

Determination of Normal Dimension of the Spleen by Ultrasound and its Correlation with Age.

Yared Tekle¹, Sanket Dadarao Hiware², Mueez Abreha², Abebe Muche³, Meselech Ambaw¹, Zerubabel Tegegne⁴

¹Lecturer, Department of Anatomy, College of Medicine and Health Sciences, Dire Dawa University, Dire Dawa, Ethiopia, ²Assistant professor, Department of Anatomy, Imam Abdulrahman Bin Faisal University, College of Medicine, Dammam, Saudi Arabia, ³Associate Professor, Department of Anatomy, College of Medicine, University of Gondar, Gondar, Ethiopia, ⁴Associate Professor, Department of Radiology, College of Medicine, University of Gondar, Gondar, Ethiopia.

Abstract

Background: Spleen size is an integral part of abdominal ultrasonography (US) because both enlarged and small spleens can be indicative of a variety of physical conditions. The purpose of this study was to define age and region corrected normal values for spleen dimensions determined with USG. **Methods:** A cross-sectional prospective study design was performed at the University of Gondar, hospital. The sonographic measurements of spleen length, width, thickness and volume were performed on 380 subjects. By Pearson's product moment correlation coefficients, the relation of spleen dimensions to age was evaluated. **Results:** The splenic dimensions (length, width and thickness) decreased with increase in age of adult subject in both male and female. Comparison between mean splenic dimensions between urban and rural residency showed no statistical significance differences ($P>0.05$) for splenic length, width and volume. There is a statistically significant negative correlation between the age of the female subjects and splenic dimensions ($r=-0.146$, -0.221 , and -0.185 for spleen length, width, and thickness, respectively). For the male subjects, there was a statistically significant negative correlation between age of subjects and splenic length, width, thickness and volume ($r=-0.271$, $P<0.0001$, $r=-0.354$, $p<0.0001$, $r=-0.223$, $p<0.01$ and $r=-0.282$, $p<0.0001$, respectively) which decreased with age. **Conclusion:** The study showed that spleen dimensions correlate partly independently with age and provide reference tables and tools for assessment of the upper limits of normal spleen dimensions for a given region.

Keywords: Spleen dimensions, Age, Ultra-sonography

Corresponding Author: Dr. Sanket Dadarao Hiware, Assistant professor, Department of Anatomy, College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia.

Received: July 2018

Accepted: November 2018

Introduction

Without a robust definition of what is normal, assessment of observations as normal or abnormal is impossible. Thus, diagnostic laboratories go through extensive exercises to establish reference values that are relevant for their patient cohorts. To maximize the predictive value of normal ranges, factors that systematically affect the respective values, such as time of day, nutritional status (fasting vs postprandial), age, sex, height, and race, are considered in their definition.^[1,2]

Spleen size is an integral part of abdominal ultrasonography (US) because both enlarged and small spleens can be indicative of a variety of physical conditions. In addition, splenomegaly may be a risk factor for splenic rupture. False-positive labelling of a patient as having splenomegaly can lead to medical tests that invariably will be negative, causing unnecessary anxiety to the patient as well as health care expenditure.^[3]

Gross splenomegaly can be detected both clinically and sonographically. But, the clinical examination is far from accurate to detect a small increase in spleen size. It must be two to three times enlarged before it is palpable. The precise

measurement of spleen by palpation is not reliable, as in cases a normal sized spleen is palpable and a non-palpable spleen may not be normal sized. Ultrasonography is a good modality for the detection of splenomegaly even when it is not clinically palpable.^[4]

Currently, the literature states that 95% of adult spleens are less than 12 cm or even 11 cm in length. In smaller studies, it was noted that spleen length or volume showed a positive correlation with age and possibly with sex; however, to our knowledge, an effort to define normal values adjusted for these variables has not been made.^[5-7] The purpose of this study was to define age and region corrected normal values for spleen dimensions determined with USG.

