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Normal values of liver size by ultrasonography in children in the Eastern Anatolia region

TURQUIA

Valores normales por ultrasonografía del tamaño del hígado en niños de la región de Anatolia Oriental

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Abstract

Purpose: To purpose of this study was to determine the normal range of liver dimension and the relationship of each with sex, age, body height, and weight in healthy children.
Materıals and methods: The study comprised 310 healthy children (150 girls and 160 boys) with ages ranging from 3 days to 16 years in children in the Eastern Anatolia Region. Children who had underlying malignant tumors, infections, hematologic diseases, or other conditions that could alter organ size were excluded. All measured organs were sonographically normal. One dimension (Midclavicular Line Longitudinal Diameter – MCLLD) was obtained for liver with ultrasonography.
Results: MCLLD of this organ showed the strongest correlation with body height. There was no significant difference between the sexes.
Conclusıons: The normal range of MCLLD can be used to objectively measure the size of the organ in children who have clinically suspected organomegaly. The presented data are applicable in daily routine sonography.

Keywords: midclavicular line, longitudinal diameter, liver, child, ultrasonography

Resumen

Objetivo: *El propósito de este estudio fue determinar el rango normal de la dimensión hepática y la relación de cada uno con el sexo, la edad, la estatura corporal y el peso en niños sanos.*
Materiales y métodos: *El estudio incluyó a 310 niños sanos (150 niñas y 160 niños) con edades comprendidas entre 3 días y 16 años en niños de la región de Anatolia Oriental. Se excluyeron los niños que tenían tumores malignos subyacentes, infecciones, enfermedades hematológicas u otras condiciones que pudieran alterar el tamaño del órgano. Todos los órganos medidos eran sonográficamente normales. Se obtuvo una dimensión (Diámetro Longitudinal de la Línea Midclavicular – MCLLD) para el hígado con ultrasonografía.*
Resultados: *MCLLD de este órgano mostró la mayor correlación con la altura corporal. No hubo diferencias significativas entre los sexos.*
Conclusiones: *El rango normal de MCLLD puede ser usado para medir objetivamente el tamaño del órgano en niños que tienen sospecha clínica de organomegalia. Los datos presentados son aplicables en la ecografía de rutina diaria.*

Palabras clave: *línea mediaclavicular, diámetro longitudinal, hígado, niño, ultrasonografía*

Introductıon

Liver size varies widely according to age. Many diseases can affect their size, ranging from infective processes to malignant disorders.[1] On the contrary, clinically a palpable liver may not be pathological. Pushed down liver due to lung or subdiaphragmatic pathology, and visceroptosis are a few examples of a palpable liver without any clinical significance.[2]

An ultrasound measurement of the liver size in children of different age groups is necessary to help the pediatrician exclude hepatomegaly.

Ultrasonography is a non-invasive, established, safe, quick and accurate method for measurement of liver size.[1] Midclavicular Line Longitudinal Diameter (MCLLD) as it is the most commonly applied measures of estimating liver size in routine diagnostic situations, and is proved to be the best-measured diameter in differentiating between healthy and diseased livers.[3]

Our purpose was primarily to document the normal range of MCLLD of the liver in healthy children. The relationship of MCLLD with sex, age, body height and weight was determined.

Materıals and methods

We measured with ultrasound the liver in 310 children (150 girls and 160 boys; age 0-16).

The children were divided into 11 different groups: 0-3 months, 3-6 months, 6-12 months, 1-2 years, 2-4 years, 4-6 years, 6-8 years, 8-10 years, 10-12 years, 12-14 years, and 14-16 years, respectively. Sex, age, body height, and weight were determined in each case.

The sonographic examinations were performed with a high-resolution real-time scanner with 3.5-MHz convex transducers with the children in the supine position.

