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The relationship between splenic length in healthy children from the Eastern Anatolia Region and sex, age, body height and weight

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Abstract

Purpose: The normal limits of spleen size must be known in order for pathological changes to be noticed. The aim of this retrospective study is to determine the normal limits of spleen size in healthy children and to reveal their relation to sex, age, body height and weight. **Patients and methods:** Three hundred and ten children (150 girls and 160 boys) between 0–16 years of age in Eastern Anatolia Region who had normal spleen ultrasound appearances were included in this study. The greatest longitudinal distance of the spleen from the dome to the tip (splenic length) measured at the hilum in the coronal plane was obtained by ultrasonography. **Results:** There was no significant difference between the sexes in children. Also, no statistically significant differences were found between the two sexes in any age group for splenic length (*t*-test, $p > 0.05$). Therefore, all data were rearranged without being separated according to sex. The correlation analysis has shown a positive and significant correlation between splenic length and age, body height, and weight, with high correlation coefficients ($r > 0.80$). Splenic length showed the strongest correlation with body height. **Conclusion:** In children clinically suspected of organomegaly, splenic length can be used to assess organ size. The presented data can be applied to routine ultrasonography examinations.

Introduction

The spleen has an average of 12 cm in length, 7 cm in width and 3–4 cm in thickness in adults. The spleen reaches its maximum size at the age of 13 years. Normally, splenic length (SL) should not exceed 15 cm. The increase in SL is rapid in the first year of life. These limits in children may vary from age to age^(1,2).

The normal limits of spleen size must be known in order for pathological changes to be recognized. It is impractical to calculate the volume of the spleen. For this reason, especially SL determination is more meaningful and important^(1,3–5).

The aim of this study has been to determine the normal range of spleen size in healthy children by ultrasonography, and to reveal its relation to sex, age, body height and weight.

Patients and methods

Our retrospective study, approved by the Ethics Committee, designed to standardize the size of the spleen is limited to children in the Eastern Anatolia Region. This study included 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. Sex, age, body height, and weight were determined in each case.

Most of the children referred for US examination had various abdominopelvic problems such as nonspecific abdominal pain. Only the children who did not have a spleen pathology on ultrasonography were included in the study. The measured organs had a normal position, contour and echo structure. In the course of about 2 years, each measurement was performed by a radiologist.



Fig. 1. Measurement of splenic length from the dome to the tip

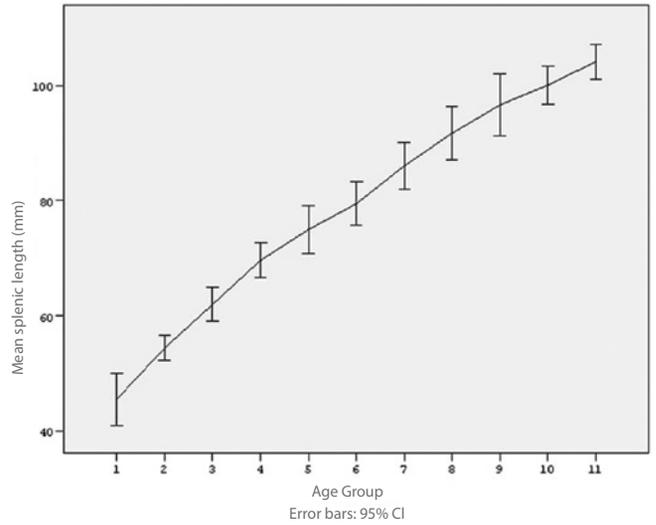


Fig. 2. The line graph shows the distribution of the upper and lower limits of 95% confidence interval (CI) for mean splenic length (mm) according to age group

For the measurement of SL, each child was placed in a supine and right lateral decubitus position. The measurements were made during deep inspiration wherever possible, with an ultrasound 3.5 MHz convex transducer. The greatest longitudinal distance of the spleen from the dome to the tip (splenic length) measured at the hilum in the coronal plane was obtained (Fig. 1).

SL was statistically analyzed on a computer using the SPSS/PC version 15.0 package program for sex, body height and weight for each age group. Mean, standard deviation, median, minimum, maximum, 10th and 90th percentile values were calculated. The upper and lower limits of 95% confidence interval for mean were determined. The graph of SL average values of the spleen according to age groups was drawn. The „t-test” and the „Nonparametric Mann-Whitney U Test ($n < 30$)” were used to assess the differences between the two independent groups. Pearson’s correlation coefficients between SL and age, height, and weight were evaluated. Linear regression analysis was performed to determine the exact pattern of the relationship.

Results

The splenic length of three hundred and ten children (150 girls and 160 boys in the age group from 0 to 16 years) was measured by ultrasonography.

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

SL has been presented in a graphic form (Fig. 2). The descriptive analysis of SL (mean, median, minimum and maximum values, standard deviations, 10th and 90th per-

centile values, and lower and upper bounds of a 95% confidence interval) has been shown in Table 1.

