



MORPHOMETRIC STUDY OF LIVER BY ULTRASOUND METHOD CORRELATING WITH HEIGHT, WEIGHT & BODY SURFACE AREA

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ABSTRACT

BACKGROUND: The liver is a vital organ of vertebrates and some other animals. In the human, the liver is the largest gland in the body, and consists of both exocrine and endocrine parts. It is located in the upper right quadrant of the abdomen, below the diaphragm. The liver has a wide range of functions, including detoxification of various metabolites, protein synthesis, and the production of biochemicals necessary for digestion.

Hepatomegaly is a condition that needs an urgent further evaluation. So it has become clear that great need for an exact determination of liver size. Ultrasound is usually the method of choice for screening, diagnostic, prognostic purpose and follow-up after treatment. Because of its accuracy, easy accessibility, avoids use of ionizing radiation, non-invasive technique and inexpensive. Various methods for assessment of liver sizes have been reported in literature.

AIM:

- To compare the dimensions of liver in relation to height.
- To compare the dimensions of liver with that of body weight.
- To compare the dimensions of liver with that of Body Surface area.

RESULTS:

The mean height of males in our study subjects is 166.8cm while the mean height of females is 115.4 cm. The mean CCL of right lobe of liver is 13.5cm in males and 12.8cm in females based on height

the Mean Weight of 42 female subjects is observed as 55.293cm, Mean liver span 13.993cm, SD weight is 9.2308cm, SD liver span of 1.7069 cm, Mean CCL of right lobe is 12.89cm, SD CCL of right lobe is 1.4371cm, Mean CCL of left lobe 4.96cm and SD CCL left lobe is 0.8912 cm. Out of 38 male subjects the Mean Weight observed as 59.771cm, SD weight is 11.6094cm, with mean liver span of 13.926cm, SD liver span is 1.2513cm, Mean CCL right lobe is 13.521cm, SD CCL of right lobe is 1.476cm, Mean CCL left lobe is 5.753cm, SD CCL left lobe is 1.1361cm.

the Mean Body Surface area of 42 female subjects is observed as 2.4276cm, Mean liver span 13.993cm, SD Body Surface area is 0.45783cm, SD liver span of 1.7069 cm, Mean CCL of right lobe is 12.89cm, SD CCL of right lobe is 1.4371cm, Mean CCL of left lobe 4.96cm and SD CCL left lobe is 0.8912 cm. Out of 38 male subjects the Mean Body Surface area observed as 2.7682cm, SD Body Surface area is 0.56261cm, with mean liver span of 13.926cm, SD liver span is 1.2513 cm, Mean CCL right lobe is 13.521cm, SD CCL of right lobe is 1.476cm, Mean CCL left lobe is 5.753cm, SD CCL left lobe is 1.1361cm.

KEYWORDS :

BACKGROUND:

If the incidences of obesity and diabetes continue to rise at the current rate, the prevalence of NAFLD in the US is expected to exceed 50 % in 2030, reaching epidemic status. Non-alcoholic steato hepatitis (NASH), first described in 1980, is a severe and progressive form of NAFLD and is now recognised as a major cause of cirrhosis¹ (Younossiet al., 2011). Also palpability below right costal margin is not a good index of hepatic size especially when, there is upward enlargement or downward displacement of liver² (Naftalisset al., 1963). Measurements of liver size based on percussion and palpation tend to be subjective, inaccurate and in reliable while radiography and radionuclide studies expose the patient to Gama radiation³ (Castell et al., 1969). Ultrasound is a cornerstone imaging method in the evaluation of the liver simply because it easy to use, inexpensive, quick, provides real time images and doesn't require anaesthesia or utilize ionizing radiation. longitudinal hepatic diameter at MCL is the most commonly applied and predominant clinical method of estimating liver size in routine diagnostic situations⁴ (Rosenfieldet al., 1974).

Reported that the best predictor for liver span was height for males and body surface area for females⁵ (Udoakaet al., 2013). Fate mapping studies in the mouse embryo at embryonic day 8.0 of gestation indicate that the embryonic liver originates from the ventral foregut endoderm⁶ (Tremblay and Zaret et al., 2005). The liver size is influenced with many diseases and with the advent of liver⁷ (Harlodet al., 2015). In another study by⁸ (Dhingra et al., 2010) 8 shows that the liver and spleen sizes were found to be significantly correlating highly with the height. Tarawneh reported that the best predictor for liver span was height for males and body surface area for Females⁹ (Tarawneh et al., 2009). The liver size is influenced with many diseases and with the

advent of liver transplantation; it has become clear that there is a great need for an exact determination of liver size. Calculated volume measurements made at ultrasound or at computed tomography provide the best estimates¹⁰ (Douglas et al., 2010).

