

Sonological Evaluation of the Liver, Spleen and the Kidneys in an Adult Southern Nigerian Population

¹A.I. Udoaka, ¹C. Enyi and ²C.E. Agi

¹Department of Anatomy,

²Department of Radiology, University of Port Harcourt, Nigeria

Abstract: The objective of this study was to determine the normal range of dimensions for the liver, spleen and kidneys and see how they correlate with some physical parameters in healthy adult Nigerians. A total of 723 Ijaw (Southern Nigerian) students of the University of Port Harcourt (363 males and 360 females) ages ranging from 18 to 40 years were utilized for the study. The liver, spleen and the kidneys were scanned and measurements taken, the corresponding age, weight, height and body mass index of each subject were also noted. The mean liver length was 13.13±1.09 cm; spleen length was 9.23±1.53 cm. The mean bipolar length and transverse diameter of the left kidney was 10.31±1.10 cm and 5.04±0.63 cm respectively, while the bipolar length and transverse diameter of the right kidney was 10.02±0.97 cm and 5.12±0.68 cm respectively. There was significant difference in organ dimensions with respect to sex ($p<0.05$). The organs dimensions however showed weak correlations with age, sex, weight, length and body mass index.

Keywords: Dimensions, kidneys, liver, spleen, ultrasound

INTRODUCTION

Ultrasonography is a diagnostic medical procedure that uses high frequency sound waves to produce dynamic images (sonograms) of organs tissues and blood flow inside the body. It visualizes the organs by recording pulses (echoes) of the ultrasonic waves using high frequency ranges (Dorland, 2000).

Scanning of the viscera are carried out to know the normal dimensions and the echopatterns and deviations from normal have led to diagnosis or prediction of pathological conditions (Marco *et al.*, 2002). Studies have been carried out on dimensions of various abdominal organs, a work done in Germany by Kratzer *et al.* (2003) demonstrated values for the liver and found that Body Mass Index (BMI) and body height are the most important factors associated with the liver dimension though age and sex also to a lesser degree influence the size of the liver. Safak *et al.* (2005) showed no significant difference with respect to sex but showed correlation of body weight with the size of the liver and spleen whereas the height of individuals only correlated with the right kidney in their study.

Niedarau *et al.* (1983) had showed different orientation of the liver with respect to stature, where slender subjects had transverse orientation while heavy subjects had longitudinal orientation of the liver. In the study by Konus *et al.* (1998), height was best correlated with the longitudinal dimensions of the liver, spleen and kidneys than the body surface area of paediatric

subjects with ages ranging from 5 days to 16 days. In their study also there was no significant difference between the two sexes. Megremis *et al.* (2004) also concluded in their study that there is a positive correlation of the spleen length with age, height and body surface area of the children studied.

Renal sizes have also been studied and the left kidney was found to be longer than the right in the both male and female Malaysian adults (Wang *et al.* 1989). The study by Emamia *et al.* (1993) showed that adult renal size decreased with age as a result of parenchymel reduction and that renal volume correlated best with the total body area while renal length correlated positively with body weight. This was corroborated by Barton *et al.* (2000) amongst the Jamaicans, who also found out in their study that there was significant correlation between the weight of males and the width of the kidneys but not so for the females. A Study in Brazil showed height as the only variable to show association with renal dimensions. Renal length reduced with aging from the 7th decade (Fernandes *et al.*, 2002). Okoye *et al.* (2005) studied adult Igbo in South East Nigerians and established a normogram for both kidneys. They found out that males renal lengths were slightly higher than that of females. Renal length correlated positively with weight but not with height or age. A study by Adeyekun *et al.* (2007) showed the independence of neonatal renal sizes on gender and races. In another study of the Mexicans adult by Carrasco *et al.* (2009), there was reduction in renal length from 60years and also greater renal lengths in males.

The aim of this study was therefore to find out the reference values of the adult liver, spleen and the kidney dimensions and to find out possible correlations with the age and the body mass index of the people of Southern Nigeria. This will be the first of such study to the best of our knowledge amongst the Ijaws of the Niger Delta region in Southern Nigeria.

MATERIALS AND METHODS

Sonographic measurements of the normal liver, spleen and kidney were taken during abdominal ultra sound examinations of 723 (360 females and 363 males) normal healthy students of University of Port Harcourt aged between 18 years and 40 years .The study was done at the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria in 2009. They were randomly selected for this exercise and all of them gave informed consent. The students were all of Ijaw ethnic nationality of the Niger Delta region of Southern Nigeria. The age, height and weight were determined for each subject and the BMI was calculated by the following formula:

$$BMI = \text{Weight(kg)}/\text{height(m)}^2$$

The liver was scanned in five views, four of the views are done with the patient lying on right lateral side, these views are the diaphragm- lung interface, the left liver lobe, sagittal plane and the transverse plane. The fifth view of the right lobe of the liver is from the left lateral side of the lying patient. The transducer was placed on the anterior abdominal wall after applying a lubricating gel at the right upper quadrant and the epigastric area. The liver was visualized as a

homogeneous collection of echoes of moderate echogenicity. Longitudinal scan of the liver in the mid clavicular line was obtained and the Cranio Caudal Length (CCL) measured.