The correlation analysis has shown a positive and significant correlation between SL, age, body height, and weight, with high correlation coefficients ($r > 0.80$). Among the body parameters, height was the one best correlated with SL. SL relative to body height has been shown in Table 2. Correlation coefficients have been presented in Table 3.

We have built the following prediction models of SL, in millimeters, according to body height and weight as an alternative method for examiners: spleen, $24.934 + (\text{body height [centimeters]} \times 0.498)$; $53.757 + (\text{body weight [kilograms]} \times 1.046)$.

The results of regression analysis concerning the relationship between SL, body height and weight have been demonstrated in Table 4.

Discussion

It is important to determine the pathologic changes in spleen sizes in the ultrasonographic evaluation of children⁽⁶⁻⁸⁾. The normal ranges should be known, so that pathological changes can be recognized. It should also be noted that the size of the spleen may vary according to the age group of the children. In adulthood, spleen size is bigger in men than in women⁽⁹⁾.

There are numerous studies in the literature related to spleen size in children. However, there has been no such retrospective study investigating splenic size in children from the Eastern Anatolia Region. Our aim was to determine the normal standards of spleen sizes in Turkish children living in the Eastern Anatolia Region.

Subjects		Splenic length (mm)								
Age Group	N	Mean	SD	Median	Min.	Max.	Percentile		95% Confidence Interval for Mean	
							10 th	90 th	Lower bound	Upper bound
0 – <3 mo	21	46	10	47	29	65	33	61	41	50
3 – <6 mo	24	54	5	55	46	67	47	62	52	57
6 – <12 mo	24	62	7	61	50	75	54	74	59	65
1 – <2 y	30	70	8	71	53	82	57	80	67	73
2 – <4 y	27	75	11	75	58	99	62	89	71	79
4 – <6 y	27	79	10	78	65	99	67	94	76	83
6 – <8 y	31	86	11	84	67	106	74	101	82	90
8 – <10 y	26	92	12	93	65	114	76	107	87	96
10 – <12 y	27	97	14	101	68	114	73	111	91	102
12 – <14 y	38	100	10	101	78	116	85	114	97	103
14 – <16 y	35	104	9	101	87	124	94	118	101	107

Tab. 1. Splenic length to age by ultrasonography in healthy children (n = 310)

Ultrasonography is the most widely used imaging method in routine practice that does not expose patients to ionizing radiation. Ultrasonographic examination can be performed in a supine and mild right lateral decubitus position. In our study, the greatest longitudinal distance of the spleen from the dome to the tip (splenic length), measured at the hilum in the coronal plane was obtained.

There is significant growth in the first 3–4 years of life in the spleen. The maximum size is reached at 13 years old^(1,2,9). Spleen size is different for each pediatric age group until they are adult⁽¹⁰⁾. We observed that the increase in SL is much more rapid during the first years of life.

It is impractical to calculate the volume of the spleen. It is also useless to associate it with body surface area, which is a somatometric parameter in daily practice. For that reason, SL is significant^(1,2,9–11).

We accepted the sizes between the 10th and the 90th percentile as within normal limits. In most other studies, the 5th and the 95th percentile were the accepted normal limits. We have shown the normal values, lower and upper bounds of a 95% confidence interval in Table 1.

Body height (cm)	Splenic length – mean (mm)	Standard deviation
45–60	44	8
61–80	62	8
81–100	74	8
101–120	81	9
121–140	86	9
141–160	100	7
161–174	108	7

Tab. 2. Splenic length relative to body height

Parameters	Spleen
Height	0.924
Weight	0.871
Age	0.874
Correlation is significant at the 0.01 level	

Tab. 3. Correlations of splenic length with height, weight, and age

There are no significant differences between the sexes in children. Sex certainly is not a determining factor for organ dimensions in the pediatric age group^(3,10,12,13). We did not find any significant difference in spleen sizes between the two sexes of any age group (t-test, $p > 0.05$). Therefore, all data were rearranged without being separated according to sex.

It has been found that SL correlates better with height in most studies^(1,10,12,14–18). The results of our study are in accordance with the findings of those studies. On the other hand, in some studies weight or age correlate better with splenic length^(3,13,19–22).

Variable		Spleen
Height	Constant	24.934
	Coefficient	0.498
	Std. Error	0.012
	P Value	<0.001
Weight	Constant	53.757
	Coefficient	1.046
	Std. Error	0.034
	P Value	<0.001

Tab. 4. Regression analysis with SL as a dependent variable

Our results provide a standard set of normal ranges of spleen size according to the age 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 routine use in US examinations.

Conclusion

The normal limits of spleen size are important parameters during a sonographic examination. This study has revealed

SL to show the best correlation with body height. Sex is not a determining factor for spleen size in the pediatric age group. We hope our research can be used as a background for further study of a larger population, and contributes to daily practice in radiology clinics.

Conflict of interest

Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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