experimental study among a sample consists of 100 patients having mean age of 37.9 years (60 female and 40 male) in the period from October 2018 to June 2019. Mindary diagnostic ultrasound equipment model DP10 and Sonoscape diagnostic ultrasound machine model A5, standardized transabdominal scan using curvilinear transducer 3.5MHZ were used, the liver was measured length(CC) and width (AP). **Results**: The result showed that the mean value for liver AP is (13.3 ± 0.84) and for liver CC (13.4 ± 0.89). A significant difference noticed between liver measure and age group, also with gender at p 0.05 and confident level CL 95% according to independent sample t-test. **Conclusion**: The study proved that: our average measured liver diameter seem close enough to 13.4 cm or less in Sudanese adults, it is recommended that further studies must be conducted to provide a more accurate assessment of liver size.***

Keywords: Ultrasonography, Liver Span, Sudanese Adults, Measurement

1. Introduction

The liver is an intraperitoneal structure situated in the right upper quadrant of the abdomen and bounded superiorly by the diaphragm. The size and shape of the liver are highly variable. The posterior surface of the right lobe of the liver is indented by the right kidney. The inferior vena cava also lies predominantly posterior to the liver substance but frequently has a short intrahepatic course just before entering the right atrium. The hepatic flexure of the colon lies adjacent to the free margin of the right lobe, but does not indent it. The left lobe is highly variable in size and shape, at times extending well into the left upper quadrant, while in other patients the left lobe barely extends to the midline The inferior margin of the left lobe lies close to the body and antrum of the stomach, and frequently lies adjacent to the body of the pancreas, splenic vein, and splenic artery [1].

In Couinaud's anatomy because sonography allows evaluation of liver anatomy in multiple planes, the radiologist can precisely localize is now the universal nomenclature for hepatic lesion localization. This description is based on portal segments and is of both functional and pathologic importance. Each segment has its own blood supply (arterial, portal venous and hepatic venous), lymphatics, and biliary drainage. Thus the surgeon may resect a segment of a hepatic lobe, providing the vascular supply to the remaining lobe is left intact. Each segment has a branch or branches of the portal vein at its center, bounded by a hepatic vein. There are eight segments [2].

The right, middle, and left hepatic veins divide the liver longitudinally into four sections. Each of these sections is further divided transversely by an imaginary plane through the right main and left main portal pedicles. Segment I is the caudate lobe, segments II and III are the left superior and inferior lateral segments, respectively, and segment IV, which is further divided into Iva and IVb, is the medial segment of the left lobe. The right lobe consists of segments V and VI, located caudal to the transverse plane, and segments VII and VIII, which are cephalad. The caudate lobe (segment I) may receive branches of both the right and the left portal vein. In contrast to the other segments, segment I has one or several hepatic veins that drain directly into the IVC. The portal venous supply for the left lobe can be visualized using an oblique, cranially angled subxiphoid view (recurrent subcostal oblique projection). A "recumbent H" is formed by the main left portal vein, the ascending branch of the left portal vein, and the branches to segments, II, III, and IV. Segments II and III are separated from segment IV by the left hepatic vein, as well as by the ascending branch of the left portal vein and the falciform ligament. Segment IV is separated from segments V and VIII by the middle hepatic vein and the main hepatic fissure. The portal venous supply to the right lobe of the liver can also be seen as a recumbent H. The main right portal vein gives rise to branches that supply segments V and VI (inferiorly) and VII and VIII (superiorly). They are seen best in a sagittal or oblique sagittal plane [3].

Livers come in a variety of shapes. Numerous approaches have been used with both CT and ultrasound. The midclavicular line is the simplest measurement and is considered the liver length. Normal liver length is in the range of 10.5 cm (plus or minus 1.5 cm), with 13 cm considered a highly reliable cut-off for normal livers. It is also possible to use the midclavicular plane to measure anteroposteriorly. At the thickest point the normal range is 8.1 cm (plus or minus 1.9 cm). The liver measures approximately 13 to 15 cm in length in an adult. Although many authors disagree, hepatomegaly is often suspected if the liver measures Greater than 15.5 cm in the mid-hepatic line. As mentioned earlier, in some individuals, particularly females, Riedel lobe can mistakenly suggest hepatomegaly [4].

