Original Research Article

Correlation analysis of splenic dimension with age and gender by ultrasonography in adult population of Gwalior region

Rahul Sharma[1], Manish Chaturvedi[2], Richa Changulani[3], Durgesh Shukla[4*]

[1]Demonstrator, Department of Anatomy, G.R.Medical College Gwalior,M.P.,India
[2]Assistant Professor, Department of Anatomy, G.R.Medical College Gwalior,M.P,India
[3]Assistant Professor, Department of Community Medicine, G.R.M.C. Gwalior,M.P,India
[4]Demonstrator cum Statistician,Department of Community Medicine, G.R.M.C. Gwalior,M.P,India

Received: 10-02-2021 / Revised: 15-03-2021 / Accepted: 04-04-2021

Abstract

Background: The spleen is part of the lymphatic system that helps to protect the body by clearing worn-out red blood cells and other foreign bodies from the bloodstream.The purpose of the present study was to define age and gender correlated normal values for spleen dimensions determined with ultrasonography.**Material and Methods:** Present cross sectional study was done at Gajra Raja Medical College Gwalior. A total of 160 participants were enrolled and measurement on spleen length, width, thickness and volume were performed using ultrasonography. **Results:** Present study conducted on 160 participants with mean age 40.98±12.53 years. Among femaless and maless; mean splenic length was 9.40±1.31 cm and 9.74±1.44 cm respectively, mean spleen thickness was 4.26±0.70 cm and 4.55±0.69 cm respectively; mean spleen width was 6.45±0.93 cm and 6.88±1.16 cm respectively; mean spleen volume was 142.76±50.12 cm^3 and 163.75±60.27 cm^3 respectively.In both femaless and maless spleen dimensions (length, thickness, width and volume) first increases at the age group of twenty onwards and then significantly decreases at older age of fifty onwards.**Conclusion:** Splenic dimensions (length, thickness, width and volume) were greater in maless than in femaless in the each age group and negative correlation for age and spleen dimension in both genders showing thatas the age increases spleen dimensions start declining.

Keywords: Length; width; thickness; volume.

Introduction

The spleen is the largest lymphoid organ with a parenchymal structure in the reticulo-endothelial system and it is situated in the left hypochondrium[1]covered by the ribs.The shape of the spleen is tetrahedral or wedge[2].As the largest secondary lymphoid organ, the spleen has a number of important roles in the immune response, including the clearance of effete or damaged cells from the bloodstream and host resistance to infection[3].The spleenhas a unique place in host defense because of its anatomic location directly connected to the circulation, it responds promptly to blood borne antigens with antigen-specific immune responses, much more effectively than can lymph nodes or other lymphoid tissues[4].The human spleen is a very important organ from the anatomical, immunological and clinical point of view. Its precise measurement by palpation or percussion is not reliable. The splenic enlargement can be detected both ultra-sonographically and clinically. But a small increase in spleen size cannot be detected accurately by clinical examination. It must be two to three times enlarged before it is palpable. The precise management of spleen by palpation is not reliable, as in cases a normal size spleen is palpable and non-palpable spleen may not be of a normal sized. In some cases a normal sized spleen is palpable whereas a non-palpable spleen is not always normal sized, hence comes the importance of imaging techniques.

**Correspondence*
Mr.Durgesh Shukla
Demonstrator cum Statistician,Department of Community Medicine, G.R.M.C. Gwalior,M.P,India
E-mail: durgeshstatsgrmc2019@gmail.com

Ultrasound has been found to be both accurate and reliable for these measurements[5].The length of the spleen is an adequate indicator of size for most purposes and provides a useful baseline for monitoring changes in disease status.The wide range of what a normal sized adult spleen is, combined with its complex three dimensional shape makes it particularly difficult to establish a normal range of sonographic measurements. Spleen size is relevant in the diagnosis of many diseases and to label an observation as abnormal, a robust definition of what is normal is must. The size of a normal spleen depends on gender and age.There is need for a study to make a strong conclusive decision regarding normal dimensions of spleen. Keeping the importance of spleen dimensions following objectives was framed:

Objectives

1.To compare and measure splenic length, width, thickness and volume with adult age and gender in Gwalior region.
2.To find the correlation among dimensions of the spleen in relation with age and gender.