The spleen was scanned at the left hypogastrium, it is viewed in its longitudinal axis and the Cranio-Caudal Length (CCL) measured from both superior and inferior poles of the spleen.

The kidneys were viewed in prone position. The Bipolar Lengths (BPL) and Transverse Diameters (TD) of both kidneys in each subject were measured.

RESULTS

From Table 1 to 4, the mean values of the measurements revealed a larger liver in the males with mean of 13.42±1.43 cm as against 13.0±0.88 cm in the females, this difference was significant (p<0.05). The spleen was also significantly larger in the males. The left kidney was significantly larger in the transverse diameter and the bipolar length in males (p<0.05).The right kidney was only significantly larger in the transverse diameter of the males. The organ dimensions showed very weak positive correlation with age, height and weight except the spleen which had negative correlation in most of the anthropometric parameters. The kidneys showed the highest positive correlation with BMI. The liver and the spleen showed negative correlation with the BMI.

In Table 5, the comparative analysis of measurements in other populations showed that there was no significant difference with the present study from the values of the Mexicans and Jamaicans but there were significant differences in the values of the liver and kidney in the Germans and Americans.

Table 1: Age groups and BMI of the females with corresponding sonographic measurements (cm) of the liver, spleen and the kidneys

Age size	Sample BMI	Liver CCL	Spleen CCL	Left kidney		Right kidney		Group (years)
				BPL	TD	BPL	TD	
18 – 20	48	20.70	13.32	10.36	10.12	4.74	9.42	5.16
21 – 23	61	20.98	13.17	9.44	9.94	4.68	9.83	5.05
24 – 25	90	23.65	13.21	8.98	10.3	4.94	9.98	4.89
27 – 29	63	21.76	12.86	8.90	10.2	4.98	9.83	4.87
30 – 32	47	24.60	12.80	8.85	10.4	5.06	10.10	5.0
33 – 35	32	24.70	12.72	8.74	10.6	5.02	10.40	4.97
36 – 38	12	26.43	12.90	8.97	11.53	4.83	11.20	4.73
39 – 41	7	25.80	13.00	9.23	10.77	5.61	10.77	4.84

Table 2: Age groups and BMI of the males with the corresponding sonographic measurements (cm) of the liver, spleen and the kidneys

Age size	Sample BMI	Liver CCL	Spleen CCL	Left kidney		Right kidney		Group (years)
				BPL	TD	BPL	TD	
18 – 20	43	22.55	12.83	9.91	10.33	5.0	10.03	4.9
21 – 23	67	21.61	13.20	9.28	10.41	5.53	9.89	5.39
24 – 25	83	22.92	13.40	9.30	10.32	5.08	9.44	5.50
27 – 29	64	22.36	13.21	9.10	10.25	4.92	10.0	4.60
30 – 32	42	22.20	13.26	9.05	10.30	4.71	9.9	4.41
33 – 35	36	23.00	13.32	9.90	10.40	4.97	9.95	5.20
36 – 38	17	24.50	12.90	8.94	10.62	4.83	11.04	4.73
39 – 41	71	24.12	13.70	9.00	11.09	5.71	11.35	5.71

Table 3: Mean Sonographic Measurement (cm) of males and females

Measurements		Male (n = 383)	Females (n = 360)	Both (n = 723)
		Mean±SD	Mean±SD	Mean±SD
Liver	CCL	13.42±1.43	13.00±0.88	p<0.05 13.13±1.09
Spleen	CCL	9.82±1.82	9.12±1.22	p<0.05 9.23±1.52
Left kidney	BPL	10.4±1.08	10.27±1.12	p<0.05 10.31±1.10
	TD	5.21±0.76	4.97±0.55	p<0.05 5.04±0.63
Right kidney	BPL	10.0±0.99	10.03±0.99	p<0.05 10.02±0.97
	TD	5.68±0.7	4.87±0.5	p<0.05 5.12±0.68

Table 4: Correlation (r) with physical data

Measurements	Age	Height	Weight	BMI	
Liver	+0.01	+0.18	+0.07	-0.04	
Spleen	-0.20	+0.20	-0.01	-0.07	
Left kidney	BPL	+0.27	+0.24	+0.44	+0.32
	TD	+0.34	+0.13	+0.30	+0.22
Right kidney	BPL	+0.36	+0.09	+0.43	+0.35
	TD	+0.04	+0.28	+0.05	+0.03

