



ULTRASOUND EVALUATION OF NORMAL SPLENIC SIZE IN PEDIATRIC POPULATION

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ABSTRACT

Background: In pediatric population knowledge of the normal splenic size and its relation to age and anthropometric parameters of growth is of importance for the determination of mild splenomegaly.

Objective: The purpose of this study is to measure normal splenic size in pediatric population of 5-15 years of age by ultrasonography and to establish correlation of the splenic size with anthropometric parameters like age, height, weight, BMI and BSA.

Methods:

Study design: cross sectional research design.

Setting: Raja Muthiah Medical College, Annamalai University for a period of one year.

Participants: A total of 100 children of age 5-15 years were included. The examination was done either in a supine or right lateral decubitus position. Measurements: The splenic length was measured from the dome to the splenic tip through the splenic hilum. Demographic data were collected on each participant at the time of their pre-participation physical examination. This information included age, sex, and height and body weight. BSA and BMI were computed from measured height and weight.

Results: The mean spleen length in the pediatric population studied was 81.8 mm among the boys and 79.01 mm among the girls. There was significant relation between the spleen size and age, height, weight and body surface area.

Conclusion: The conventional method of recording splenic size by clinical examination has been reported to lack both accuracy and reliability. Our aim was to provide a more objective assessment of splenic size during routine abdominal Ultrasonogram. Our results would be used as handy, reliable normative values and is suitable for sonography units and pediatric radiology departments with a large number of patients.

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INTRODUCTION

Palpation and percussion are the standard bedside techniques to document spleen size but are far from accurate to detect small increase in size. The spleen has to be enlarged two to three times its normal size to be clinically palpable. Clinical assessment lacks both accuracy and reliability. The purpose of this study was to establish a standard nomogram for splenic length based on age, sex and somatometric parameters like body weight, height, body surface area and body mass index in children aged 5-15 years. A single, simple sonographic measurement gives a clinically useful indication of splenic

size. Knowledge of the normal range of spleen size in the pediatric population is a pre-requisite.

Methods: Study design: cross sectional research design.

Setting: Raja Muthiah Medical College and Hospital, Annamalai University for a period of 1 year.

Participants: A total of 100 children of age 5-15 years were included. The examination was done either in a supine or right lateral decubitus position. A coupling medium was first applied to the area being scanned to ensure good transmission of the ultrasound beam into the subjects.

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Measurements: The splenic length was measured from the dome to the splenic tip through the splenic hilum. The longitudinal measurement of splenic length was done in the coronal plane between the most superomedial and most inferolateral points of the spleen. The technique of right lateral decubitus position was adopted for this measurement.

Demographic data were collected on each participant at the time of their pre-participation physical examination. This information included age, sex, and height and body weight. BSA and BMI were computed from measured height and weight. Weight was measured on a calibrated portable weighing scale to the nearest 0.1 kg with the participants wearing light clothes and without footwear. Height was measured without footwear to the nearest 0.5 cm with the participants standing upright with head in the Frankfurt position. Body mass index and body surface area were calculated using the following formulae.

$$BMI = Wt \div HT^2$$

$$BSA = \sqrt{(Wt \times Ht) \div 3600}$$

Inclusion Criteria

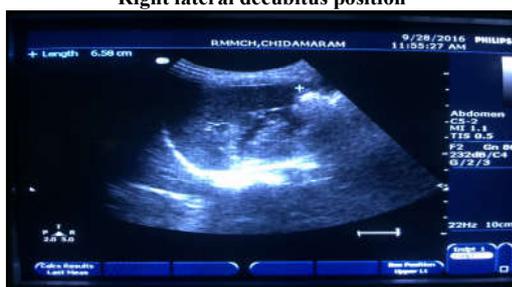
- Subjects with no history of malaria, typhoid fever, sickle cell disease or obesity.
- Subjects with no evidence of splenic parenchymal mass lesions.
- Subjects without accessory spleens or splenic cysts.

Exclusion Criteria

- Subjects with tropical splenomegaly, lymphadenopathy, and splenic parenchymal disease.
- Subjects with congenital anomalies of spleen.
- Subjects with splenic cysts.
- Subjects with hemoglobinopathies.
- Subjects with history of splenectomy.
- Subjects with skin infection at the area of spleen.



Right lateral decubitus position



Coronal view of the spleen

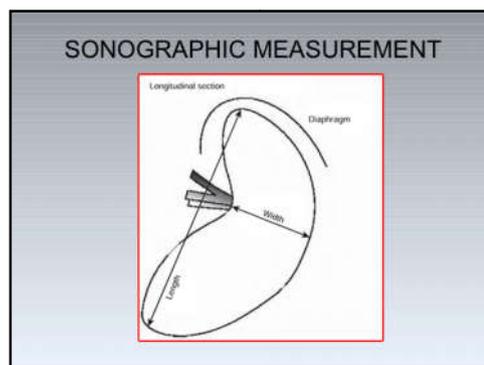


Diagram shows sonographic approach to measure splenic length and width. Splenic size is best measured by obtaining a coronal view that includes the hilum.