Most diagnostic ultrasound units of hospitals and diagnostic centers all over the world to determine the parenchyma echo texture, position, shape and pathological conditions of liver, gallbladder, spleen, pancreas and kidneys¹¹ (Marco et al., 2002). The liver growth is a general type of growth. In children, the growth is in high velocity within one to two years of age¹² (Houssaintet al., 1980).

MATERIALS AND METHODS

80 healthy subjects were selected for this prospective study which included 38 males and 42 females ranging from 17 years to 60 years of age appeared to the department of radio diagnosis, THE OXFORD MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTER, YEDAVANAHALLI, BENGALURU. these subjects are screened by investigative history and physical examinations. The sonographic measurements of the liver were collected from real ultrasound images. In this study subjects demographic data such as age, gender, weight, height and had been collected using designed questionnaire. This data is recorded using by weighing machine and stadiometer. The body surface area was calculated with the help of Mosteller's formula:
$$\text{body surface area} = \frac{\text{height} \times \text{weight}}{3600}$$

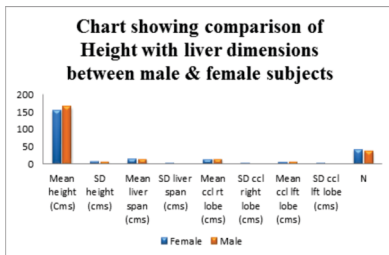
The sonographic examinations were performed with a high-resolution real-time scanner (XARIO; Toshiba Medical Systems Co. Ltd. Tokyo, Japan) with a 3.5 MHz convex transducer with a curvilinear probe of 3.5 MHz frequency. The measurements of organ dimensions were made during deep inspiration.



RESULTS

Showing comparison of height with liver dimension between male and female subjects.

S. No.	Sex	Number	Mean height(cm)	Mean liver span(cm)	SD liver span(cm)	Mean CCL of right lobe(cm)	SD CCL of right lobe(cm)	Mean CCL of left lobe(cm)	SD CCL of left lobe(cm)	
1	female	42	115.405	13.993	1.7069	12.89	1.4371	4.96	0.8912	
2	male	38	166.868	13.926	1.2513	13.521	1.476	5.75	1.1361	
P - value			Mean liver span		Mean CCL of right lobe			Mean CCL of left lobe		
			0.045		0.022			0.018		



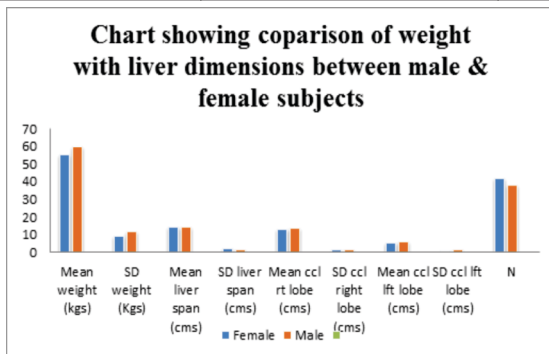
In the above table the Mean Height of 42 female subjects is observed as 115.405cm, Mean liver span 13.993cm, SD liver span of 1.7069 cm, Mean CCL of right lobe is 12.89cm, SD CCL of right lobe is 1.4371cm,

Mean CCL of left lobe 4.96cm and SD CCL left lobe is 0.8912 cm. Out of 38 male subjects the Mean Height observed as 166.868cm, with Mean liver span of 13.926cm, SD liver span is 1.2513cm, Mean CCL right lobe is 13.521cm, SD CCL of right lobe is 1.476cm, Mean CCL left lobe is 5.753cm, SD CCL left lobe is 1.1361 cm. This indicates the Mean liver span value is slightly less in males when compared to females. Regarding increase in CCL right and left lobes compared to increased height in both males and females is significant. Based on comparison of height with liver span 'P' value is 0.045 indicates it is significant. The liver span values are slightly more in female than males. Regarding the CCL of right lobe 'P' value is 0.022 cm indicates it is significant. The right lobe CCL is slightly more in males than females. Regarding the left lobe of CCL 'P' value is 0.018 indicates it is significant. The CCL of left lobe is more in males than females.