Subjects and Methods

This prospective study was comprised of data collected from subjects under ultra-sonographic evaluation for diseases not effecting the spleen conducted between October 2017 and February, 2018 in the University of Gondar Hospital, Department of Radiology.

Ethical clearance was obtained from the University of Gondar Research and Publication Office, ethical review

committee. Official letter was submitted to University of Gondar hospital, Department of Radiology. Study subjects were informed about the purpose of the study and its procedure. Informed verbal consent was obtained from each individual at the time of data collection.

The patients selected for the present study were examined using a Sonoscape SSI 8000 ultrasound machine (Soonchunhyang University Medical centre, China) for abdominal and/or pelvic problems not related to the spleen, mostly due to abdominal pain and urinary tract infection. The study subjects had no history of disease related to the spleen and hematologic, oncologic or traumatic conditions. The spleen data were recorded on file. Besides this, sex, age and other demographic features of subjects were documented.

Splenic length was measured in the longitudinal section maximum distance between the domes of the spleen and the splenic tip. The splenic width defined as the maximum distance between the medial and lateral borders of the spleen was measured in a plane perpendicular to the length through the hilum. Transverse scans were obtained with the transducer rotated through 90° splenic thickness defined as the maximum AP dimension was measured on the transverse section. The volume of the spleen was calculated manually from the formula (length × width × depth × 0.524). The formula is frequently used for estimation of the volume of many irregularly shaped organs.

To maintain reproducibility, each measurement was repeated at least 3 times and most repeated value was recorded according to the guidelines of the American Institute of Ultrasound in Medicine and as described by lamp and collaborators.

The sonographic measurements of spleen dimensions was measured by the experienced radiologist. Cross checking numerical values were done at least three times while recording and transferring to the statistical software package for social sciences (SPSS).

The collected data were checked for completeness, accuracy and clarity before analysis. The data were entered into a spreadsheet and analyzed using the IBM SPSS Statistics, version 20. The means (± standard deviation), ranges, minimum, maximum, and the 95% confidence intervals for the mean (in order to include the true population mean in 95% of the cases) were all calculated. P- Value less than 0.05 is considered as statistically significant. The coronal measurements of the spleen and the volume were compared with the age. Differences of continuous variables between two independent groups were assessed with the 2-tailed t-test.

Results

A total of 380 adults encompassing 47% males and 53% females were enlisted. The age range of the study populations was between 18 and 80 years, with the mean age of 35.4 years (±12.2).

As it is presented in Table 1, the dimension of spleen indicated gradual decrement in size from the age group of

18-27 years to the age greater than 58 years. The maximum mean of spleen length, thickness and volume of the spleen was obtained in the age group of 28-37 years, whereas the maximum mean of spleen width was obtained in the age group of 18-27 years [Table 1].

Table 1: Mean and standard deviations of spleen length, width, thickness and volume of the adult age groups of 380 subjects, sonographic study of spleen.

Age (years)	Frequency	Mean splenic dimensions and SD (cm)			
		Length	Width	thickness	Volume
18-27	125	10.07(1.28)	4.49(.71)	3.99(.87)	97.69(36.6)
28-37	106	10.10(1.27)	4.42(.69)	4.03(.84)	97.93(38.8)
38-47	77	9.97(1.12)	4.21(.64)	3.68(.79)	83.75(31.2)
48-57	48	9.56(1.26)	4.01(.94)	3.69(1.07)	81.15(49.6)
≥58	24	9.45(.92)	3.97(.51)	3.48(.61)	85.67(33.4)

Table 2: Gender wise distribution of mean and standard deviation of spleen length, width and thickness. Sonographic study of spleen.

