Contents lists available at

Journal of Association of Radiographers of Nigeria

Journal homepage: www.jarn-xray.org

Sonographic Correlation of Liver Dimension and Anthropometric Variables of Height, Weight and Body Mass Index (BMI)

Ekpo EU*, Ikamaise VC, Egbe NO, Akwa EE, Eyo BA

Department of Radiography and Radiological Sciences, University of Calabar, Calabar

***Correspondence:**

E-mail: ernestramsey@live.com

ARTICLE INFO

Article history

Received 12th April, 2012
Received in revised form 13th December, 2012
Accepted 13th March, 2013
Available online December 2013.

Keywords:

Body mass index, Body weight, Height, Liver, Organometry Midclavicular line, anterior axillary line.

ABSTRACT

Background: Estimation of liver size can be used as an index to monitor various aspects of liver disease and response to therapy.

Purpose: To evaluate the relationship between anthropometric variables (Height, Weight and Body Mass Index) with liver size was carried out in subjects with clinically and sonographically confirmed normal liver.

Materials & Methods: This prospective sonographic study was carried out in Calabar, Uyo, Zaria and Makurdi cosmopolitan cities of Nigeria. Scans were performed on 388 subjects and their liver sizes measured in the Midclavicular and anterior axillary lines, respectively. Patients' heights and weights were also measured and used to calculate their respective body mass indices.

Results: Mean liver diameter in the study population was 12.9±1.7cm (Range 9.2 – 15.2cm) and 11.6±1.7cm (Range 8.0 – 14.5cm) at the midclavicular and anterior axillary lines respectively. About 98.5 % of the study population had liver sizes ≤15.0cm while 1.5% had sizes at the upper limits of 15.3 – 16cm. Height and BMI appeared to have sone influence on liver size (r=+60; P<0.05, +0.65; P<0.05) respectively at the midclavicular line but not at the anterior axillary line. An insignificant relationship was observed with weight and liver size (r= +0.1; P<0.05) both in the MCL and AAL.

Conclusion: Liver size is affected more by individual's height and body mass index and less by their weight in the region studied.

Introduction

The liver is one of the organs in the body vested with a lot of functions. As part of its vast functions, it is involved in combating a number of disease processes that alter its size. Clinical examination has been used to determine its size. Percussion and palpation are the standard bedside techniques used to document liver disease. These however are limited in the detection of small increment in size and lack accuracy and reliability[1].

The advent of ultrasound improves the imaging of the liver and other soft tissues/organs in the abdomen. Ultrasound not only aids in determination of liver size, but also in the detection of the disease processes that may be responsible for such changes in size. It has also proven to be easy, quick and valuable in the evaluation of the progress or regression of such diseases, following therapy[2].

Since ultrasound has been established as a tool for assessment of the liver and related pathologies, anatomical status, epidemiological studies and control programmes, attempts have been made to standardize the methods of examination and reporting in both normal and pathological conditions[3]. In order to develop a system which uses data on organ dimension, it is necessary to establish normal organ dimensions from the population studies. Organometry is the statistical and quantitative measurement of the organ dimension using standard acceptable unit to define the organ morphology. Sonographically, the liver is measured after clear visualization mostly in the right midclavicular line (MCL) because of its ease and practicability with the patient supine or in the right oblique position for full visualization[4]. Advocated planes for measurement include right anterior axillary line (AAL), midclavicular line (MCL) and the sternal plane (SP). A longitudinal measurement of 16.0cm or greater in the midclavicular line is considered enlargement[4].

Factors such as body mass index, body height, sex, age, and (in male subjects) frequent alcohol consumption have been reported to exert an influence over liver sizes measured at the midclavicular line[4,5,6,7,8].

Liver longitudinal diameter increases with age however; a decrease after the fifth decade and a more drastic decrease after the 7th decade of life have been observed[4].

Body weight shows an unstable correlation with liver longitudinal diameter since it is affected by a variety of factors including recent eating habits, existing gastrointestinal conditions, physiological changes and technical factors in weight determination. However, a correlation has been demonstrated between liver size and body weight at the midclavicular line[6, 7].

Height is considered a moderately important factor influencing liver diameter in the midclavicular line[4, 6].

This study sought to determine the relationship between anthropometric variables; height, weight and body mass index and the dimension of the liver in normal subjects and establish a baseline data for assessment of liver size in the regions studied.

Methodology

A randomized sample collection using Medison SA600 and Mindray DP3300 ultrasound machines with 3.5 MHz was employed in four different hospitals in Calabar, Uyo, Zaria and Makurdi). Subjects included in the study were those with clinically and sonographically confirmed normal liver. A total of 388 subjects aged between 1 - 80 years were sampled after approval by the local ethical committees covering the hospitals. Patients were asked to fast for 4 – 5 hours prior to the examination.