2. Previous Studies

Awad Elkhadir et al., (2015) a prospective study was carried out at King Abdul-Aziz University Hospital (KAUH)- Saudi Arabia, Jeddah between (11-30) March 2015, A total of 90 adults subjects (59 females, 31 males; mean age 44.8889 years) underwent sonographic examination of the liver in the midclavicular line (MCL)to determine liver span. The average liver length in the midclavicular line for the overall collective was 15.00 cm; the average for females was 14.6800 cm and 14.629 cm for males. Liver length exceeded 15 cm in 37.8% of subjects. Results of the multivariate analysis showed that, BMI and weight were the two factors potentially influencing liver span ($p<0.000$).While there was no significant differences in liver size were observed, between subjects with sex, body height and age [5].

Bárbara et al., (2016) stated that the liver is one of the principal organs in the body and is involved in over 500 physiological functions related to metabolism, digestion, immunity, and storage of nutrients. Given that there are a number of approaches to measure liver length through diagnostic 2D sonography, this work was undertaken to determine the most accurate measurement of this organ. Cadaveric specimens (n = 21) were employed to assess measurements in the midclavicular line (MCL) and the midaxillary line (MAL). Statistical differences were detected between MCL and MAL measurements ($P < .05$), and a positive correlation between MAL CC and in situ anterior measurements were noted ($r = 0.97$). Liver size, as assessed through in situ measurements, varied as a funtion of BMI and waist circumference ($P < .05$) [6].

El Mouzan et al., (2005) stated that the liver size in Saudi children and adolescents from the general population by multistage random probability sampling for the assessment of physical growth. The maximum palpable liver size below the costal margin was 2.4 cm. The median and + 2 SD liver span at birth were 4 and 6.9 cm, respectively. There was no difference in the liver span between boys and girls of up to 60 months of age. Thereafter, a difference could be seen increasing with age, with girls having smaller liver spans than boys [7].

Kratzer et al., (2000) stated that Ultrasound Measurement of Liver Size in 2,560 Subjects: Defining the Risk Factors for Hepatomegaly Data from large-scale sonographic surveys documenting normal and borderline increases in hepatic dimensions are unavailable. The measurement of liver size was successful in 2,539 subjects and yielded a median maximum hepatic diameter at the RMCL of 13.6 ± 1.86 cm (females: 13.2 cm ± 1.84 cm; males: 14.1 cm ± 1.84em; range for all subjects: 7.7-21.3 cm). Univariate analysis, dependent on the severity of fatty degeneration of the liver, showed a uniform increase in median liver size from 13.2 cm to 14.1 ± 1.69 cm, to 15.2 ± 1.76 cm and to 15.5 ± 1.52 cm in subjects with slight, moderate and severe degrees of fatty degeneration, respectively. With regard to alcohol consumption, median maximum hepatic diameters at the RMCL were 13.2 ± 1.88cm, 14.1 ± 1.51 cm and 14.6 ± 1.71 cm in subjects with no or infrequent alcohol consumption, in those with alcohol intake several times weekly and those with daily alcohol consumption, respectively. In diabetic subjects (n = 70), an increase in median maximum hepatic diameter from 13.6 ± 1.84 cm to 15.0 ± 2.01 cm was documented. The coefficient of correlation for BMI and hepatic diameter was 0.53. The univariate analysis of factors potentially involved in increased hepatic size showed a correlation between increased maximum hepatic diameter and the degree of fatty degeneration of the hepatic parenchyma, as well as for regular alcohol consumption and subject's status as diabetics. There was also a close correlation between liver size and subjects BMI [8].

Zhao et al., (2014) Magnetic resonance elastography (MRE) has excellent performance in detecting liver fibrosis and is becoming an alternative to liver biopsy in clinical practice. Results - Ultrasound and MRE measurements were correlated ($r= 0.86$; $P< .001$). Receiver operating characteristic (ROC) analysis was applied to the ultrasound measurement results with the MRE diagnosis as the "ground truth." The area under the ROC curve for separating patients with minimum fibrosis (defined as μMRE≤2.9 kPa) was 0.89 (95% confidence interval, 0.77–0.95), and the area under the ROC curve for separating patients with advanced fibrosis (defined as μMRE ≥5.0 kPa) was 0.96 (95% confidence interval, 0.87–0.99). Conclusions—Results indicate that the ultrasound-based shear wave measurement correlates with MRE and is a promising method for liver fibrosis staging [9].