Age (Year)	Frequency		Splenic Length		Splenic width		Splenic thickness	
	Male	Female	Male	Female	Male	Female	Male	Female
18-27	55	70	10.79(1.13)	9.51(.09)	4.85(.67)	4.21(.62)	4.26(.81)	3.78(.85)
28-37	50	56	10.76(1.03)	9.51(1.18)	4.75(.60)	4.12(.64)	4.22(.77)	3.85(.86)
38-47	39	38	10.46(.85)	9.46(1.14)	4.36(.50)	4.05(.72)	3.84(.65)	3.51(.89)
48-57	21	27	10.29(1.28)	8.98(.91)	4.45(.96)	3.68(.78)	4.12(1.15)	3.35(.88)
≥58	15	9	9.74(.59)	8.97(1.18)	4.02(.50)	3.91(.55)	3.54(.69)	3.4(.47)

[Table 2], shows that the splenic length, width, and thickness were measured with respect to the sex and age groups. The maximum measurements were attained at age group 18-27 for both male and female. It was also observed that there is a difference in spleen dimensions between males and females.

As observed in the [Table 2] indicated that in the male subjects the splenic length decreased at a slower rate up to the age of 57 years, then decreased rapidly whereas in the female subjects the splenic length decreased at a slower rate up to 47 years and then rapidly decreased. In each age group, the splenic length was greater in males than in females.

In male study subjects, the mean splenic width was progressively decreased from age group of 18-27 years (4.85 cm) to the age of 58 years and above (4.02 cm) [Table 2]. Similarly, in female subjects, the splenic width was gradually declined from the age of 18-27 (4.21cm) to the

age of greater than 58 years (3.9 cm). Comparatively, in all age groups, the splenic width was greater in male than female subjects. It was observed that the mean splenic thickness in male was slightly decreased from the age group of 18-27 years (4.26cm) to the age group of 58 years and

above (4.12cm). Similarly, in female subjects, the splenic thickness was gradually declined from the age of 18-27 years (3.78cm) to the age of greater than 58 years (3.4 cm). Comparatively, in all age groups, the splenic thickness was greater in male than female subjects.

Table 3: Independent sample test for mean difference of spleen dimensions by residency, sonographic study of spleen.

Variables	Urban		Rural		Independent Sample Test	P value (P<0.05)	95% Confidence interval of the difference	
	Mean±SD		Mean±SD				Lower	Upper
	Spleen length	9.97	1.27	9.93	1.2	0.275	0.783	-0.215
Spleen width	4.36	0.77	4.28	0.69	0.98	0.324	-0.074	0.223
Spleen thickness	3.96	0.94	3.78	0.8	2.067	0.039	0.009	0.361
Spleen volume	95.89	41.04	88.43	35.49	1.896	0.059	-0.277	15.185

Comparison between mean splenic dimensions between urban and rural residency showed no statistical significance differences (P>0.05) for splenic length, width and volume. But spleen thickness of urban resident statistically difference (P<0.05) being higher than rural resident [Table 3].

Table 4: Pearson`s correlation (r) of spleen dimension with age of the subjects, sonographic study of spleen.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Age (years)	Pearson Correlation	-0.152	-0.245	-0.183	-0.159
	Sig. (2-tailed)	0.003	0	0	0.002
	N	380	380	380	380

Pearson`s correlation finding indicated a weak negative statistically significant correlation (P<0.05) between splenic length, width, thickness and volume, and age (r= -.152, -.245, -.183 and -.159, respectively) [Table 4].

Table 5: Pearson`s correlation (r) of spleen dimension with age of the female subjects, sonographic study of spleen.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Age (years)	Pearson Correlation	-0.146	-0.221	-0.185	-0.111
	Sig. (2-tailed)	0.039	0.002	0.009	0.118
	N	200	200	200	200

Table 6: Pearson`s correlation (r) of spleen dimension with age of the male subjects, sonographic study of spleen.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Age (years)	Pearson Correlation	-0.271	-0.354	-0.223	-0.282
	Sig. (2-tailed)	0	0	0.003	0
	N	180	180	180	180

As it is presented in [Table 5], there was a statistically significant negative correlation between the age of the female subjects and splenic dimensions (r=-0.146, -0.221, and -0.185 for spleen length, width, and thickness, respectively). However, there was no statistically significant correlation between age and splenic volume (r=-0.111).