Scans were performed by qualified sonographers and sonologists in supine and right lateral oblique positions and measurements made on arrested full inspiration. Three different measurements were obtained and the average determined. Measurements were made in the midclavicular line (MCL) and Anterior axillary line (AAL) as described by Borners et al [9]. Subjects' heights and weights were measured and used to calculate body mass index (BMI). Pearson's correlation was used for statistical analysis at 0.05 confidence interval.

Results.

Average diameter of the liver measured in the MCL in the total studied population was 12.9±1.7cm (Range 9.2 – 15.2cm) and 11.6±1.7cm (Range 8.0 – 14.5cm) at the anterior axillary line. The distribution of the liver sizes shows that 1.5% (n=6) had liver diameter at the upper limits of 15.3 – 16.0cm in the MCL and AAL measurement planes [Figures 1 - 3].

The mean height and weight of the population was 161.0±14.9cm (range 47.0 – 187.0cm) and 60.1±2.4Kg (Range 20.0 - 106.0 Kg) respectively.

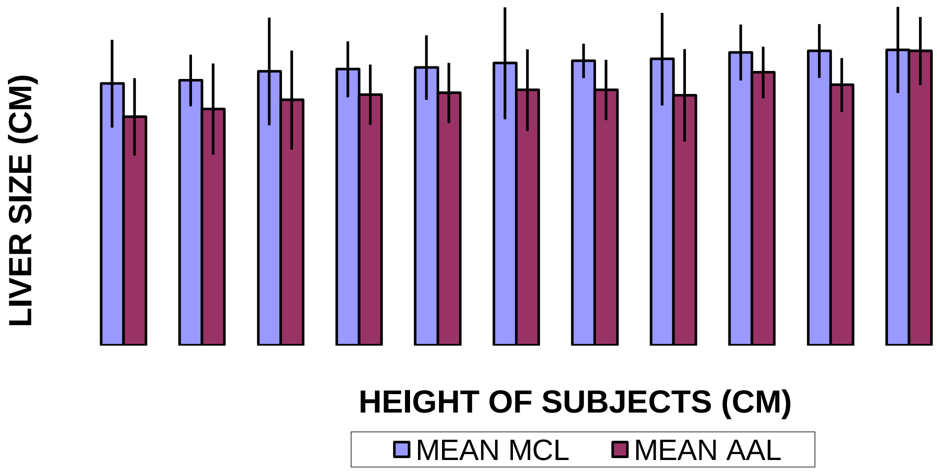

Figure 1: Distribution of liver sizes (cm) with heights of subjects (cm). Errors indicate one standard deviation from the mean.

Subjects with BMI <20Kgm^{-2} (17.6%, n=68) were found to have liver diameters of 12.6±1.7cm (Range 10.9 – 12.4) and 10.8±0.8cm (Range 9.9 – 11.5) at the midclavicular (MCL) and anterior axillary line (AAL), respectively. Subjects with BMI 20 – 25Kgm^{-2} (47.9%, n=186) had liver diameter of 12.7±0.1 (Range 12.6 – 12.8) and 11.8±0.6 (Range 11.4 – 12.2) at the midclavicular and anterior axillary lines respectively. Subjects with BMI > 25Kgm^{-2} (34.5%, n= 134) had liver diameters at 13.7±0.9 (Range 12.3 – 15.0cm) at MCL and 12.4±1.1 (range 11.4 – 14.3cm) at AAL [Figure 2]. A moderate positive correlation was found between height and liver size (r= +0.6; P<0.05) and between BMI and liver size (r= +0.65; P<0.05) at the MCL only. An insignificant relationship (r= +0.1; P<0.05) was found between weight and liver size at the MCL.