Table 5: Comparative Mean Sonographic measurements for the pooled sample

Measurements	Population	Population	Author/year	
LIVER	CCL	Germans	14.0±1.7	Kratecekes 2003
		Nigerians	13.13±1.09	Present study
Spleen	CCL	Germans	5.8±1.8	Niedaruet <i>et al.</i> (1983)
		Americans	10.65±1.55	Hosey <i>et al.</i> (2006)
		Nigerians	9.23±1.52	Present study
Left kidney	BPL	Jamaicans	10±0.7	Barton <i>et al.</i> (2000)
		Danish	11.20	Emamia <i>et al.</i> (1993)
		Mexicans	10.58±0.75	Carraso <i>et al.</i> (2009)
		Nigerians	10.31±1.10	Present study
Right kidney	BPL	Jamaicans	9.7±0.7	Barton <i>et al.</i> 2000
		Mexicans	10.43±0.65	Carraso <i>et al.</i> (2009)
		Nigerians	10.02±0.97	Present study

DISCUSSION

Ultrasonography is one of the most common imaging methods used in routine practice for visualizing the normal anatomy and is also simple and reliable to visualize pathological changes in the abdominal organs. The objective of this study was to define mean organ dimensions in adult Southern Nigerians, correlate the measurements with age, weight, height and BMI and compare the values with those of other nationals from earlier studies.

Diagnostic imaging techniques are superior to the clinical examination in determining the size of the liver (Sapira and Wiliamson, 1979; Zoli *et al.*, 1995). However, there is a paucity of data regarding normal and borderline values and no uniform procedure for sonographical measurement of the size of the liver has been established. The method used in this study was the method described by Borner *et al.* (1987). Analysis of craniocaudal length of the liver in this study showed that the mean length of the liver at mid clavicular line was 13.0±0.88 cm and 13.42±1.43 cm for females and males respectively. This data showed an absolute size difference between male and female subjects (p<0.05). This study is keeping with that of Andersen *et al.* (2002). A pooled mean of 13.13±1.09 cm was found for the population.

Comparative analysis of the liver size in this study with those of South West Germany (Kratzer *et al.*, 2003) showed larger liver size of 14.0±1.7 cm for the Germans and this difference was significant (p<0.05). The liver size however showed weak correlation with

age, height, weight and BMI. This finding is in line with the study of Niedarau *et al.* (1983) where they found that abdominal organs had poor correlation with physical data.

Enlargement of the spleen is an important criterion in diagnosing pathologies of the spleen. Ultrasound examination is an accurate and safe method to determine normal spleen size. In this study, the craniocaudal length of the spleen was measured. The value was 9.62±1 cm and 9.12±1.22 cm for the males and females respectively. A significant difference (p<0.05) was found between the gender and this finding was similar to that of Hosey *et al.* (2006) amongst the Americans. A mean spleen length of 10.65±1.55 cm for the pooled population from their study is significantly greater than ours. This fact was also noted by them in their conclusion that the spleen size of the white subjects was larger than the black Americans. Correlation with physical data in our findings was weak and negative implying that the spleen sizes got slightly smaller with age and BMI. Megremis *et al.* (2004) on the contrary found strong correlation of the spleen with age, height and body surface area.

Renal dimensions and growth charts were originally measured at intravenous urography (Hodson *et al.*, 1975). Measurement of renal size was subject to marked variability (Griffith *et al.*, 1975) because of differences in tube centering, respiratory changes and osmotic effects of the contrast material. The advent of real time sonography has enabled accurate measurement of the kidneys. The sizes of the kidneys were determined by measuring the bipolar length and the transverse diameter in this study. The bipolar length of the left kidney (10.31±1.10 cm) was greater than the right kidney (10.02±0.97 cm) and this corroborates earlier studies (Safak *et al.*, 2005; Eze and Okaro, 2005). The mean transverse diameter was 5.04±0.63 cm and 5.12±0.68 cm for left and right kidneys respectively. This shows a slender but longer left kidney than the right. This was reported by Ludin (1956) who suggested the idea of measuring both renal length and breath since the kidney may have varying lengths and breaths.

Comparative analysis of the kidney dimensions showed no significant difference between the study population and those of Mexicans (Carraso *et al.*, 2009) and previous study among the South East Nigeria by Okoye *et al.* (2005) and the Jamaicans (Barton *et al.*, 2000). The Danes studied by Emamia *et al.* (1993)

showed larger renal size compared to the study population. Our subjects showed relatively stronger correlation with the physical parameters of age, height, weight and BMI in the kidneys than the liver and spleen.

In conclusion, our study has provided anthropometric parameters of the liver, spleen and the kidneys for the Ijaw speaking people of Southern Nigeria which will be useful in assessing these organs for any pathological enlargement or reduction in clinical practice.

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