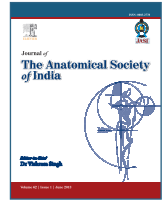




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Original article

Sonographic measurement of the spleen: splenic length in adults and its correlation with different parameters

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KEYWORDS

Sonography, Measurements, Spleen length, Height, Weight, Body surface area.

ABSTRACT

Aim: The purpose of this study was to establish guidelines for normal splenic length at different ages by using a simple and reproducible sonographic method and to find out a relation between spleen length, age, height, weight, and surface area. **Materials and methods:** One hundred sixty subjects, from 21 years to 60 years old, had sonography because of abdominal and/or pelvic problems unrelated to the spleen. The splenic size was measured by obtaining a coronal view that included the hilum during deep inspiration to minimize masking by lung. The greatest longitudinal distance between the dome of the spleen and the tip (splenic length) was measured and correlated with age, height, and weight. **Results:** The results show that the splenic length decreased with increase in age in both males and females. The length of the spleen increased with increase in the body height, body weight, and body surface area in both males and females. In most of the subjects, the splenic length was found to be <11 cm. The splenic size in males was greater than that in females. **Discussion:** The findings of present study that the splenic length decreases with age are similar to the findings of Loftus and Metreweli. Konus et al in 1998 proposed that the splenic length correlated best with the body height. This is similar to the findings of the present study. The finding of present study that the splenic length has positive correlation with the body height, weight, and surface area is similar to the finding of Megremis et al. **Conclusion:** On the basis of the above study, it was concluded that the splenic length decreased with increase in age in both males and females. The length of the spleen has positive correlations with increase in the body height, body weight, and body surface area in both males and females. The splenic length was less in females than that in males with the corresponding age, body height, body weight, and body surface area. In most of the subjects, the splenic length was found to be <11 cm.

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1. Introduction

A large number of entities can affect spleen and the clinical examination is far from accurate to detect a small increase in spleen size. In most individuals, it must be two to three times enlarged before it is palpable. Splenic enlargement can be the result of a number of disorders (including infectious, infiltrative, immunologic, and malignant conditions) and viral illnesses. Splenic enlargement is particularly marked with infectious mononucleosis, a condition endemic on college campuses.

Ultrasonography (USG) is an established safe, quick, and reliable method for the calculation of splenic dimensions, and among all the latter that have been used in the past, spleen length at the hilum is considered the most reproducible linear measurement.¹ In order to establish our own standards and suggest upper limits and to provide additional data to the literature on this subject, the purpose of our study is to investigate normal spleen length in healthy adults with USG.

The purpose of this study is to establish guidelines for normal splenic length at different ages by using a simple and re-

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producible sonographic method and to find out a relation between spleen length, age, height, weight, and body surface area of subjects. One hundred sixty subjects, 21–60 years old, had sonography because of abdominal and/or pelvic problems unrelated to the spleen. Findings on sonograms of the liver and kidneys were normal in all cases. Splenic size was measured by obtaining a coronal view that included the hilum during deep inspiration to minimize masking by lung. The greatest longitudinal distance between the dome of the spleen and the tip (splenic length) was measured and correlated with age, height, and weight.

2. Materials and methods

This work was carried out after getting permission from Institutional ethical committee. The written informed consent of the patients was taken.

An age- and sex-related random sample of 160 patients, including 80 men and 80 women from 20 years to 60 years of age living in the eastern part of North India, was drawn from the trauma center of King George's Medical University, Lucknow. The patients selected for the study were being evaluated sonographically for abdominal or pelvic problem unrelated to the spleen, most often because of urinary tract infection or abdominal pain. Two cases of pregnancy and five cases of splenomegaly were excluded. The dimensions of spleen in a number of cases in which abdominal gas prevented reliable size measurements of spleen were excluded. All measured spleen had a normal position, shape, and normal texture. They had no history of disease related to the liver or spleen and no gastrointestinal, hematologic, oncologic, or traumatic conditions. Their liver and both kidneys had to be normal in size, position, and echotexture to qualify for inclusion in the study. The weight and height of the subjects were taken. The body surface area was calculated with the help of Mosteller formula.²