3. Methodology

This descriptive prospective study was carried out in Khartoum State, Sudan in the period from October 2018 to June 2019. The study population was a random sample of 100 subjects (40 adult males and 60 adult females) with age ranging between (18-72) years. Subjects who were included in this study were referred for abdominal sonographic examinations. All subjects included in the study, those subjects should not be diabetic nor jaundiced have no history of hepatitis or frequent alcohol consumption, no history of chronic anemia, no history of abdominal trauma nor surgery, no history of biliary disease and pregnant women were not included in the study. Liver span measurement was done in the midclavicular line for the right lobe with the subject lying in supine position taking deep inspirations to fully visualize the superior borders of the liver. The probe was applied gently on the abdominal wall of the subject running from the right hepatic dome to the inferior hepatic tip; the right hand of the subject was raised behind the subject head to create better access to the liver. Another mid-sagittal plane was done for the left lobe, from the highest to the lowest point of the liver. Liver span represents the diagonal axis from the most lateral aspect on the left to the most inferior aspect on the right. Scans were done with Mindary diagnostic ultrasound equipment model DP10 and Sonoscape diagnostic ultrasound machine model A5, standardized transabdominal scan using curvilinear transducer 3.5MHZ.

Statistical analyses were performed using SPSS 21.0 software. The BMI was calculated according to recommendations of the World Health Organization. The variables were summarized as percentage or average as indicated. Correlation between hepatic measurements undertaken by ultrasound and several anthropometric factors including age, gender, weight, height and BMI performed on the data to test the statistical significance of the various relationships between liver span as represented by MCL.

4. Results

The following tables and figures show summary of the results including distribution of gender, age, and body weight and body height of the sample of study. They also include frequency of distribution of width and length of the liver and the association of these variations with male and female.

Table 1: Descriptive Statistics of patient body characteristics (age, Height and weight)

Variable	Min	Max	Mean	Std. D
Age	18.0	72.0	37.9	14.5
Weight	45.0	105.0	68.9	13.5
height	148.0	190.0	167.9	9.5

Table 2: Descriptive Statistics of liver anterioposterior (AP) & caudocranial (CC)

Variable	Min	Max	Mean	Std. D
Liver AP	11.0	15.0	13.3	0.84
Liver CC	11.0	15.8	13.4	0.89

Table 3: Shows the significant level of independent sample t-test at p=0.05 and CL=95% for liver measurement

Independent Samples Test				
	t-test for Equality of Means			
	Sig.	t	Sig. (2-tailed)	Mean Difference
Liver AP	0.605	4.508	0	0.7067
Liver CC	0.302	2.596	0.011	0.4617

Table 4: Statistical difference of liver measuring in AP and CC with gender according to independent sample t-test.

Group Statistics				
	Gender	N	Mean	Std. D
Liver AP	Male	40	13.740	0.8050
	Female	60	13.033	0.7423
Liver CC	Male	40	13.690	0.9388
	Female	60	13.228	0.8234

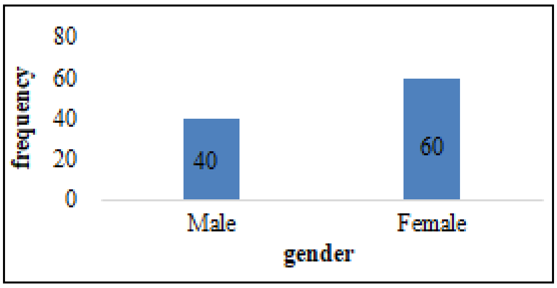

Figure 1: Bar graph shows frequency distribution of gender

Table 5: Mean difference of liver AP measures according to the age groups.

Group Statistics				
Age		N	Mean	Std. D
Liver AP	18-23	18	12.872	0.8950
	23.1-31.1	21	13.010	0.8780
	31.2-39.2	19	13.468	0.6183
	39.3-47.3	15	13.32	0.9151
	47.4-55.4	13	13.900	0.6000
	55.5-63.5	8	13.825	0.7536
	63.6-72	6	13.283	0.5231

Table 6: Mean difference of liver CC measures according to the age groups

Group Statistics				
Age		N	Mean	Std. D
Liver CC	18-23	18	13.100	0.7639
	23.1-31.1	21	13.043	1.0600
	31.2-39.2	19	13.563	0.4991
	39.3-47.3	15	13.407	0.7146
	47.4-55.4	13	13.931	0.9123
	55.5-63.5	8	14.050	1.1613
	63.6-72	6	13.217	0.8954

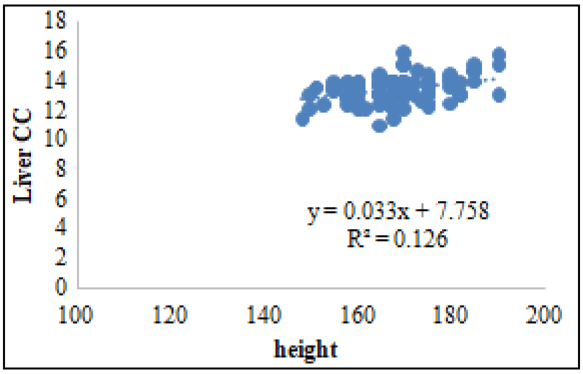

Figure 2: Scatter plot shows linear correlation of liver CC (cm) with patient height