The retrospective patient record study of the normal size of the liver by ultrasound is limited in children in the Eastern Anatolia Region. Most children were completely healthy, although some were undergoing follow-up for a disease unrelated to the measured organs, such as hip dysplasia or undescended testes. All subjects included have demonstrated normal homogenous echo pattern of the liver.

MCLLD for each subject was measured. The upper and lower points of the measurement of the liver span were marked and then measured from the sonographic image. **(Fig. 1)**

Statistical analysis was carried out with SPSS/PC version 15.0. Differences in continuous variables between two independent groups were assessed with the t-test and the non-parametric Mann–Whitney U test (n<30).

The measurements were correlated with age, body height and weight of the children evaluated, with the Pearson's correlation coefficient.

Linear regression analysis was carried out to body height, weight, and MCLLD.

Results

Three hundred and ten children (150 girls and 160 boys in the age group from 0 to 16 years) were screened. The liver size increased progressively from birth to 16 years with accelerated growth in the first year.

There were no significant differences in MCLLD with respect to sex. Also, no statistically significant differences were found between the two sexes in any age group for MCLLD (t-test, $p > 0.05$). Therefore, all data were rearranged without being separated according to sex. MCLLD is presented in graphic form. **(Fig. 2)**

Fig. 1: Measurement of MCLLD from hepatic dome to lower hepatic margin

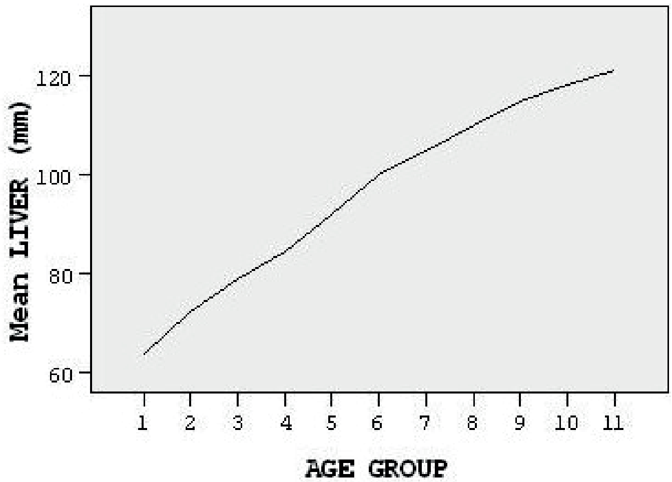

Fig. 2: The line graph shows the distribution of MCLLD of the Liver (mm) according to age group

We determined the normal values, lower (10th percentile) and upper limits (90th percentile) of the liver, and the lower and upper bounds of a 95% confidence interval.

The values for the liver measurement obtained were grouped according to age and the mean values for each age group were calculated.

The descriptive analysis of MCLLD (mean, median, minimum, and maximum values; standard deviations; 10th and 90th percentile values; and lower and upper bounds of a 95% confidence interval) is shown in **Table I**

Subjects			Longitudinal Dimensions (mm) of Right Lobe of Liver								
Age Group		No	**Mean**	SD	Median	Minimun	Maximun	Percentile for Mean		95% Confidence Interval	
								10th	90th	Lower Bound	Upper Bound
1	0-<3 mo	21	**64**	14	63	45	85	46	84	57	70
2	3-<6mo	24	**72**	14	76	47	90	50	87	66	78
3	6-<12 mo	24	**79**	10	78	64	100	68	96	75	83
4	1-<2y	30	**85**	11	84	66	104	69	100	80	89
5	2-<4y	27	**92**	11	93	70	111	75	106	88	96
6	4-<6y	27	**100**	15	104	70	120	77	118	94	106
7	6-<8y	31	**105**	14	108	72	125	80	121	99	110
8	8-<10y	26	**110**	14	112	81	130	85	127	104	115
9	10-<12y	27	**115**	12	117	87	130	94	127	110	119
10	12-<14y	38	**118**	12	122	90	133	97	131	114	122
11	14-<16y	35	**121**	12	127	95	137	99	133	117	125

MCLLD: Midclavicular Line Longitudinal Diameter

Table I: MCLLD of the liver to age by ultrasonography in healthy children (N=310)

The correlation analysis showed a positive and significant correlation between MCLLD, age, body height, and weight, with high correlation coefficients (r > 0.80). Among the body parameters, height was the one best correlated with MCLLD. Correlation coefficients are presented in **Table II**.