High-resolution USG scanner (LOGIQ™ α 200 ultrasound machine) with a curvilinear 3.5 MHz transducer was used for scanning. Splenic measurement was taken sonographically during deep inspiration, to minimize masking by the lung in the right lateral position with the left side elevated. As the upper part of the spleen was partly masked by air in the lung, the margin between the lung and the spleen served as a limit of transverse and longitudinal diameter. Splenic length was measured on longitudinal coronal image between the most superomedial and the most inferolateral points of the spleen through the hilum (Fig. A). To determine reproducibility, each measurement was repeated at least three times and the mean was calculated thus ensuring minimum intraoperative variation. The data were analyzed by the F ratio and t test. Pearson's correlation coefficient (r) was used to measure the strength of the association between the two variables.

3. Results

Tables 1a and 1b show that the mean splenic length in both males and females decreases with increase in age from 21

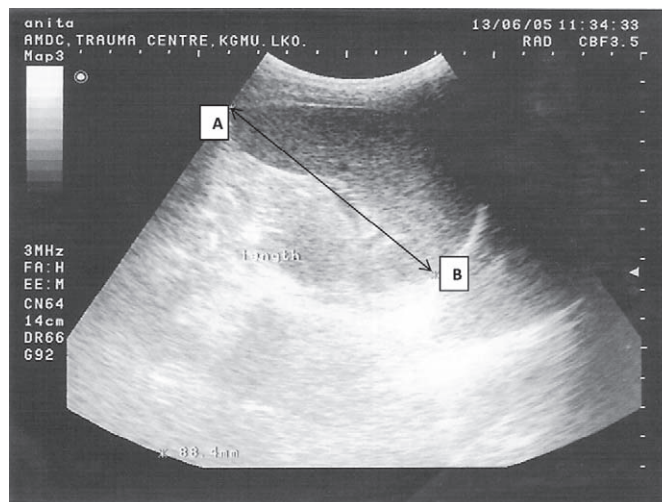


Fig. – A – Splenic length was measured on longitudinal coronal image between the most superomedial (A) and the most inferolateral (B) points of the spleen through the hilum.

Table 1a – Comparison of splenic length in different age groups in males.

Age	N	Mean (mm) \pm S.D.	Range (mm)	F ratio
21–30 years	20	107.24 \pm 13.18	85.6–132	F = 9.096 P = 3.23×10^{-5} ($p < 0.001$)**
31–40 years	20	103.50 \pm 10.12	87–128	
41–50 years	20	100.23 \pm 14.11	74.8–121	
51–60 years	20	87.85 \pm 12.15	70–120	

S.D.: Standard deviation; ** highly significant; N: Number of subjects.

Table 1b – Comparison of splenic length in different age groups in females.

Age	N	Mean (mm) \pm S.D.	Range (mm)	F ratio
21–30 years	20	97.09 \pm 16.16	73.80–123.3	F = 3.042 P = 0.034 ($p < 0.05$)*
31–40 years	20	94.69 \pm 13.67	73.20–122	
41–50 years	20	92.88 \pm 12.77	74.80–121.0	
51–60 years	20	85.06 \pm 10.09	65.40–108.60	

S.D.: Standard deviation; * significant.

year to 60 year age groups. The F ratio for male being 9.996 is statistically significant and for females being 3.042 is also statistically significant.

In both males and females, the splenic length decreases with age.

Figure 1 shows that the splenic length decreases at a slow rate up to the age of 50 years after which it decreases rapidly. The splenic length is greater in males than that in females in each age group.

Tables 2a and 2b show that the mean splenic length in both males and females increases with height. The F values for males being 2.8747 and for females being 3.441 are statistically significant.