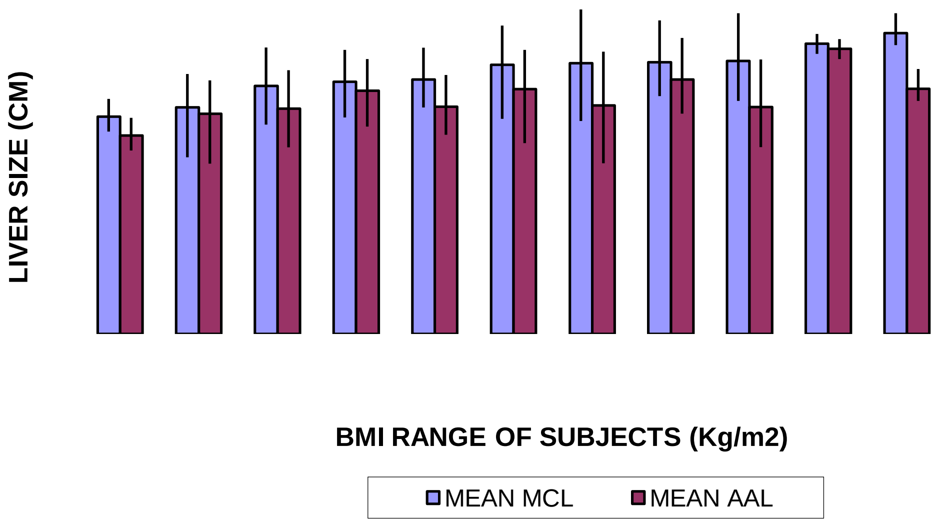

Figure 2: Distribution of liver size with BMI of subjects. Errors are 1 standard deviation of the mean

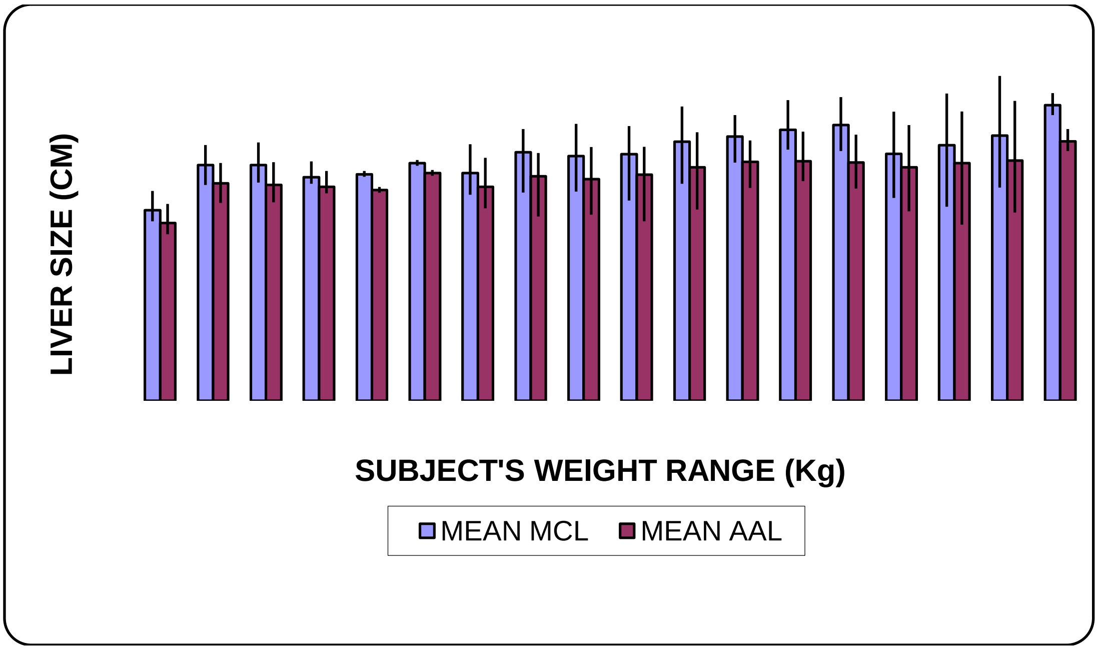

Figure 3: Distribution of liver size with weight of subjects. Errors indicate 1 standard deviation from the mean.

Discussion

Estimation of liver size can be used as an index to monitor various aspects of liver disease and response to therapy. Diagnostic imaging techniques are superior to clinical examination in determining the size of the liver and associated pathologies. To date, however there is little data on normal and borderline size of the liver that can serve as guideline for ultrasound examination of the liver[4]. This study employed the method used by Borner et al. [9], for assessment of liver size and correlated values with anthropometric variables; height, weight and BMI.

In our study, the mean diameter of the liver at the right midclavicular line (MCL) was 12.9±1.7cm (Range 9.2 – 15.2cm) and 11.6±1.8cm (Range 8.0 – 14.5cm) at the right anterior axillary line (AAL). In 1.5% (n=6) of subjects, the liver diameter was at upper limits of 15 – 16cm. These findings agree with similar work by Kratzer et al [4]. About 98.5% of the study population had liver size of 15cm.

