Original Article

SONOGRAPHIC ASSESSMENT OF LIVER DIMENSION AMONG SCHOOL AGED CHILDREN IN CALABAR, SOUTH-SOUTH NIGERIA

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ABSTRACT

BACKGROUND: One of the organs readily assessed during abdominal scanning is the liver and this is due to the wide range of diseases associated with changes in liver size. Ultrasound scan remains a very important modality for liver evaluation because it is simple, not expensive, non-invasive and readily available but yet there is no record of ultrasound measurement of liver sizes among school - age children in Calabar.

METHOD: Four hundred and seventy apparently healthy school-age children (3-14 years) were studied. 244(52%) were females, mean age 8.2±1.6 years and 226(48%) were males, mean age 8.0±1.4 years. Liver size of the subjects was measured sonographically in the right midclavicular line to determine anteroposterior (AP) and longitudinal diameters of the liver. Biodata of the subjects (sex, age, height, weight and body mass index (BMI) were evaluated prospectively . The subjects were divided into four groups according to age, sex, height and weight.

RESULTS: The mean AP and longitudinal diameter of the liver for males was 102.5±7.3mm and 130.9±7.4mm respectively and that of females was 98.3±6.6mm and 121.0±5.1mm respectively. Age, height and BMI significantly correlated with the longitudinal and AP diameter of the liver ($r > 0.5, P < 0.002$).

CONCLUSION: School age children in Calabar have a mean AP diameter of liver as 100.3±7.3mm with a range of 75.2-129mm and a mean longitudinal diameter of liver as 125.0±10.4mm with a range of 100 - 158mm.

KEYWORDS: liver, sonography, diameter, midclavicular line.

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INTRODUCTION

Hepatomegaly (enlargement of the liver) is a frequent clinical finding in children, and may be caused by intrinsic liver diseases or by systemic alterations (Walker et al., 1975)[1]. In cases of clinical suspicions, ultrasonography (US) is generally the method of choice for diagnostic investigation in paediatric patients.

Diagnostic imaging techniques are superior to clinical examination in determining the size of the liver (Sapina et al, 1978 and Zoli et al., 1995)[2,3]. To date, however, there is a paucity of data regarding normal and borderline values of liver dimension in school aged children in the locality. Biometry studies in children by means of ultrasonography, however propose different methods (Walker et al., 1975);[1] Holder et al., 1975[4]; Wladimiroff et al., 1977[5]; Rylance et al; 1977[6]), but none of them with consensus acceptance.

Liver size may give information about the diagnosis and prognosis of gastrointestinal and haematological diseases. Hepatic distention and smooth enlargement are typical of significant right-sided heart failure, which occurs because of hepatic venous congestion secondary to impaired myocardial function (Douglas et al., 1990)[7]. Many diseases can affect their size, ranging from infective processes to malignant disorders (Zhang et al., 1989[8] and Joshi et al., 2004)[9].

Palpation and percussion are the standard bedside techniques to determine liver size, but are far from accurate to detect small increase in size and are not reliable (Zhang et al., 1989[8]). Technetium liver scan were popular in the past but often underestimate the size of the liver (Douglas et al., 1990)[7]. Radiography and

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radionuclide studies expose the patients to ionizing radiation (Yagan et al., 1962[10]; Ptahler et al., 1962[11]; Zelman 1959[12]; Peternal et al., 1966[13]; Walk et al., 1967)[14]. Computed tomography is quite expensive and uncommon in our locality. Ultrasound has been found to be both accurate and widespread in clinical use and in the imaging of the liver (Benjamin et al) [15] and has no proven health hazard.

The liver supports almost every organ in the body and is vital for survival. Because of its strategic location and multidimensional functions, the liver is also prone to many diseases. With the advent of liver transplantation, it has become clear that there is a great need for an exact determination of liver size in a given locality

Alper et al., (2005)[16] sonographically assessed the normal limits and percentile of liver dimension in healthy school age children between 7-15 years and found out that there was no significant difference in liver dimensions with respect to sex ($P > 0.05$). On the other hand, KonuUs et al., (1998)[17] noted that there is a statistically significant correlation between age, weight, height and body surface area (BSA) of children and the liver size, after evaluating liver size dimension in 358 school children.

Sonography is routinely used to determine the internal structures of the body and their measurement because the examination is real time, three-dimensional and independent of organ function. The variation in the dimension of the liver of various populations, races and regions is an established fact. The climate, socio-economic status, and type of food in Calabar makes the population of this region special.

Despite the affordability of ultrasound services in Calabar, Cross River State, there is no comprehensive anthropometric study on the normal measurements of liver dimension in this region. This study was conducted to establish the normal liver dimensions using ultrasound in apparently healthy school age children of Calabar, Cross River State.

Method

Four hundred and seventy (470) apparently healthy school - age children (3- 14 years) from six Primary Schools in Calabar were scanned using scanner 250 (Sonoline LX Siemens Medical System) with curvelinear array transducer of frequency 3.5-5.0MHZ. Permission and consent was obtained from the head teacher, teachers and parents of the children in the different schools. The examination was carried out with the subjects in the supine position on the couch. An ultrasound gel was applied on the abdomen and the subjects were scanned in different planes to assess the anteroposterior diameter and the longitudinal diameter of the liver at the midclavicular region.