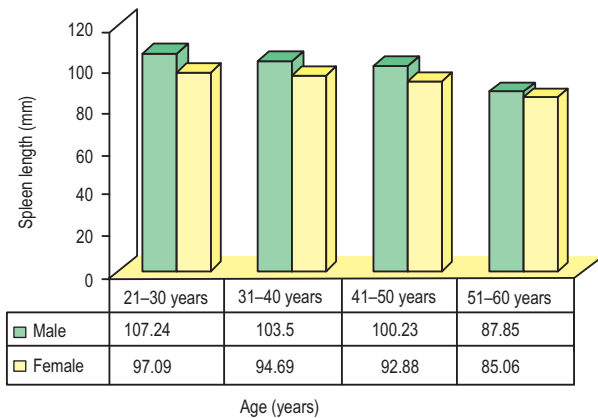


Fig. 1 – Comparison of the splenic length with age in males and females.

Table 2a – Comparison of splenic length with height in males.

Height	N	Mean (mm) ± S.D.	Range (mm)	F = 2.874 P < 0.05*
151–155 cm	12	91.49 ± 11.74	70–113	
156–160 cm	13	95.65 ± 15.37	73.2–132	
161–165 cm	18	98.70 ± 12.74	79.1–128	
166–170 cm	21	102.8 ± 13.59	71.6–123	
171–175 cm	16	107.6 ± 9.942	86.9–119.5	

S.D.: Standard deviation.

Table 2b – Comparison of splenic length with height in females.

Height	N	Mean (mm) ± S.D.	F = 3.441 P < 0.05*
146–150 cm	14	85.66 ± 13.87	
151–155 cm	22	91.15 ± 14.07	
156–160 cm	16	92.88 ± 13.58	
161–165 cm	12	96.34 ± 11.02	
166–170 cm	16	102.05 ± 12.09	

S.D.: Standard deviation.

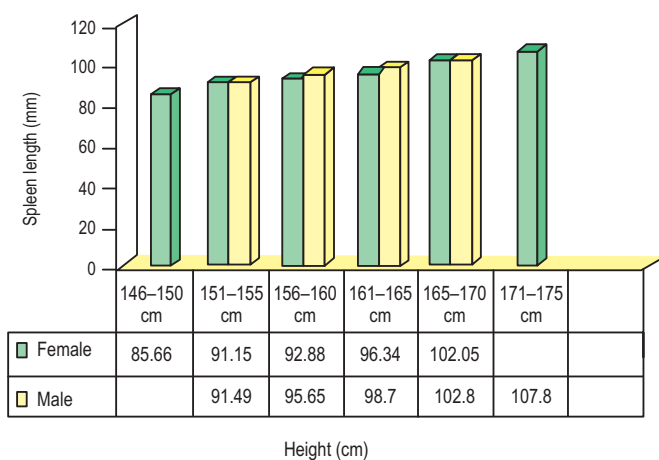


Fig. 2 – Comparison of the splenic length with the height of the subjects.

Table 3a – Comparison of splenic length with body weight in males.

Weight (kg)	N	Mean (mm) ± S.D.	Range (mm)	F = 0.3910 P = 0.8145 (ns)
41–47	10	96.11 ± 14.48	74.9–118	
48–54	17	98.31 ± 14.86	73.2–132	
55–61	20	99.14 ± 16.69	71.6–121	
62–68	17	101.55 ± 12.92	70–120	
69–75	16	102.23 ± 12.56	87–132	

S.D.: Standard deviation; ns: Not significant.

Table 3b – Comparison of splenic length with body weight in females.

Weight (kg)	N	Mean (mm) ± S.D.	Range (mm)	F = 1.014 P = 0.4059 (ns)
36–41	12	87.46 ± 11.79	73.2–123.3	
42–47	19	89.76 ± 13.04	68.4–115	
48–53	16	90.48 ± 12.53	73.8–118	
54–59	17	92.17 ± 10.31	71–109	
60–65	16	96.35 ± 14.63	65.4–122	

S.D.: Standard deviation; ns: not significant

Figure 2 shows that the splenic length increases with height both in males and females. It also shows that the splenic length is more in males as compared to females for all height groups.

Tables 3a and 3b show that the splenic length increases with weight in both males and females but this increase is not statistically significant.

Figure 3 shows that the splenic length increases with increase in body weight. For all weight groups, the splenic length is more in males than that in females.

