https://doi.org/10.36570/jduhs.2023.2.1822

JDUHS

ORIGINAL ARTICLE

Sonographic Evaluation of Splenic Dimensions in Healthy Pregnant and Non-Pregnant Women

Fatima Syed Muhammad,[1] Syed Muhammad Yousaf Farooq,[1] Naveed Asad,[1] Shameem Akram,[1] Aqsa Hafeez,[1] Shanza Zafar,[1] Zoha Sabeeh,[1] Ume Hani Rashid,[1] Lina Khaled Jallad[2]

1. The University of Lahore, Lahore, Pakistan.
2. Fatima College of Health Sciences, United Arab Emirates.

Correspondence to: Dr. Syed Muhammad Yousaf Farooq, Email: yousafgelani@gmail.com, ORCiD: 0000-0001-5768-224X

ABSTRACT

Objective: To compare the ultrasonographic findings of splenic dimension in healthy pregnant and non-pregnant women.

Methods: This analytical cross-sectional study was conducted at University Ultrasound Clinic, Lahore from August 2022 to February 2023. A total of 200 females (100 non-pregnant and 100 pregnant) were examined. Mindray and Toshiba Ultrasound Machines were used to perform the ultrasonography. The measurements of splenic length, width, and thickness were recorded. The length of the spleen was measured in a longitudinal view. The width of the spleen was measured in a transverse view. The anteroposterior diameter (thickness) of the spleen was also measured.

Results: The overall mean age was 29.0 ± 7.8 years. The mean difference of splenic width, thickness, and volume were significantly higher in pregnant women as compared to non-pregnant women i.e., 5.58 ± 1.44 cm vs. 5.15 ± 1.42 cm (p-value 0.033), 6.37 ± 2.56 cm vs. 4.46 ± 1.10 cm (p-value <0.001), and 178.2 ± 97.90 cm^3 vs. 118.8 ± 47.57 cm^3 (p-value <0.001) respectively. A significant difference of splenic width (p-value <0.001) and thickness (p-value <0.001) were observed with respect to gestational age of the individuals. Moreover, mean difference of splenic width was significantly increased in age group 15-30 years as compared to 31-51 years i.e., 5.68 ± 2.25 cm vs. 4.94 ± 2.00 cm (p-value 0.022) respectively.

Conclusion: In pregnancy, the splenic thickness and splenic volume is seen to be increased when compared to non-pregnant women.

Keywords: Gestational Age, Maternal, Obstetrics, Pregnancy, Spleen, Ultrasound.

INTRODUCTION

Spleen is the largest and one of the most important organs of reticuloendothelial and lymphatic system. Spleen is responsible for most of immune reaction occurring in human body.[1] It is located between the left kidney and the hemi diaphragm in the left hypochondriac area. It has very smooth surfaces and is a soft, purple, triangular or circular, friable organ. The size of the spleen varies from person to person. Its dimensions are normally 12 cm long, 7 cm wide, and 5 cm thick. The spleen typically weighs 150 grams.[2]

Pathological enlargement of spleen is called as splenomegaly, which is measured by its size and weight. It is reported that Infectious process, malignancies, or portal hypertension are the potential risk factors of splenomegaly. In these cases, spleen is palpable in physical examination as compared to normal spleen.[4]

Pregnancy is also reported in literature as one of the factors for splenomegaly. During pregnancy increase in maternal blood volume is a major cause due to which spleen size increases. Maternal blood volume increases above 45% in early pregnancy and increases up to 60% at the end of second trimester.[5]

During pregnancy, in bone marrow the increase of erythrocytes, plasma and also moderate erythrocyte hyperplasia causes increase in maternal blood volume. Throughout gestational age there is a slight elevation in reticulocyte count. The platelets and erythrocytes width and volume increases throughout normal pregnancy.[6]

Spleen functions more progressively during pregnancy, it increases its immune function against microorganism

or foreign body to protect fetus. Fluctuation of hormones in pregnancy can also be the case of increase in spleen size in pregnancy. Moreover, the spleen is also responsible for hematopoietic activity in fetal life and store platelets.[7]

Spleen is the organ that showed linear growth pattern throughout the pregnancy when measured by ultrasound.[9]

Splenic index is a formula (length × width × depth × 0.523) that can be used to calculate the spleen's volume. There are two methods to calculate the spleen's volume. One is length measured along a longitudinal axis, and the other is width measured across a transverse axis.[10]

The ultrasonographic appearance of spleen is very consistent and uniform. The splenic parenchyma also appears to be homogenously echoic on ultrasound. When imaged, the echogenicity of the spleen is usually compared to the liver. The splenic parenchyma tends to be slightly greater echoic than liver parenchyma. The spleen on its own is mid or low echogenic.[11,12]

Although sonographic splenic size estimation has been performed in various study populations, still there is a lack of information in pregnant state. For measuring splenic dimensions, ultrasonography (US) is a recognized noninvasive, reliable, and safe method with reproducible results. There is a need to better understand how various measurements change throughout different stages of pregnancy and between pregnant and non-pregnant women. This information can be used to help diagnose and monitor conditions that affect the spleen, such as infections, autoimmune diseases, and hematologic disorders. In addition, understanding the changes in splenic dimensions during pregnancy is important to distinguish physiological enlargement from pathological causes. This can help healthcare providers to identify any potential issues that may arise during pregnancy and to provide appropriate care.