Statistical analysis: Difference of continuous variables is tested using one –way analysis of variance (ANOVA). Statistical package was done with SPSS version 16.0. Statistical significance was considered at p value <0.05.

RESULTS

A total of 100 children from the age group of 5-15 years were included in the study. Fig 1 shows the sex distribution from different age groups. The Table 1 shows the age wise distribution of the spleen length in both genders. As age increases, the splenic size increases showing a positive correlation. Table 2 shows the relationship of the splenic size with the height. The mean spleen length in the pediatric population studied was 81.8 mm among the boys and 79.01 mm among the girls. Fig 2 shows the relationship of splenic size with height. As height increases the splenic size also increases significantly (p=0.018). This indicates a positive correlation between these two variables. Similarly as weight and body surface area increases, the splenic size increases indicating a positive correlation with p value of 0.007 and 0.012 respectively. But the variables like body mass index and spleen size do not show significant relationship (p=0.858).

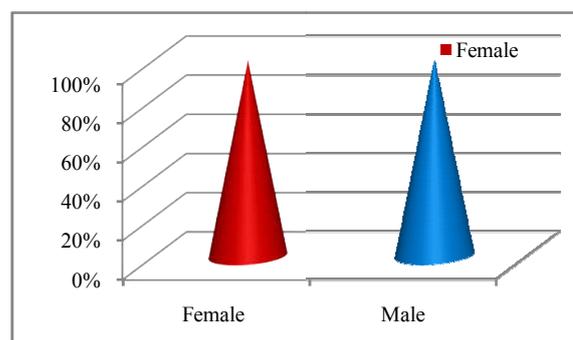


Fig. 1 Sex distribution

The above table shows the distribution of subjects on the basis of their age. Out of 100 subjects selected for this study majority 13% falls in the age between 13 and 15 years. Nearly 50% of the subjects fall in the age between 5 and 10 years and a little more than 50% of the subjects falls in the age between 11 and 15 years. Out of the 100 selected subjects the least number of subjects was found to be 4% in the age of 7 years.

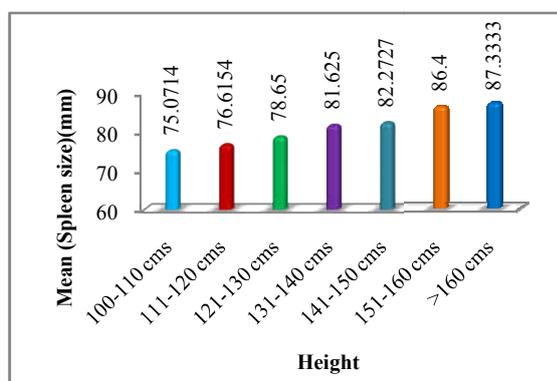
Table -1 Spleen size according to age in pediatric population

Age in year	Female	Male	N	Mean	Std. Deviation	F	Sig.
5	2	5	7	73.0000	2.88675		
6	4	3	7	75.7143	4.75094		
7	3	1	4	74.5000	3.41565		
8	5	2	7	78.7143	3.45033		
9	6	2	8	76.2500	4.16619		
10	4	8	12	78.6667	7.04961		
11	4	7	11	80.7273	4.62798	7.497	<0.001
12	5	3	8	81.2500	3.73210		
13	6	7	13	84.4615	6.35892		
14	4	6	10	83.2000	3.99444		
15	8	5	13	86.9231	3.47519		
Total	51	49	100	80.4200	6.16962		

Table -2 Spleen size according to height in pediatric population

Height	N	Mean	Std. Deviation	F	Sig.
100-110 cms	14	75.0714	4.15959		
111-120 cms	13	76.6154	5.37802		
121-130 cms	20	78.6500	6.15822		
131-140 cms	24	81.6250	3.88769		
141-150 cms	11	82.2727	6.26244	9.201	<0.001
151-160 cms	15	86.4000	4.83735		
>160 cms	3	87.3333	1.52753		
Total	100	80.4200	6.16962		

One-way ANOVA is carried out to test the significant relationship between height and spleen size. The minimum spleen size is found in subjects with lowest height as 100-110 cm and the maximum spleen size is found in subjects with more than 160 cm height. The minimum and maximum size of spleen is found to be 75.07 and 87.33 respectively. It is also found that there is a gradual increase in size of the spleen as the height of the subject increases. The observed F value 9.201 and its corresponding p value 0.000 confirm the significant difference between the height and spleen size. Hence it is concluded that the height of the subjects and spleen size has significant relationship with each other.