Material and Methods

This cross sectional study was comprised of data collected from subjects under ultra-sonographic evaluation for diseases not effecting the spleen conducted between December 2017 to December 2018 at Department of Anatomy, Gajra Raja Medical College Gwalior and Department of Radiodiagnosis,Gajra Raja Medical College Gwalior. Total 160 participants were included in the study .The participants selected for the study were evaluated with Ultrasonography for abdominal and/or pelvic problem unrelated to the spleen,mostly because of UTI or abdominal pain. They have no history of disease related to the liver or spleen and no GIT, hematologic, oncologic or

traumatic conditions.Dimensions of the spleen were defined as: **Splenic Length(SL)** is defined as the maximum distance between the dome of the spleen and tip of the spleen on a longitudinal section in the sagittal plane. **Splenic Width(SW)** is defined as the maximum distance between the medial and lateral border of the spleen. It is measured in a plane perpendicular to the length. **Splenic Thickness (ST)** is defined as the distance between the inner and outer surface. It is measured at the level of the splenic hilum on a transverse section. **Splenic Volume** is calculated with the following standard ellipsoid formula as = (0.524 x Width x Length x Thickness)[6].After taking note of the routine parameters i.e.,splenic length,splenic thickness, splenic width and splenic volume,the complete information was recorded in the proforma. From these measurement Means, Standard deviation (SD), Standard error (SE) was calculated. Statistical test like independent t test,One way ANOVA and Pearson's correlation coefficient was calculated and p value were calculated at 5 % level of significance.Data entry were done in Microsoft excel software and analysis were performed on the SPSS-16 software.

Ethical Clearance: Ethical clearance was obtained from institutional ethical committee. Informed consent was obtained from each participant at the time of data collection.

Result

A total of 160 participants with 1:1 males and females ratio; were included in the study. Mean age of the participants was 40.98±12.53 years which ranged from 21 years to 60 years. Mean age of the females participants was 40.67±12.42 years while it for males was 41.29±12.71 years. Mean length of spleen for females participants was 9.40±1.31 cm and among maless, it was 9.74±1.44 cm; statistically it was found that there was no significant difference in the mean age and mean length between the males and females participants. While mean spleen thickness among females was 4.26 ±0.70 cm and among males was 4.55±0.69 cm; mean spleen width among females was 6.45±0.93 cm while among males it was 6.88±1.16 cm; mean spleen volume among females was 142.76± 50.12 cm^3 while among males it was 163.75±60.27 cm^3.Mean spleen thickness, width and volume was significantly higher among males as compared with femaless. (Table 1)Overall mean splenic length of participants were measured as 9.57±1.38 cm .Mean splenic length in the early age group (20-25 years) was recorded as 9.80±1.26 cm; mean splenic length among the middle age group(36-50 years) was 9.98±1.45 cm while mean splenic length was among older age group (>50 years) was 8.64± 1.03 cm.Among the 160 participants mean splenic thickness was measured as 4.40±0.71 cm. Mean splenic thickness in the early age group (20-25 years) was recorded as 4.47±0.72 cm; mean splenic thickness among the middle age group(36-50 years) was 4.53±0.77 cm while mean splenic thickness was among older age group(>50 years)was 4.12 ±0.49 cm. Overall mean splenic width of participants were measured as 6.67±1.07 cm. Mean splenic width in the early age group (20-25 years)was recorded as 6.75±1.01 cm; mean splenic Width among the middle age group (36-50 years) was 7.00±1.14 cm while mean splenic Width was among older age group (>50 years) was 6.07±0.80 cm. Overall mean splenic Volume of participants were measured as 153.26±56.25 cm^3. Mean splenic Volume in the early age group(20-25 years)was recorded as 158.67±52.43 cm^3; mean splenic Volume among the middle age group (36-50 years) was 172.35 ±60.81 cm^3 while mean splenic Volume was among older age group (>50 years) was 117.86±37.21 cm^3 .One way ANOVA analysis shown that there was significant difference in mean splenic length, thickness, width and volume in the different age groups.