Tables 4a and 4b show that the mean splenic length in males and females increases with increase in the body surface area. The F value for males being 3.442 and that for females being 3.392 are statistically significant.

It was found that the splenic length increases in both males and females with increase in the body surface area.

Figure 4 shows that the splenic length is greater in males than that in females with each corresponding group of the surface area.

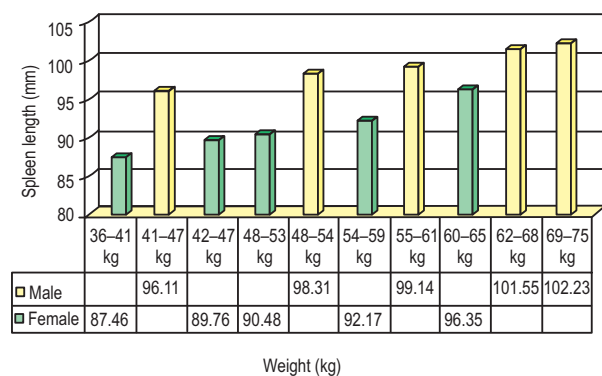


Fig. 3 Comparison of splenic length with the body weight of the subjects.

Table 4a – Comparison of splenic length with body surface area in males.

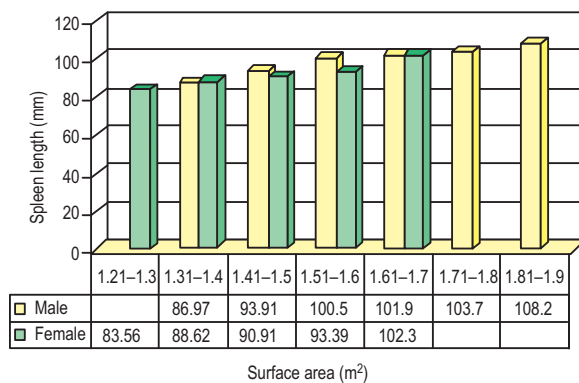
Surface area (m ²)	N	Mean (mm) ± S.D.	Range (mm)	
1.31–1.4	09	86.97 ± 13.70	70.0–111	
1.41–1.5	11	93.91 ± 14.67	73.2–121	F = 3.442
1.51–1.6	16	100.5 ± 10.01	87.6–123	P = 0.0076**
1.61–1.7	17	101.9 ± 15.84	79.1–128	
1.71–1.8	15	103.7 ± 12.30	87–132	
1.81–1.9	11	108.2 ± 11.02	89.4–130	

S.D.: Standard deviation; ** highly significant.

Table 4b – Comparison of splenic length with body surface area in females

Surface area (m ²)	N	Mean (mm) ± S.D.	Range (mm)	
1.21–1.3	10	83.56 ± 11.73	65.4–99.6	
1.31–1.4	18	88.62 ± 11.68	68.4–115	F = 4.071
1.41–1.5	13	90.91 ± 15.69	73.8–118	P = 0.005**
1.51–1.6	19	93.39 ± 11.79	71.0–119	
1.61–1.7	17	102.3 ± 13.96	74.4–123.3	

S.D.: Standard deviation; ** highly significant.

**Fig. 4** Comparison of the splenic length with the body surface area of the subjects.

Tables 5a and 5b show that in both males and females, a positive statistically significant correlation of the splenic length is found with height as well as the body surface area.

Table 5a – Pearson correlation table of the splenic length with height, body weight, and body surface area in males.

Spleen length	R	P
With height	0.3083	P < 0.05*
With weight	0.17	ns
with surface area	0.3786	P < 0.001*

ns: Not significant.

Table 5b – Pearson correlation table of spleen length with height, weight, and surface area in females.

Spleen length	r	P
With height	0.3042	P < 0.01*
With weight	0.1938	ns
With surface area	0.2466	P < 0.05*

4. Discussion

The splenic size may give information about the diagnosis and course of the gastrointestinal and hematologic diseases.³

Kaneko et al evaluated the splenic size in patients with sarcoidosis and thrombocytosis⁴; the splenomegaly was present in 57% of the patients (using sonographic criteria to evaluate the size), but only clinically palpable in 8% of the cases. Therefore, the imaging has become essential for the accurate measurement of the splenic size, the serial monitoring of the splenic size over the course of the patient's illness, and development of the guidelines for re-treatment to play.