**Fig. 2** Spleen size according to height in pediatric population

DISCUSSION

Spleen is the largest organ in the reticuloendothelial system. It is an intraperitoneal organ located posterolaterally in the left hypochondrium.

In the supine position the long axis of the spleen is in line with the tenth rib, but in the upright position it is more vertical. It is known that measurement of splenic length in routine clinical practice is a very good indicator of actual splenic size. The shape of the spleen is tetrahedral. The splenic hilum is not covered by peritoneum. The spleen is attached to the stomach by the gastrosplenic ligament and to dorsal body wall by the lienorenal ligament. The phrenicocolic ligament supports its inferior end. Prior to the development of sonography measurement of splenic length was obtained from plain radiography, which gives a composite shadow, which may not be entirely the spleen. Volumetric measurements are most accurately obtained on computed tomography or magnetic resonance imaging. But the use of CT in pediatric population is not justified in the context of radiation exposure and the expense. The use of MRI is also difficult in view of expense and availability. Ultrasonography affords a useful, non-invasive role in evaluating the spleen in pediatric population.

We have used only the splenic length measurements since it has been shown in autopsy series that sonographic measurements of splenic length correlate with actual splenic dimensions^{1,2}. Loftus *et al* found a linear relationship between the sonographic measurement of splenic length and the actual length, volume and weight as measured at autopsy¹. They suggested that a simple single sonographic measurement of splenic length could be used for routine work reserving the more complex volumetric measurement for problematic cases. Niederau *et al*³ reported that in normal subjects the length of spleen was less than 8.7 cm and mean spleen length was 5.5cm. Selim

*et al*⁴ found the mean splenic length was 10.76 cm in their study group. Bezerra *et al*⁵ found the maximum spleen length was 9.7 cm.

In children, there is an expected increase in splenic length with age and body weight and height. In adult population some studies demonstrate splenic volume is independent of physical data⁶. In our study school children ranging from 5-15 years were included. We grouped the subjects into definite age groups. Splenic length increased with increasing age. In our study, the mean spleen length in the pediatric population studied was 81.8 mm among the boys and 79.01 mm among the girls.

In our study, 51 girls and 49 boys were included. There is a significant increase in splenic length ($p=0.018$) as height of the children increases. But there is no significant difference in the measured splenic length with respect to sex ($p>0.05$).

Bhavna Dhingra⁷ *et al* found that splenic length showed positive correlation with both height and body surface area; no significant association was found with age and body weight. They found that height was a significant correlate with the spleen size across all ages and weights in both the sexes.

Alp Alper Safak *et al*⁸ found that there was no significant differences in organ dimensions with respect to sex. In their study body weight showed the best correlation with organ dimension like spleen. Soyupak⁹ and Dinkel *et al*¹⁰ showed that organ dimensions showed the best correlation with body weight. Dittrich *et al*¹¹ reported the spleen size nomogram with sonographically determined volume estimation in 194 healthy children but this method is very cumbersome, time-consuming and not reproducible. Konus *et al*¹² examined 299 healthy children by Ultrasonogram and provided results for both spleen length and transverse spleen dimension. Capaccioli *et al*¹³ measured sonographically 237 healthy children the three dimensions of the spleen and tabulated the means for every year. They reported that spleens were longer in males especially from 5-6 year age group to older age group.

In our study, splenic length ($p=0.007$) increases as weight increases. Splenic length ($p=0.012$) increases as body surface area increases. No significant relationship was found between BMI and the splenic length ($p=0.858$).

Marco Picardi *et al*¹⁴ found that in healthy subjects spleen longitudinal diameter ranged from 8 to 11 cm and spleen volume from 60 to 200 ml. measurement of volume had significantly higher sensitivity in detecting splenomegaly. Al Iman *et al*¹⁵ showed a steady progressive increase in splenic length with age and corresponding increase in 90th percentile up to the age of 15 years. Above the age of 15 years no increase in splenic length was noted. Schlesinger *et al*¹⁶ studied normal spleen volume by CT in 48 children. They found that spleen volume correlated better with body weight than age. The best regression model was a simple linear relationship of spleen volume to body weight.

Although spleen in general has known anatomical features, they widely differ in their measurement in pediatric age group. Ultrasonogram provides probably the most dependable information for assessing the splenic

length because of its relatively established stage, quick and reliable method.

CONCLUSION

The conventional method of recording splenic size by clinical examination has been reported to lack both accuracy and reliability. Our aim was to provide a more objective assessment of splenic size during routine abdominal Ultrasonogram. Splenic length increases with age and somatometric parameters like height, weight and body surface area without significant relationship with gender or body mass index. We present our data in both tabular and graphic form with the aim of enabling a more practical evaluation during a sonographic assessment. The methods of measurement and analysis we used in this study are standardized and easy to apply. Our results would be used as a handy, reliable normative value and is suitable for sonography units and pediatric radiology departments with a large number of patients.

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