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

Mete Özdikici

Department of Radiology, Bakirköy Training and Research Hospital, Istanbul, Turkey
Correspondence: Mete Özdikici, Department of Radiology, Bakırköy Training and Research Hospital, Istanbul, Turkey, tel. +90 506 530 94 67, e-mail: metezdikici@hotmail.com

DOI: 10.15557/JoU.2018.0001

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.

Keywords
spleen, splenic length, splenomegaly, child, ultrasonography

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 age1,2.

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 important1,3–5.

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.
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 percentile 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 + (body height [centimeters] x 0.498); 53.757 + (body weight [kilograms] x 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 pathologic 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.
The relationship between splenic length in healthy children from the Eastern Anatolia Region and sex, age, body height and weight

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.

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).

| Subjects | Splenic length (mm) |
|----------|---------------------|
| Age Group | N | Mean | SD | Median | Min. | Max. | Percentile | 95% Confidence Interval for Mean |
|----------|---|------|----|--------|-----|------|------------|--------------------------------|
|          |   |      |    |        |     |      | 10th | 90th | 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)

| Parameters | Spleen |
|------------|--------|
| Height     | 0.924  |
| Weight     | 0.871  |
| Age        | 0.874  |

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

| 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

| 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
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.

References

1. Megremis SD, Vlachonikolis IG, Tsilimigaki AM: Spleen length in childhood with US: Normal values based on age, sex, and somatometric parameters. Radiology 2004; 231: 129–134.
2. Prassopoulos P, Cavouras D: CT assessment of normal splenic size in children. Acta Radiol 1994; 35: 152–154.
3. Safak AA, Simsek E, Bahcebasi T: Sonographic assessment of the normal limits and percentile curves of liver, spleen, and kidney dimensions in healthy school-aged children. J Ultrasound Med 2005; 24: 1359–1364.
4. De Odorico J, Spaulding KA, Pretorius DH, Lev-Toaff AS, Bailey TB, Nelson TR: Normal splenic volumes estimated using three-dimensional ultrasonography. J Ultrasound Med 1999; 18: 231–236.
5. Watanabe Y, Todani T, Noda T, Yamamoto S: Standard splenic volume in children and young adults measured from CT images. Surg Today 1997; 27: 726–728.
6. Guibaud L: [Sonography of the pediatric abdomen: pancreas and spleen]. J Radiol 2001; 82: 755–763.
7. Capaccioli L, Stecco A, Vanzi E, Brizzi E: Ultrasonographic study on the growth and dimensions of healthy children and adults organs. Ital J Anat Embryol 2000; 105: 1–50.
8. Eze CU, Agwu KK, Ezeezor DN, Agwuna KK, Aronu AE: Sonographic determination of spleen to left kidney ratio among Igbo school age children of south east Nigeria. Afr Health Sci 2014; 14: 246–254.
9. Niederer C, Sonnenberg A, Müller JE, Erckenbrecht JF, Scholten T, Fritsch WP: Sonographic measurements of the normal liver, spleen, pancreas, and portal vein. Radiology 1983; 149: 537–540.
10. Konuş OL, Ozdemir A, Akkaya A, Erbaş G, Celik H, İşik S: Normal liver, spleen, and kidney dimensions in neonates, infants, and children: evaluation with sonography. AJR Am J Roentgenol 1998; 171: 1693–1698.
11. Sarac K, Kutlu R, Yakinci C, Durmaz Y, Baysal T, Özgen Ü: Sonographic evaluation of liver and spleen size in school-age children. Turk J Med Sci 2000; 30: 187–190.
12. Thapa NB, Shah S, Pradhan A, Rijal K, Pradhan A, Basnet S: Sonographic assessment of the normal dimensions of liver, spleen, and kidney in healthy children at tertiary care hospital. Kathmandu Univ Med J (KUMJ) 2015; 13: 286–291.
13. Wuznakulasuriya DTD, Peries PPUC, Rathnasekara YAC, Jayawardena KATM, Upasena A, Wickremasinghe AR: Ultrasonographic parameters of the liver, spleen and kidneys among a cohort of school children in Sri Lanka. BMC Pediatr 2017; 17: 192.
14. Rosenberg HK, Markowitz RI, Kolberg H, Park C, Hubbard A, Bellah RD: Normal splenic size in infants and children: sonographic measurements. AJR Am J Roentgenol 1991; 157: 119–121.
15. Dittrich M, Milde S, Dinkel E, Baumann W, Weitzel D: Sonographic biometry of liver and spleen size in childhood. Pediatr Radiol 1983; 13: 206–211.
16. Ehimiwenma O, Tagbo MT: Determination of normal dimension of the spleen by ultrasound in an endemic tropical environment. Niger Med J 2011; 52: 198–203.
17. Poddar U, Jagadisan B: Measuring liver and spleen by ultrasonography. Indian Pediatr 2010; 47: 475–476.
18. Dhingra B, Sharma S, Mishra D, Kamari R, Pandey RM, Aggarwal S: Normal values of liver and spleen size by ultrasonography in Indian children. Indian Pediatr 2010; 47: 487–492.
19. Soyupak SK, Narli N, Yapicioglu H, Satar M, Aksungur EH: Sonographic measurements of the liver, spleen and kidney dimensions in the healthy term and preterm newborns. Eur J Radiol 2002; 43: 73–78.
20. Tanna NA, Ambiy MV, Tanna VA, Joshi HA: Ultrasonic measurement of normal splenic size in infants and children in paediatric Indian population. Natl J Community Med 2012; 3: 529–533.
21. Eceofor SN, Obikili EN, Anyanwu GE, Onuh AC, Mgbor SO: Sonographic assessment of the normal limits of the spleen in healthy school children in South-East Nigeria. Niger J Clin Pract 2014; 17: 484–488.
22. Schlesinger AE, Kang GB, Boxer LA: Volume of the spleen in children as measured on CT scans: normal standards as a function of body weight. AJR Am J Roentgenol 1993; 160: 1107–1109.