For better access to the liver, subjects were instructed to raise their right hand behind their head, thus increasing the intercostal spaces and the distance from the lower costal margin to the iliac crest. The measurements were made during quiet breathing with a relaxed abdominal wall in younger children and during breath-holding in older children. No preparation or sedation was used. The size of the liver was measured in the right MCL (with measurement from the hepatic dome to the inferior hepatic tip) according to the method described by Borner et al., (1987)[18]. An imaginary vertical line was drawn from the midclavicular point to the midinguinal point and was defined as the midclavicular line (MCL). The age was recorded to the nearest completed month. An electronic weighing scale (accuracy 50g) and a measuring tape/meter rule were used to measure weight and height of the subjects. The subjects' BMI were calculated by the following formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}.$$

Statistical Analysis

Descriptive statistics was used to compute the mean and range of the variables. Correlation and regression equations were used to assess the relationships of liver dimensions with sex, age, height, weight, and BMI. $P < 0.05$ was chosen as level of significance. Data was analyzed with SPSS version 16.0 (SPSS Inc, Chicago, IL).

Results

Four hundred and seventy (470) apparently healthy school aged children were studied. There were 244 females, mean age 8.2±1.6 years and 226 males, mean age 8.0±1.4 years. Majority of the subjects were between 6 and 8 years (Table 1).

The mean AP diameter of the liver for male subjects was 102.5±7.3mm (range =85-129mm) while that of the females was 98.3±6.6mm (range = 75 – 121mm). The mean longitudinal diameter of the liver for male subjects was 130.9 ± 10.4mm (range = 105 – 158mm) while that of female was 121.0 ± 5.1mm (range, 100 – 150mm). There was a significance difference in liver dimension between male and female subjects ($p < 0.002$). Males had larger liver dimension than females. The study also showed that liver dimension increases with age. When correlated with age and physical data, age had the largest correlation co-efficient (0.7) with antero-posterior dimension while height had the largest correlation co-efficient (0.5) with longitudinal diameter of the liver (Table 3). The body habitus correlated significantly with liver dimensions. Age, however, exerts the greatest influence on liver size among the pupils (Table 2).

Table 1: Age Range of subjects

Age Range (Yrs)	Frequency	Percentage
[illegible]	48	10.21%
6 – 8	264	56.17%
9 – 11	122	25.96%
12- 14	36	7.66%
Total	**470**	**100**

Table 2: Distribution of liver dimension of pupils according to age

Age group	AP diameter		Long Diameter	
	[illegible]		Mean ± SD	Range
3- 5	[illegible]	[illegible]	[illegible]	[illegible]
6-8	100.3 ±6.0	75- 115	121.0 ± 10.6	105 – 135
9-11	107.5 ± 6.7	96-118	131.5 ± 12.0	123 – 153
12-14	113.7 ± 7.1	106 -125	142.3 ± 13.4	126 - 158

Table 3: Distribution of liver dimension of pupils according to height

Height (m)	AP diameter (mm)		Long Diameter (mm)	
	Mean ± SD	Range	Mean ± SD	Range
<1.10	50.3±6.0	75- 85	106.7 ± 8.2	100 – 110
1.10 – 1.29	99.3 ± 4.1	87- 106	124.2 ± 10.2	112 – 127
1.30 – 1.49	109.6 ± 4.6	97-127	135.1 ± 93	117 – 141
1.50 – 1.69	115.8 ± 4.5	109 -125	141.6 ± 6.1	132 - 152

DISCUSSION

The results of this present study show that the mean AP diameter of the liver for male subjects was 102.5±7.3mm (range 85-129mm) while that of females was 98.3±6.6mm (range 75-121mm). The mean longitudinal diameter of the liver for males was 130.9±10.4mm (range 105-158mm), while that of the females was 121.0±5.1mm (range 100-150mm). There was a significant difference in the liver dimension between male and female subjects ($P < 0.001$), males had larger liver dimensions than females. This agrees with the well-known phenomenon that male gastrointestinal organs are larger than female organs. This phenomenon has been documented in studies using other diagnostic imaging techniques (Gladish et al., 1988[19], Anderson et al., 2000)[20].

The sex-related difference in the size of the liver dimensions among school - age children was also observed by other authors. (Rosenberg et al., 1991[21]; Soyupak et al., 2002[22]; Dinkel et al., 1985[23]). The liver size in selected children population presented a continuous and progressive increase with age. This is also in agreement with literatures (Holder et al., 1975[24]; Wladimiroff et al., 1975[5]; Dittrich et al., 1983[25]; Konus et al., 1998[17]; Capentieri et al., 1977[26] and Safak et al., 2005)[27]. Rocha et al., (2009)[28] noted that the liver size present a progressive growth from birth up to the age of 7. They also documented that there was no correlation of liver size with the body mass index. On the other hand, Konus et al., (1998)[17] found a correlation coefficient of 0.80 and 0.85 between child's weight and height (respectively) with liver size.

In the past, clinical liver span measurement was the simplest and most applicable in the developing countries (Singh et al., 1985)[29], 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 (Nafallis et al., 1963)[30]. In addition, radiography and scintigraphy proved to be non-practical because of magnification and unnecessary radiation exposure (Zhang et al., 1989[8], Martisz et al., 1987)[31]. Ultrasound is a cornerstone imaging method for evaluation of the liver. It is easy to use, not expensive nor time consuming and does not involve the use of ionizing radiation.

Liver size and understanding of its significance are important not only because this organ is the largest gland in the body from anatomical standpoint, but also due to the fact that to some extent liver size reflects the extremely multifaceted and complicated functions and may undergo considerable modifications in some diseases. The knowledge of the liver size in different ethnic and age groups could help us understand the intimate mechanisms and involvement of the liver in various pathologies and could assist us find the right and effective approaches to their treatment.

CONCLUSION

Normal liver dimension of school - age children in Calabar ranges from 75.0 - 129mm in AP diameter and 100 – 158mm in longitudinal diameter. This may serve as a quick reference when assessing Liver diseases associated with changes in Liver size in the pediatric age group. Liver dimensions greater than these values may be considered enlarged and would require further investigations.

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