Height appears to be a significant factor influencing liver size at the right midclavicular line but not in the anterior axillary line [Figure 1]. Liver size increases in the right midclavicular line as height increase ($r= +0.65$; $P<0.05$),

the increase being insignificant at 165 – 200cm. Mean liver diameter in the midclavicular and anterior axillary line appear to be equal in individuals of 177 – 200cm in height [figure 1]. Several studies [4-7]have also reported a positive correlation of liver size with height at the midclavicular line (MCL). Racial and geographical difference in liver size at the same height has also been reported [8]
Body mass index (BMI) also influences liver size at the right midclavicular line with gross obesity being more influential. An increase in BMI increases liver size ($r= +0.65; p<0.05$) [Figure 2]. This is expected as obesity is associated with increased fat deposition on the liver [10, 11]. No association was found between body mass index and liver size at the anterior axillary line. Kratzer et al[4], Verma et al[2], and Da silva et al[12] have reported an increase in liver size with increasing BMI at the MCL in Caucasians.
We observed a weak positive correlation between body weight and liver size in both Midclavicular and anterior axillary lines ($r= +0.1; P<0.05$) [Figure 3]. A positive association has been reported by Kratzer et al [4], Udoh et al [6].
Variation in liver size based on the aforementioned anthropometric indices is evident from study. The effect of these indices on liver size should be taken into cognizance during ultrasound examination to avoid the possibility of false negative and false positive diagnosis. Also estimation of liver size on the basis of a single parameter such as MCL or AAL may be limited by some of these variables because the liver is oriented longitudinally in slender individuals and transversely in heavily built individuals[13].

Conclusion

Based on findings of this study, height and BMI exert an influence on the size of the liver with BMI having a greater influence. It is important that liver size be measured in both midclavicular and anterior axillary line before a diagnosis based on size is made. The influence of anthropometric variables on liver size should also be taken into consideration. Establishment of average liver sizes in different regions and sub-regions will provide a baseline data for diagnosis of any liver related disease that may alter its size in that particular region.

Reference

1. Joshi R, Singh A, Jajoo N, Pai M, Kalantri SP: Accuracy and reliability of palpation and percussion for detecting hepatomegaly: a rural hospital based study. Indian J Gastroenterol 2004:23: 271-274.
2. Verma, SK, McClure K, Parker, L, Mitchell, DG, Verma, M, Bergin D. "Simple linear measurements of the normal liver: Interobserver agreement and correlation with hepatic volume on MRI" (2010). Department of Radiology Faculty Papers,Paper 8. Available at: http://jdc.jefferson.edu/radiologyfp/8
3. Li YS, Kardoff R, Richter J, Sun KY, Zhou H, McManus DP, Hatz C. Ultrasound organometry: the importance of body height adjusted normal ranges in assessing liver and spleen diameters among Chinese subjects with schistosoma japonicum

infection. Acta. Trop. 2004; 92(2):133-8

4. Kratzer W, Fritz V, Mason RA. Haenle MM, Kaechele V. Factors affecting liver size: a sonographic survey of 2080 subjects.J Ultrasound Med 2003; 22:1155–1161
5. Dhingbra B, Sharma S, Mishra D, Kumari R, Pandey RM, Aggarwal S: Normal values of liver and spleen size by Ultrasonography in Indian Children. Indian Pediatrics 2010; 47:487-491.
6. Udoh B, Eze CJ, Chiegwu HU: Sonographic Assessment of Liver Sizes in Healthy South East Nigerians. American Journal of Scientific Research 2011, 14:88-92
7. Onwuchekwa RC, Onwuchekwa AC, Arogundade RA: Ultrasonic measurement of the liver in normal adult Nigerians at the University of Port Harcourt Teaching Hospital. Port Harcourt Medical Journal 2012: 6:162-169.
8. Friis H, Ndhlovu P, Mduluza T, Kaondera K, Frank D, Vennevard JB, Christensen NO, Doehring E. Ultrasound organometry: liver and spleen dimensions among children in Zimbabwe. Tropicana medicine and Internal health. 1996, Vol. 1, Issue 2, Pages 183-190
9. Börner N, Schwerk WB, Braun B. Leber. In: Braun B, Günther R, Schwerk WB (eds). Ultraschalldiagnostik. Landsberg, Germany: Ecomed; 1987:1–18.
10. Reddy JK, Rao MS. Lipid metabolism and liver inflammation in fatty liver disease and fatty acid oxidtation.AM. J. Physiol. Gastrointest. liver physiol. 2006; 209(5): 852-858
11. Qian Y, Fan JG. Obesity, Fatty liver and liver cancer.Hbpd. Int. 2005; 4(2): 173- 177.
12. Da Silva RM, Pereira RB, Siqueira MV. Correlation between clinical evaluation of liver size versus ultrasonography evaluation according to body mass index (BMI) and biotypes. Rev Med Chile 2010; 138: 1495-1501. doi: 10.4067/S0034-98872010001300004
13. Niederau C, Sonnenberg A, Muller JE, Erckenbrecht JF, Scholten T, Fritsch WP. Sonographic measurements of the normal liver, spleen, pancreas, and portal vein.Radiology 1983; 149:537–540.

.