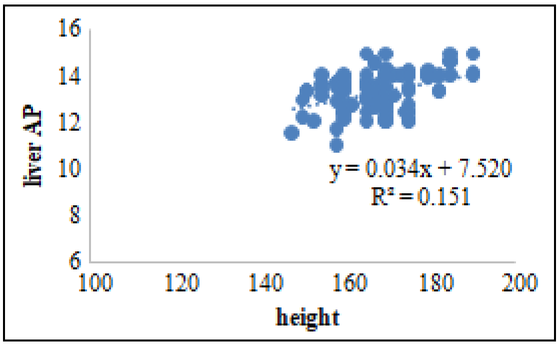

Figure 3: Scatter plot shows linear correlation of liver AP (cm) with patient's height

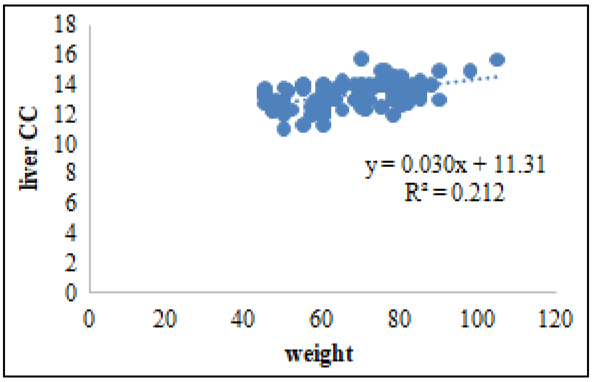

Figure 4: Scatter plot shows linear correlation of liver CC (cm) with patient's weight

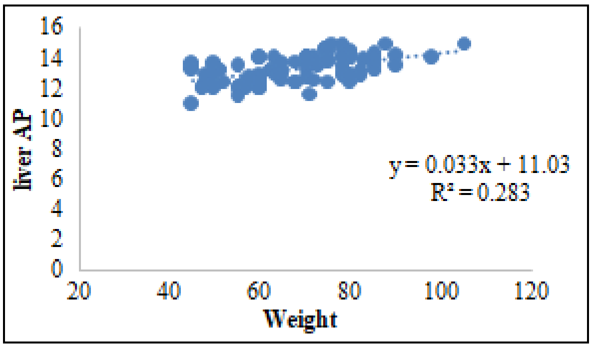

Figure 5: Scatter plot shows linear correlation of liver AP (cm) with patient weight

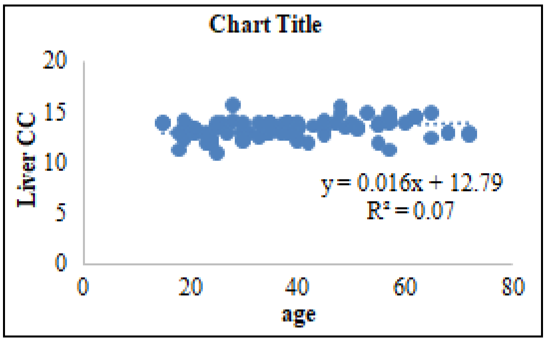

Figure 6: Scatter plot shows linear correlation of liver CC (cm) with patient's age

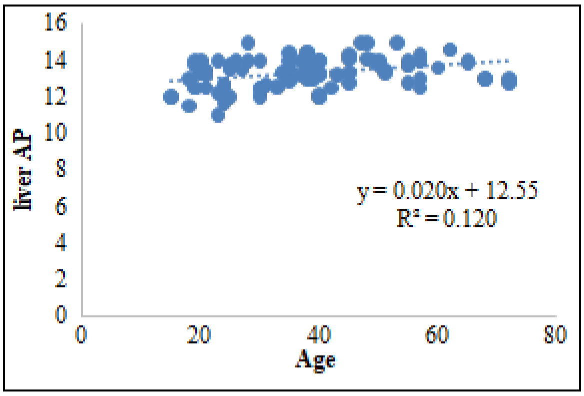

Figure 7: Scatter plot shows linear correlation of liver AP (cm) with patient's age