S. No.	sex	number	Mean weight (kgs)	SD weight (kgs)	Mean liver span (cm)	SD liver span (cm)	Mean CCL right lobe (cm)	SD CCL right lobe (cm)	Mean CCL left lobe (cm)	SD CCL left lobe (cm)
1	Female	42	55.293	9.2308	13.993	1.7069	12.89	1.4371	4.96	0.8912
2	Male	38	59.771	11.6094	13.926	1.2513	13.521	1.476	5.753	1.1361

Showing comparisons of weight with the liver dimension between male and female.

P - value	Mean liver span	Mean CCL of right lobe	Mean CCL of left lobe
	0.0001	0.0001	0.0001



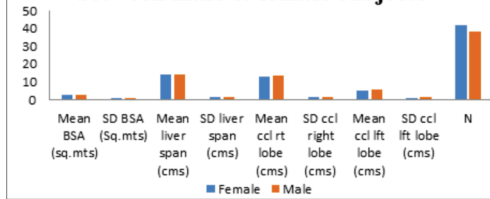
The above table the Mean Weight of 42 female subjects is observed as

55.293cm, Mean liver span 13.993cm, SD weight is 9.2308cm, SD liver span of 1.7069 cm, Mean CCL of right lobe is 12.89cm, SD CCL of right lobe is 1.4371cm, Mean CCL of left lobe 4.96cm and SD CCL left lobe is 0.8912 cm. Out of 38 male subjects the Mean Weight observed as 59.771cm, SD weight is 11.6094cm, with mean liver span of 13.926cm, SD liver span is 1.2513cm, Mean CCL right lobe is 13.521cm, SD CCL of right lobe is 1.476cm, Mean CCL left lobe is 5.753cm, SD CCL left lobe is 1.1361cm. This indicates the Mean liver span value is slight less in males when compared to females. Based on comparison of weight with liver span 'P' value is 0.0001 indicates it is significant. The liver span values are slightly more in females than males. Regarding the CCL of right lobe 'P' value is 0.0001 indicates it is significant. The right lobe CCL is slightly more in males than females. Regarding the left lobe of CCL 'P' value is 0.0001 indicates it is significant. The CCL of left lobe is more in males than females.

Showing comparisons of BSA with liver dimensions between male & female.

S. No.	Sex	Number	Mean BSA (sqmts)	SD BSA (sqmts)	Mean liver span (cm)	SD liver span (cm)	Mean CCL right lobe(cm)	SD CCL right lobe (cm)	Mean CCL left lobe (cm)	SD CCL left lone(cm)
1	Female	42	2.4276	0.45783	13.993	1.7069	12.89	1.4371	4.96	0.8912
2	Male	38	2.7682	0.56261	13.926	1.2513	13.521	1.476	5.753	1.1361
P - value			Mean liver span		Mean CCL of right lobe			Mean CCL of left lobe		
			0.0001		0.0001			0.0001		

Chart showing comparison of BSA with liver dimensions between male & female subjects



The above table the Mean Body Surface area of 42 female subjects is observed as 2.4276cm, Mean liver span 13.993cm, SD Body Surface area is 0.45783cm, SD liver span of 1.7069 cm, Mean CCL of right lobe is 12.89cm, SD CCL of right lobe is 1.4371cm, Mean CCL of left lobe is 4.96cm and SD CCL left lobe is 0.8912 cm. Out of 38 male subjects the Mean Body Surface area observed as 2.7682cm, SD Body Surface area is 0.56261cm, with mean liver span of 13.926cm, SD liver span is 1.2513 cm, Mean CCL right lobe is 13.521cm, SD CCL of right lobe is 1.476cm, Mean CCL left lobe is 5.753cm, SD CCL left lobe is 1.1361cm. This indicates the Mean liver span value is slight less in males where compared to females. Based on comparison of BSA with liver dimension 'P' value liver span is 0.0001 indicates that it is significant. The mean liver span is slightly more in females than males. Regarding the CCL right lobe of liver 'P' value is 0.0001 indicates it is significant. The CCL of right lobe is more in male than females. The CCL left lobe liver 'P' value is 0.0001 indicates it is significant. The left lobe of liver CCL is slightly higher in males than females.