METHODS

This analytical cross-sectional study was conducted at University Ultrasound Clinic, Green Town, Lahore from August 2022 to February 2023. Study was conducted after the approval from Research Ethical Committee, REC # 92 The University of Lahore. Signed Informed consent form was obtained from all the eligible study participants.

Total 200 females were examined. Hundred were non pregnant and 100 were pregnant. All participants were recruited by using non-probability convenient sampling technique. Women aged 15 years or above attending sonography clinic were included. Females with splenomegaly, dengue and any other abnormality were excluded. Females with history of splenectomy were also excluded.

Mindray and Toshiba Ultrasound Machines were used to perform the study. A 3.5 MHz frequency probe was used, scanning was performed in deep inspiration in supine position. The sonographer identifies the spleen by locating the left upper quadrant of the abdomen. The spleen is typically found between the 9th and 11th ribs, extending from the mid-axillary line to the mid-clavicular line. The length of the spleen was measured in a longitudinal view from its superior to its inferior pole. The width of the spleen was measured in a transverse view at the widest point. In some cases, the anteroposterior diameter (thickness) of the spleen was also measured. This was done in a sagittal or transverse view by placing the calipers at the widest point between the anterior and posterior aspects of the spleen. The recorded measurements of length, width, and thickness were documented on the data collection sheets.

Data entry and analysis were done using a Statistical Package for Social Sciences (SPSS) version 20.0. Mean ± SD were computed for quantitative variables like, age (years), length (cm), width (cm), thickness (cm), and splenic volume (cm^3) while frequency and percentages were computed for categorical variable like gestational age. Inferential statistics were explored using Independent t-test and One-way ANOVA to compare mean difference of splenic dimensions between pregnant and non-pregnant women. Moreover, Pearson's correlation test was applied to see the relationship of age with splenic dimensions between healthy pregnant and non-pregnant women. The p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Of 200 pregnant and non-pregnant women, the mean age was 29 ± 7.8 years. The mean splenic length, width, thickness, and volume were 9.7 ± 1.4 cm, 5.3 ± 1.4 cm, 5.4 ± 2.1 cm, and 148.5 ± 82.3 cm^3 respectively. Most of the pregnant women gestational age was 13-27 weeks i.e., 47 (47.0%) followed by 28-40 weeks 41 (41.0%) and 6-12 weeks 12 (12.0%).

The mean difference of splenic width, thickness, and volume were significantly increased in pregnant women as compared to non-pregnant women i.e., 5.58 ± 1.44 cm vs. 5.15 ± 1.42 cm (p-value 0.033), 6.37 ± 2.56 cm

Table 1: Mean difference of splenic dimensions between pregnant and non-pregnant women (n=200)

	Pregnant Women (n=100) Mean ± SD	Non-Pregnant Women (n=100) Mean ± SD	p-value
Length (cm)	9.65 ± 1.55	9.76 ± 1.37	0.596
Width (cm)	5.58 ± 1.44	5.15 ± 1.42	0.033*
Thickness (cm)	6.37 ± 2.56	4.46 ± 1.10	<0.001*
Splenic Volume (cm³)	178.2 ± 97.90	118.8 ± 47.57	<0.001*

Independent t-test applied, SD: Standard Deviation, cm: Centimetre, *p-value ≤ 0.05

Table 2: Mean difference of splenic dimensions with respect to age between healthy pregnant and non-pregnant women (n=200)

	Age (years)		p-value
	15-30 (n=128) Mean ± SD	31-51 (n=72) Mean ± SD	
Length (cm)	9.57 ± 1.45	9.95 ± 1.45	0.073
Width (cm)	5.33 ± 1.44	5.42 ± 1.44	0.654
Thickness (cm)	5.68 ± 2.25	4.94 ± 2.00	0.022*
Splenic Volume (cm³)	152.44 ± 82.39	141.55 ± 82.38	0.370

Independent t-test applied, SD: Standard Deviation, cm: Centimetre, *p-value ≤ 0.05