5. Discussion

The study showed that the mean ± SD values were (37.9 ± 14.5), (68.9 ± 13.5), (167.9 ± 9.5) for age, weight and height respectively (Table: 1), as well as (13.3 ± 0.84) for liver anterioposterior (AP) dimension and (13.4 ± 0.89) for liver caudocranial (CC) dimension (Table: 2), this result indicate that the normal value equal to (13.3 and 13.4) which consider relatively close to each other, As stated by Steven 2011 [4] and Rumack et al., 2011 [3] that the liver measures approximately 13 to 15 cm in length in an adult. Also Dean 2007 [1] stated that normal liver length in the range of 10.5 cm (±1.5 cm), with 13cm considered a highly reliable cut-off for normal liver. These differences may result from different regional of the patients or from operator or minimal mechanical difference in measuring may present.

The gender distribution revealed that female was more predominant in this study account for 60% while 40% for males as in (Figure: 1).

Independent sample T-test at 95% confident level, P-value (0.05) was done to test the significant difference of liver measurement for liver AP diameter (Table: 3). There was a significant difference between both genders for 60 female and 40 male, where males have relatively larger AP diameter than females (13.74 compared by 13.03) and significant difference for both gender for liver CC diameter, where males also have relatively larger CC diameter than females 13.69 for males compared by 13.22 for female as in (Table 4).

The result of frequency distribution showed most of the patients was found between 23.1& 31.1years have 21% from the study sample and the least frequency distribution was found between 63.6&72years have 6% in both measurements (liver AP & liver CC) (Tables: 5 & 6).

Also T-test is reveal a significant difference according to the age for AP and CC measurement, AP measuring more than CC because the values in the "Sig. (2-tailed)" Colum was 0.000 for AP and 0.011 for CC which was less than 0.05 (Table 3).

Liver correlation was performing to assess the relationship of liver measurements with, height, weight and age, there was a positive linear relationship between liver CC and liver AP with height stated that liver CC increased by 0.033 (Figure: 2) while liver AP increased by 0.034 (Figure: 3). Also the relationship of liver measurements with weight showed increments by 0.030 & 0.033 (Figures: 4 & 5) for liver CC and liver AP respectively. Finally the study showed the linear relationship of liver CC increased by 0.016 (Figures 6) and increased by 0.020 for liver AP (Figures 7).

6. Conclusion

At the end, the worth outcome of this study proved that: our average measured liver diameter seem close enough to 13.4 cm or less in Sudanese adults, it is recommended that further studies must be conducted to provide a more accurate assessment of liver size .

References

[1] Dean, D., Abdominal Ultrasound and Instrumentation. Burwin Institute of Diagnostic Medical Ultrasound Luneburg, Canada, 2011, 13.16.
[2] Shin, David S., et al. Surgical resection of a malignant liver lesion: what the surgeon wants the radiologist to know. American Journal of Roentgenology, 2014, 203.1: W21-W33.
[3] Carol M. Rumack, Stephanic R.Wilson and J.William Charboneau. Associate Editor: Jo-Ann M. Johnson Diagnostic Ultrasound third edition 2011.
[4] Steven M. Penny, B.S., Rt(R), Rdms. Examination Review For Ultrasound Abdomen & Obstetrics and Gynecology, 2011.
[5] Elkhadir, A., Abduljabbar, A., Wazzan, A., Almalki, F., & Alomari, W. Normal Liver Dimension in Saudi Arabia Using Ultrasonography.
[6] Riestra-Candelaria, Bárbara L., et al. "Ultrasound accuracy of liver length measurement with cadaveric specimens." Journal of Diagnostic Medical Sonography 32.1 (2016): 12-19.
[7] El Mouzan, M.I., Al Salloum, A.A., Al Herbish, A.S., Qurachi, M.M. and Al Omar, A.A., 2009. Liver Size in Saudi Children and Adolescents. Saudi journal of gastroenterology: official journal of the Saudi Gastroenterology Association, 15(1), p.35
[8] Kratzer, W., Fritz, V., Hay, B., Hoegel, J., Adler, G. and Kaechele, V., 2000. Ultrasound measurement of liver size in 2,560 subjects: Defining the risk factors for hepatomegaly. Gastroenterology, 118(4), p.A719.
[9] Zhao, H., Chen, J., Meixner, D.D., Xie, H., Shamdasani, V., Zhou, S., Robert, J.L., Urban, M.W., Sanchez, W., Callstrom, M.R. and Ehman, R.L., 2014. Noninvasive Assessment of Liver Fibrosis using Ultrasound-based shear wave measurement and comparison to magnetic resonance elastography. Journal of Ultrasound in Medicine, 33(9), pp.1597-1604.