In the present study, it was observed that the splenic length decreases with age in both males and females. The splenic length decreases at a slow rate up to the age of 50 years after which it decreases rapidly.

This was similar to the findings of Loftus and Metreweli.⁵ They observed a rapid growth in the splenic length up to the age of 20 years followed by a mild decrease up to the age of 50 years and then rapid fall after the age of 50 years.

In the present study, it was revealed that the splenic length of males was found to be 0.2 cm longer than that of females. This was different to the findings of Loftus and Metreweli.⁵ They observed that the splenic length of males is 0.5 cm longer than that of females. Perhaps this may be due to the difference in height, weight, surface area, and the genetic factors.

In the present study, it was observed that the splenic length is found to be <11 cm in most of the subjects. This is similar to the finding of Frank et al.⁶

Rosenberg et al demonstrated that the upper normal limit of the splenic length is observed to be 12 cm for girls of 15 years or more and 13 cm for boys of 15 years or more.⁷ These findings were slightly different from the findings of the present study. This difference may be due to the genetic factors, nutritional factors, or the environmental factors.

Konuş et al proposed that the splenic length correlated best with the body height. This was similar to the findings of the present study.⁸

Megremis et al revealed that the body height, weight, and surface area have a significant positive correlation with the splenic length.⁹ Their findings were similar to the findings of the present study. Spielmann et al also proposed that the body height was correlated with the length and width of the spleen in males and females.¹⁰ They also proposed that all the splenic dimensions correlated better with the height than the weight. This was similar to the findings of the present study.

5. Conclusion

In the present study, an attempt has been made to determine the normal range of the length of the spleen and to correlate length with the body height, body weight, and body surface area in the male and female subjects.

The length of the spleen was measured with the help of the ultrasound in 80 male and 80 female subjects.

On the basis of the above study, the following conclusions were drawn:

1. The splenic length decreases with increase in age in both males and females.
2. The length of the spleen increases with increase in the body height, body weight, and body surface area in both males and females.
3. The splenic length is less in females than that in males with the corresponding age, body height, body weight, and body surface area.
4. In most of the subjects, the splenic length is found to be <11 cm.

REFERENCES

1. Simes RJ. An improved Bonferroni procedure for multiple tests of significance. *Biometrika* 1986;73:751–4.
2. Mosteller RD. Simplified calculation of body-surface area. *N Engl J Med* 1987;317:1098.
3. Niederau C, Sonnenberg A, Muller JE, et al. Sonographic measurements of the normal liver, spleen, pancreas, and portal vein. *Radiology* 1983;149:537–40.
4. Kaneko J, Sugawara Y, Matsui Y, et al. Normal splenic volume in adults by computed tomography. *Hepatogastroenterology* 2002;49:1726–7.
5. Loftus WK, Metreweli C. Normal splenic size in a Chinese population. *J Ultrasound Med* 1997;16:345–7.
6. Frank K, Linhart P, Kortsik C, et al. Sonographic determination of spleen size: normal dimensions in adults with a healthy spleen. *Ultraschall Med* 1986;7:134–7.
7. Rosenberg HK, Markowitz RI, Kolberg H, et al. Normal splenic size in infants and children: sonographic measurements. *AJR Am J Roentgenol* 1991;157:119–21.
8. Konus OL, Ozdemir A, Akkaya A, et al. Normal liver, spleen, and kidney dimensions in neonates, infants, and children: evaluation with sonography. *AJR Am J Roentgenol* 1998;171:1693–8.
9. Megremis SD, Vlachonikolis IG, Tsilimigaki AM. Spleen length in childhood with US: normal values based on age, sex, and somatometric parameters. *Radiology* 2004;231:129–34.
10. Spielmann AL, DeLong DM, Kliewer MA. Sonographic evaluation of spleen size in tall healthy athletes. *AJR Am J Roentgenol* 2005;184:45–9.