As the age increases dimension of spleen start increasing while significant decrease is seen in older age group.(Table 2)Mean splenic length among the femaless was 9.4±1.30 cm while among the maless it was 9.74±1.44 cm. Mean splenic thickness among the femaless was 4.26±0.70 cm while among the maless it was 4.55±0.69 cm. Mean splenic width among the femaless was 6.45±0.92 cm while among the males it was 6.88± 1.16 cm. Mean splenic volume among the females was 142.75±50.12 cm while among the males it was 163.76± 60.27 cm. It was observed that the mean splenic length in females in the first age group i.e. 20-35 years was 9.68±1.13 cm; in the second age group i.e. 36-50 years was 9.96±1.28 cm, in the third age group i.e. >50 years was 8.19± 0.79 cm. It was observed that the mean splenic length in males in the first age group i.e. 20-35 years was 9.93±1.40 cm, in the second age group i.e. 36-50 years was 9.99±1.60 cm, in the third age group i.e. >50 years was 9.08±1.06 cm. In both females and males with the advancing age; the mean splenic length first increased and then decreased significantly. It was observed that the mean splenic thickness in females in the first age group i.e. 20-35 years was 4.22± 0.73 cm; in the second age group i.e. 36-50 years was 4.45±0.76 cm, in the third age group i.e. >50 years was 4.10±0.54 cm. It was observed that the mean splenic thickness in males in the first age group i.e. 20-35 years was 4.76± 0.61 cm, in the second age group i.e. 36-50 years was 4.60± 0.79 cm, in the third age group i.e. >50 years was 4.14± 0.46 cm. In both females and males with the advancing age; the mean splenic thickness first increased and then decreased significantly. Similar results were obtained for splenic width and volume; in both females and males with the advancing age; the mean splenic width and volume first increased and then decreased significantly. (Table 3) Correlation analysis done for age and other dimensions of spleen and Pearson's correlation coefficient was calculated for, to ascertain strength of correlation. Among the femaless age was found to be negatively correlated with length, width and volume. Findings indicate that as the age increases spleen length significantly decreases (r= -0.323, p=0.003).Length, thickness, width and volume were found to be significantly positively correlated. Among maless age was negatively correlated with length, width and volume. It found that among maless as the age increases spleen thickness start significantly decreasing (r= -0.327, p=0.003).Overall correlation analysis shows that age is found to be significantly correlated with length(r= -.254, p=0.001); width (r= -0.206, p=0.009) and volume(r= -0.198, p=0.012).Length, thickness width and volume are significantly correlated with each other.(Table 4)

Table 1: Independent sample test for mean difference of spleen dimensions by gender, sonographic study of spleen.

Variable	Females Mean ± SD	Males Mean ± SD	Independent Sample t test	P Value	95 % confidence interval of difference	
					Lower	Upper
Age	40.67±12.42	41.29±12.71	-0.308	0.758	-4.54	3.31
Length	9.40±1.31	9.74±1.44	-1.567	0.119	-0.77	0.09
Thickness	4.26±0.70	4.55±0.69	-2.566	0.011	-0.50	-0.06
Width	6.45±0.93	6.88±1.16	-2.586	0.011	-0.76	-0.10
Volume	142.76±50.12	163.75±60.27	-2.396	0.018	-38.30	-3.68

Table 2: Mean and standard deviations of spleen length, width, thickness and volume of the adult age groups of 160 subjects, sonographic study of spleen.

Age (Years)	Frequency	Mean Splenic dimensions and SD (cm)			
		Length	Thickness	Width	Volume
20-35	64	9.80±1.26	4.47±0.72	6.75±1.01	158.67±52.43
36-50	56	9.98±1.45	4.53±0.77	7.00±1.14	172.35±60.81

>50	40	8.64±1.03	4.12±0.49	6.07±0.80	117.86±37.21
F Value		14.498	4.613	10.182	13.202
P Value		0.000001	0.011	0.000001	0.000001

Table 3: Gender wise distribution of mean and standard deviation of spleen length, width, thickness and volume in different age group.Sonographic study of spleen.

Age (Years)	Frequency		**Mean Splenic dimensions and SD (cm)**							
			Length		Thickness		Width		Volume	
	Females	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**
20-35	34	30	9.68± 1.13	9.93± 1.40	4.22± 0.73	4.76± 0.61	6.46± 0.87	7.07± 1.07	148.37± 50.11	170.34± 53.39
36-50	26	30	9.96± 1.28	9.99± 1.60	4.45±0.76	4.60± 0.79	6.90±0.93	7.08± 1.30	164.69± 48.84	178.99± 69.72
>50	20	20	8.19± 0.79	9.08± 1.06	4.10±0.54	4.14± 0.46	5.84±0.64	6.29± 0.90	104.70±26.59	131.02± 42.08
F Value			16.307	2.908	1.510	5.559	8.958	3.622	10.510	4.444
P Value			0.00001	0.061	0.227	0.006	0.00001	0.031	0.00001	0.015

Table 4: Correlation (r) Matrix of spleen dimension with age and sex of the subjects in sonographic study of spleen.