For the male subjects, there was a statistically significant negative correlation between age of subjects and splenic length, width, thickness and volume (r=-0.271, P<0.0001, r=-0.354, p<0.0001, r=-0.223, p<0.01 and r=-0.282, p<0.0001, respectively) which decreased with age [Table 6].

Discussion

The splenic size may give information about the diagnosis and course of gastrointestinal and hematologic disease.^[8] Grossly, splenomegaly can be detected both clinically. But, the clinical examination is far from accurate to detect a small increase in spleen size. It must be two to three times enlarged before it is palpable. The precise measurement of spleen by palpation is not reliable, as in cases of normal sized spleen that is palpable and a non-palpable spleen that may not be of normal size.^[9] Hence, ultrasonography is a good modality for the detection of splenomegaly even when it is not clinically palpable.

In the present study, it was observed that the length of spleen decreased with age in both males and females. The spleen length decreases at a slower rate up to the age of 57 years in male and up to 47 years in female subsequently decreases rapidly. Similarly, study conducted among Chinese population reported a rapid growth in splenic length up to the age of 20 years and slowly decrease up to the age of 50 years then rapid fall after the age of 50 years.^[10] The notion of the decrement of the splenic size with age also supported by studies conducted in Tripura, west Nepal, east Nepal and north India reported that age of the adult study subject`s has inverse relation with splenic size.^[11,12] However, African sonographic measurement of spleen dimensions report statistically non-significant correlation between age of the adult study subject`s and splenic size.^[13] This differences may be explained by socio

demographic factors, age enrolment of subjects and nutritional status of the subjects.

The spleen varies considerably in size. But, on average it is 2.5 cm thick, 7.5 cm wide and 12.5 cm long.^[14] A sonographic study of adult spleen showed that spleen size decreased with increasing age. And, as it is reported from autopsy findings, the size of spleen was smaller in females than male study subjects.^[15]

The identification of any observation as normal or abnormal hinges on the availability of robust normal ranges. According to the published upper limit of normal of 12 cm,^[16-18] 6% of our healthy volunteer cohort's women and 26% of men would, by definition, have been diagnosed with splenomegaly. This observation agrees with those of published reports.^[19] This being a very extensively evaluated cohort exclusively of healthy volunteers, it is immediately apparent that published upper limits of normal, although reasonably describing our female cohort, clearly are not applicable to current-day healthy men.

An effect of age on spleen size was previously considered (although those studies failed to control for height and sex); the effect turned out to be marginal or non-existent. Small studies also suggested (quantitatively minor) ethnic or racial effects on what constitutes a normal-sized spleen,^[20,21] but these did not carefully rule out, and thus could not account for, relevant highly frequent factors that affect spleen size in those groups (eg, the highly prevalent hemoglobinopathies in Africans or African-Americans). Because these studies describe only white subjects predominately in their 3rd or 4th decade of life, they cannot shed additional light on either issue but identify the need for similar analyses in carefully assessed healthy volunteers from other ethnicities and age groups.

Conclusion

- The splenic dimensions (length, width and thickness) decreased with increase in age of adult subject in both male and female.
- Comparison between mean splenic dimensions between urban and rural residency showed no statistical significance differences ($P > 0.05$) for splenic length, width and volume.
- There is a statistically significant negative correlation between the age of the female subjects and splenic dimensions ($r = -0.146$, -0.221 , and -0.185 for spleen length, width, and thickness, respectively).
- For the male subjects, there was a statistically significant negative correlation between age of subjects and splenic length, width, thickness and volume ($r = -0.271$, $P < 0.0001$,

$r = -0.354$, $p < 0.0001$, $r = -0.223$, $p < 0.01$ and $r = -0.282$, $p < 0.0001$, respectively) which decreased with age.