In regression analysis, the relationship between the MCLLD, body height and weight was demonstrated in **Table III.**

Parameters	LIVER
Height	0.885
Weight	0,826
Age	0.819

* Correlation is significant at the 0.01 level.
MCLLD: Midclavicular Line Longitudinal Diameter

Table II: Correlations of MCLLD of the Liver with Height, Weight, and Age

Variable		LIVER
Height	Constant	**40.653**
	Coefficient	**0.515**
	Std. Error	**0.015**
	P Value	**<0.001**
Weight	Constant	**70.726**
	Coefficient	**1.072**
	Std. Error	**0.042**
	P Value	**<0.001**

MCLLD: Midclavicular Line Longitudinal Diameter

Table III: Regression Analysis with MCLLD of the Liver as Dependent Variable

Discussion

Establishing normal parameters is mandatory for defining the pathologic changes in the size of the liver in routine sonographic examinations of children.[4-5]

Our objective in this study was to define the normal limits of liver size in children in the Eastern Anatolia Region.

There is no consensus on which measurement parameter is most sensitive for investigating the normal limits of organ dimensions. It is not practical to use the volumes of the liver.[6]

The midclavicular line is better than sagittal line because of the left lobe of the liver, in particular, differs in extension and size from person to person and with age but right lobe measurements are more consistent.[2]

In many studies, the lengths of the liver in the midclavicular and midsagittal planes were both measured, but they found better correlation between the measurement of the midclavicular plane and the body parameters.[7-10]

Thus an assessment in a single longitudinal axis is sufficient and is easier to use.[2-6]

Longitudinal hepatic diameter at the midclavicular line is the most commonly applied and predominant clinical method of estimating liver size in routine diagnostic situations.[7] Therefore, we chose to use only the MCLLD for liver size measurement in our study.

The measurements of the liver presented a positive and significant correlation (p<0.05) with age, weight and body height.[11] Soyupak et al reported that liver dimension showed the best correlation with body weight.[12] Other measurement values also showed an approximately linear increase in the course of development and correlated best with the body height.

The results of our study were in accordance with the findings of those studies.[4-9-10-13]

We found that MCLLD shows the best correlation with the body height. We observed that the increase in the longitudinal dimension of the liver is much more rapid during the first years of life.

We accepted as normal limited the sizes between the 10th end the 90th. In most other studies, sizes between the fifth and the 95th percentile were the accepted normal limits. We also showed the normal values, lower and upper bounds of a 95% confidence interval in **Table I.**

We did not find any significant difference in liver sizes between the two sexes of any age group (t-test, $p > 0.05$). This was concordant with the findings of the other authors.[1-2-4-6-11-13]

Therefore, sex certainly is not a determining factor for organ dimensions in the pediatric age group.[4]

Our results provide a standard set of normal range of liver size according to age and sex of the children, as determined by ultrasonography. We present our data both in tabular and graphic forms with the aim of enabling a more practical evaluation during a sonographic examination.

The tables are practical for use in the routine of the sonographer. Also, we have built the following prediction models of the longitudinal length of the liver, in millimeters, according to body height and weight as an alternative method for the examiners: liver, 40.653 + (body height [centimeters] x 0.515; 70.726 + (body weight [kilograms] x 1.072).

In conclusion, the normal limits of the liver are important parameters during a sonographic examination.

This study revealed that MCLLD showed the best correlation with body height.

We hope this study can be used as a background for further study of a large population and contributes to daily practice in radiology clinics.

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