Gender	Variables		**Pearson`s correlation (r) coefficient and P value**				
			Age (Years)	Length	Thickness	Width	Volume
Females	Age	r value	1	-.323**	.066	-.215	-.197
		P Value		.003	.561	.056	.080
	Length	r value		1	.472**	.432**	.839**
		P Value			.000	.000	.000
	Thickness	r value			1	.232*	.720**
		P Value				.038	.000
	Width	r value				1	.614**
		P Value					.000
	Volume	r value					1
Males	Age	r value	1	-.202	-.327**	-.219	-.216
		P Value		.072	.003	.051	.055
	Length	r value		1	.491**	.756**	.898**
		P Value			.000	.000	.000
	Thickness	r value			1	.375**	.689**
		P Value				.001	.000
	Width	r value				1	.801**
		P Value					.000
	Volume	r value					1
Total	Age	r value	1	-.254**	-.124	-.206**	-.198*
		P Value		.001	.118	.009	.012
	Length	r value		1	.493**	.627**	.873**
		P Value			.000	.000	.000
	Thickness	r value			1	.337**	.711**
		P Value				.000	.000
	Width	r value				1	.737**
		P Value					.000
	Volume	r value					1

Discussion

Researchers concluded that sonographic measurements of splenic dimensions can give a true indication of its size.Therefore measurement of the length of spleens is generally the standard practice for clinical use. Present study was conducted with the aim to measure the variations in spleen size according to age and sex by ultrasonography and to find out possible correlations with the age and gender distribution with the dimensions of the spleen. Our study finds that spleen length among males (9.74±1.44 cm) were 0.34 cm longer than those of females splenic length (9.40±1.31 cm). Capaccioli et al in his study finds spleens of men being 0.5cm longer than those of women splenic length[7]. Arora et.al. (2013) found that among most of the subjects splenic length was <11cm and splenic size was more in males as compared to females[8]. In the study done by Chakraborti et. al. in Tripura population, the mean spleen length in adults was 8.8cm; In maless the splenic length was 8.85cm while in femaless 8.72 cm[9]. In the study done by Mittal & Chowdhary in Rajasthan the splenic length in maless and femaless measure 9.4cm and 9.34cm respectively [10]. Similar findings of splenic length below 11 cm were observed by Frank K et al. who demonstrated that in 95% of the cases splenic length was less than 11 cm[11] and also in Udoaka et al. study with splenic length of 9.82 cm and 9.12 cm in males and females respectively[12].In our study at Gwalior region of M.P. India, the mean Splenic Width was 6.45±0.93 cm and 6.88±1.16 cm in femaless and maless respectively. In another study of India done by Kankraj K et al in south Indian population the splenic width was 8.5 cm and 7.9 cm in maless and femaless[13]. In Ehimwenma and Tagbo study, the width was 7.8 cm and 7.1 cm in maless and femaless respectively[2].Our study findings were in accordance with the study done by Kanakraj K et al[13] where the mean values of splenic length, thickness, width and volume were 8.8 cm, 3.6 cm, 7.9cm and 137.8cc in femaless and 9.6cm, 3.9cm, 8.5cm and 180.8 cc in maless respectively. In the study done by Okoye IJ et al. the mean values of splenic length, thickness and width were 11.5