References

1. Sinnatamby CS. Abdomen. Last's Anatomy: Regional and Applied. 12th ed. Elsevier limited; 2006. 270 p.
2. Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy. 6th ed. Williams and Wilkins: Philadelphia; 2010. 263-65 p.
3. Susan standring. Gray's Anatomy. The anatomical basis of clinical practice. 39th ed. Elsevier, Spain; 2008. 890 p.
4. Ioanitecu S, Iliescu L, Harza M, Ismail G. Student Edition. The spleen. In EFSUMB course book of Ultrasound. EFSUMB; 2012. 1-46 p.
5. Frank H. Netter: Atlas of Human Anatomy. Elsevier: Philadelphia; 2011. 282 p.
6. Rodrigues Junior AJ, Rodrigues CJ, Germano MA, Rasera Junior I, Cerri GG. Sonographic assessment of normal spleen volume. Clin Anat. 1995;8:252-5.
7. Breiman RS, Beck JW, Korobkin M. volume determinations using computed tomography. Am J Radiol. 1982;138:329-33.
8. Douglas G, Nicol F, Robertson C. Macleod's clinical examination. 12th ed. Elsevier: Philadelphia; 2009. 205 p.
9. Al-Imam O, Suleiman A, Khuleifat S. Ultrasound assessment of normal splenic length and spleen-to-kidney ratio in children. East Mediterr Heal J. 2000;6(2):514-6.
10. Arora N, Sharma PK, Sahai A, Singh R. Sonographic measurement of the spleen: splenic length in adults and its correlation with different parameters. J Anat Soc India. 2013;62(2):57-61.
11. Schindler G, Longin F, Helmschrott M. The individual limit of normal spleen size in routine x-ray film. Radiology. 1976;16(4):166-71.
12. Ezeofor SN, Obikili EN, Anyanwu GE, Onuh AC, Mgbor S. Sonographic assessment of the normal limits of the spleen in healthy school children in South east Nigeria. Niger J Clin, Pr. 2014;17(4):484-6.
13. Krestin GP, Brennan R. Ultrasound diagnosis of the abdomen. Ther Umsch. 1992;49(6):484-6.
14. Sarac K, Kutlu R, Yakinci C, Durmaz Y, Baysal T, Ozgen U. Sonographic Evaluation of Liver and Spleen Size in School-Age Children. Turk J Med Sci. 2000;30(1):187-90.
15. Serter S, Ceylan C, Tuncyurek O, Orguc S, Pabuccu Y. Sonographic evaluation of spleen size and prevalence of accessory spleen in a healthy male Turkish population. Turk J Hematol. 2010;27(2):25-8.
16. Larsen W. Anatomy: Development, Function, clinical correlations. Philadelphia: Elsevier Sciences; 2002. 228 p.
17. Niederau C, Sonnenberg A, Muller JE, Erckenbrecht JF, Scholten T, Fritsch W. Sonographic measurement of the normal liver, spleen, pancreas and portal vein. Radiology. 1983;149(1):537-40.
18. DeLand FH. Normal spleen size. Radiology. 1970;97(1):589-92.
19. Alhazmi DA, Mazi OA, Alsulami AM, Abduljabbar AH. Normal size and values in adult population in the western region of Saudi Arabia. Eur J Pharm Med Res. 2017;4(2):166-9.
20. Chakraborti S, Saha N, Debbarma B, Das S, Leishram D. Normal Spleen Length by Ultrasonography in Adults of Tripura. IOSR J Dent Med Sci. 2016;15(1):55-60.
21. Sharma K, Lamichhane PS, Sharma B, Sharma BK. Sonographic Measurement of Spleen in Relation to Age. A Prospective Study among Adult Nepalese People in Western Nepal. J Gandaki Med Coll Nepal. 2017;10(1):11-6.

Copyright: © the author(s), publisher. Asian Journal of Medical Research is an Official Publication of "Society for Health Care & Research Development". It is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Tekle Y, Hiware SD, Abreha M, Muche A, Ambaw M, Tegegne Z. Determination of Normal Dimension of the Spleen by Ultrasound and its Correlation with Age. Asian J. Med. Res. 2018;7(4):AT08-AT11.
DOI: dx.doi.org/10.21276/ajmr.2018.7.4.AT3

Source of Support: Nil, **Conflict of Interest:** None declared.