DISCUSSION

The Aetiology is typically established to a combination of history, specific blood tests and wherever appropriate imaging and liver biopsy. There is increasing interest in non-invasive approach including various imaging modalities, but the staging of liver disease mostly depends on histological approach. Among the valuable non-investigatory procedures the Ultrasonography occupies prominent chair, because of least side effects when compared to other investigatory methods. Ultrasonography being the best investigatory procedure, the present study is taken up with the help of Ultrasonography method. The present study was done on 80 healthy adult subjects consist of 38 male and 42 female subjects, with age groups of 17-60 years.

The mean height of males in our study subjects is 166.8cm while the mean height of females is 115.4 cm. The mean CCL of right lobe of liver is 13.5cm in males and 12.8cm in females based on height which is significant with $P < 0.05$. In present study the correlation of liver right lobe CCL and height, we found that there is a significantly high correlation with CCL of right lobe. A study done by (Konus et al., 1998)¹³ stated that height was best correlation with liver dimensions. Singhet et al., and Toukan et al. also stated in their study that height was best determinant of CCL. Found height is weak correlation to determine liver dimensions¹⁴(Niederau et al., 1983 and Udoaka et al., 2013).

Based on correlation of weight and CCL of right lobe in present study the mean weight of males is 59.77kgs with mean CCL of right lobe 13.5cm, while in females mean weight is 55.29kg, with 12.89 cm of CCL of right lobe. The correlation between CCL of right lobe and body weight is highly significant with $P < 0.05$ which is inline of study with (Konus et al., (1998). But Niederou et al., (1983) and Udoaka et al., (2013) found in their studies that weight is a weak correlation factor to determine liver dimensions.

The mean BSA in males is 2.7 Sq metres with 13.5cm CCL of right lobe while mean Body surface area in female is 2.4 Sq meters with 12.8cm CCL of right lobe. Which show highly significant with $P < 0.05$ cm. In current study the mean CCL of left lobe of various age group of 17-20, 21-30, 31-40, 41-50, 51-60 were measured and values are 4.9, 5.4, 5.5, 5.9, 4.8cm which indicates the CCL of left lobe increases in size as age advances up to 50years and there after it size decreases. This study is similar to the study conducted by Moawia Gameraddinet al., (2015). According to gender in present study the mean CCL of left lobe in males is 5.8cm while in females it is about 5 cm. In this study there is difference of 8mm which is higher in males than females.

A similar study done by Moawia Gameraddinet al., (2015) has got mean value of left lobe CCL in males and female were 5.05cm and 4.9cm with difference of 0.07cm between male and female, which was lower to the values of present study. With a 'P' value of 0.001 which is significant. Based on correlation between height and CCL of left lobe in this study the mean CCL in males 5.7cm, in females it is 4.9cm with a difference of 0.8cm. For correlation between body weight and CCL of right lobe the mean weight in females 55.2kgs and 59.7kgs in males with a mean CCL of left lobe 4.96cm and 5.7cm.

In the present study mean height male and females 166 and 115cm which are significantly high in males with a 'P' value of 0.001. However males nearly 51cm taller than females, 50 compared to 55kgs. The Body surface area is slightly higher in males than females. Although the parameters like height, body weight, Body surface area more in males but the liver span is slightly higher in female than that of males in present study.

CONCLUSION

The data analysed based on mean height of both males and females indicate that the CCL of right lobe and CCL of left lobe is proportionately increasing as per height. Regarding liver span it is inferred that the span has not increased as per increase in mean height. In the present study the CCL of right and left lobes in correlation to mean weight indicate that CCL of right and left lobe proportionately increase as per weight.

Contrary to CCL of right and left lobe the liver span is not increasing proportionately based on mean body weight.

The analysis of data regarding the body surface area and CCL parameters of liver indicate that the CCL of right and left lobes is more when compared to increase in body surface area and more so regarding CCL of right lobe than the left lobe.

It is observed that the data regarding liver span is not surging up as the Body surface area increases. From the available data it is observed that the CCL of right and left lobes is mainly showing variation with relevance to various parameters unlike the span which is not exhibiting the changes.

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