cm, 4.5 cm, 7.5 cm in males and 9.9 cm, 4 cm, 6 cm in females respectively [14]. In the study done by Ehimwenma and Tagbo the mean splenic length, thickness, width, and volume for males were 11.1 cm,4.4 cm,7.8 cm,and 202.7 cc, respectively and for the femaless the corresponding values of were 10.1 cm, 4.0 cm, 7.1 cm, and 153.7 cc respectively[2].In our study it was also observed that, there was overall decrease in the splenic length, width, thickness and volume in advanced age group, which was found to be statistically significant and comparable with Arora N et al. 8 study in Lucknow, and Chakraborti et al[9] study in Tripura on splenic length which was possibly due to the genetic & developmental factors of different populations of various regions in India.Megremis et al. (2004) reported that age had significant positive association with spleen length [15]. Arora et. al. (2010) used ultrasonography to examine 160 subjects (80 males &80 females) and finds that the splenic length, width & thickness decreases with the increase in age in both males and females and all the dimensions were greater in males than in females [8]. The spleen varies considerably in size. But, on average it is 2.5 cm thick, 7.5 cm wide and 12.5 cm long[16]. Our study finds there was a negative correlation between age of subjects and splenic length,width,thickness and volume;similar findings was also reported by Tekle et al[6] The present study was an attempt to determine the normal range of the spleen length, thickness, width and volume which correlated variably with different age in groups. So, our study had provided anthropometric parameter of spleen length, width, thickness and volume by ultrasonography which will be useful for reference value of spleen dimensions and volume in Gwalior region.

Conclusion

Our result shows that in both males and females splenic dimensions slightly increased at first and finally decreased at older age group. It was found that the splenic dimensions like length, thickness, width and volume was greater in males than in females in the each age group. It can be concluded that the basic knowledge of splenic dimensions by ultrasonography may be essential for providing the guideline and reference value to the radiologists, surgeons and clinicians for splenic diseases in Gwalior region.

Acknowledgement

TheAuthors are thankful to all the medical and paramedical staff of the Department of Radiology, G.R. Medical College (M.P.) for their continuous support, co-operation and guidance during the process of data collection. The Authors are also thankful to all the study participants.

References

1. Danila M. The ultrasound examination of the spleen. Med. Ultason. 2010; 12(3):253-4.
2. Ehimwenma O,Tagbo MT. Determination of normal dimension of the spleen by ultrasound in an endemic tropical environment. Niger. Med.J. 2011; 52(3):198-203.
3. Dailey, M. O. (2002). The immune functions of the spleen. In *The complete spleen* (pp. 51-69). Humana Press, Totowa, NJ.S
4. Bowdler, A. J. (Ed.). (2001). *The complete spleen: structure, function, and clinical disorders*. Springer Science & Business Media.
5. Petzoldt R, Lutz, Ehler R,Neidhardt B.Determination of splenic size by ultrasonic scanning. Med Klin.1976;71(48): 2113-6.
6. 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.
7. Capaccioli L, Stecco A, Vanzi E, Brizzi E. Ultrasonographic study on the growth and dimensions of healthy children and adult organs. Ital J AnatEmbryol. 2000;105(1):1-50.
8. Arora N, Sharma PK, Sahai A, Singh R. Sonographic measurements of the spleen in: splenic length in adult and its correlation with different parameters. Journal of Anatomical Society of India.2013; 62 (1): 57-61.
9. Chakraborti S, Saha N, Debbarma B, Das S, Leishram D. Normal spleen Length by Ultrasonography in Adults of Tripura. IOSR JDMS. 2016; 15(1):55-60.
10. Mittal R, Chowdhary DS. A pilot study of the normal measurements of the liver and spleen by ultrasonography in the Rajasthani population. JCDR. 2010;4:2733-6.
11. Frank K, Linhart P, Kortsik C, Wohlenberg H. Sonographic determination of spleen size: Normal dimensions in adults with a healthy spleen. Ultraschall Med. 1986; 7(3):134-7.
12. Udoaka AI, Enyi C, Agi CE. Sonological evaluation of the liver, spleen and the kidneys in adult Southern Nigerian population.Asian Journal of Medical Sciences.2013; 5(2): 33-36.
13. Kanakraj K, Mariappan K. Ultrasonographic study of Splenic Dimensions. Sch. J. App. Med. Sci. 2018; 6(10): 4100-4105.
14. Okoye IJ, Agwu KK, Ochie K. Sonographic splenic sizes in normal adult in Nigerian population. West African Journal of Radiology 2005;12(1):37-4.
15. Megremis SD, Vlachonikolis IG, Tsilimigaki AM. Spleen length In childhood with US: normal values based on age, sex, and somatometric parameters radiology. 2004;231(1): 129-34.
16. 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.

Conflict of Interest: Nil
Source of support:Nil