Table 3: Relationship of age with splenic dimensions between healthy pregnant and non-pregnant women (n=200)

	Age (years)			
	Length (cm) r (p-value)	Width (cm) r (p-value)	Thickness (cm) r (p-value)	Splenic Volume (cm³) r (p-value)
Total (n=200)	0.14 (0.046)*	0.01 (0.873)	-0.17 (0.015)*	-0.07 (0.268)
Pregnant Women (n=100)	0.08 (0.407)	-0.02 (0.801)	-0.11 (0.273)	-0.02 (0.797)
Non-Pregnant Women (n=100)	0.18 (0.069)	0.09 (0.331)	-0.06 (0.502)	0.06 (0.552)

Pearson's correlation test applied, cm: Centimetre, *p-value ≤ 0.05

Table 4: Mean difference of splenic dimensions with respect to gestational age of healthy pregnant women (n=100)

	Gestational Age (weeks)			p-value
	6-12 (n=12) Mean ± SD	13-27 (n=47) Mean ± SD	28-40 (n=41) Mean ± SD	
Length (cm)	9.22 ± 1.09	9.74 ± 1.38	9.94 ± 1.42	0.279
Width (cm)	7.34 ± 0.92	5.47 ± 1.16	4.14 ± 0.78	<0.001*
Thickness (cm)	3.81 ± 0.41	3.99 ± 0.80	5.20 ± 1.13	<0.001*
Splenic Volume (cm³)	137.25 ± 36.37	115.32 ± 50.79	117.44 ± 46.40	0.355

One-Way ANOVA test applied, SD: Standard Deviation, cm: Centimetre, *p-value ≤ 0.05

vs. 4.46 ± 1.10 cm (p-value <0.001), and 178.2 ± 97.90 cm^3 vs. 118.8±47.57 cm^3 (p-value<0.001) respectively (Table 1). Majority of the women were 15-30 years 128 (64.0%) and 72 (36.0%) were 31-51 years old. The mean difference of splenic length and width were insignificantly increased in age group 31-51 years as compared to 15-30 years i.e., 9.95 ± 1.45 cm vs. 9.57 ± 1.45cm (p-value 0.073) and 5.42 ± 1.44 cm vs. 5.33 ± 1.44 cm (p-value 0.654) respectively. While mean difference of splenic width was significantly increased in age group 15-30 years as compared to 31-51 years i.e., 5.68 ± 2.25 cm vs. 4.94 ± 2.00 cm (p-value 0.022) respectively. (Table 2).

A significant positive correlation was observed between the age and splenic length of the individuals (r=0.14, p-value 0.046). However, significant negative correlation was observed in between age and splenic thickness of the individuals (r=-0.17, p-value 0.015) (Table 3). Significant difference of splenic width (p-value <0.001) and thickness (p-value <0.001) was observed with respect to gestational age of the individuals (Table 4).

DISCUSSION

Ultrasound has most efficient characteristics which are useful in imaging abdominal organs and also it is the safest modality to be used in pregnancy. In pregnancy, the imaging of spleen has important role, because spleen undergoes some physiological changes which brings changes in its dimensions and causes its enlargement. It is reported that the enlargement of spleen can occur due to various reasons such as infectious disease, cancer, blood disorder or any kind of liver disease.[13] In this current study, the width, volume and thickness of the spleen were significantly larger in pregnant women compared to non-pregnant women. This study compared, splenic dimension between pregnant and non-pregnant women. A study conducted in 2004, they also found overall increase in spleen size of pregnant females as compared to non-pregnant.[14] Another study has reported that spleen size increases significantly in pregnancy with increasing gestational age.[8]

In 2014 Gayer *et al*. reported that mean splenic volume in post-partum women was more than non-pregnant women. In post-partum women the mean volume was 68% larger than non-pregnant women. The increase in pregnancy hormones required for foetal development, which indirectly increases splenic size, has been related to the larger splenic volume in the expectant mothers in the current study compared to other studies for non-pregnant women. Hemodynamic changes during pregnancy are another explanation that might be possible.[15]

In a previous studies conducted by Okoye *et al*.[16] and Imo *et al*.[17] it was reported that splenic volume in non-pregnant women is lower.

In 2021, Udoh *et al*. stated that the splenic dimension's increase in accordance with gestational age.[7] In 2006 Maymon *et al*. conducted a study which also showed there is a positive correlation between splenic dimensions and gestational age.[8] Our results contradict with these studies results because there only splenic width and volume increased. In 2013 Ugboma *et al*. conducted a study which resulted that there is no relationship between splenic size and gestational age.[18]

In this current study, the result showed no changes in the splenic dimension except splenic thickness in relation with age. In 2021 Demissie *et al*. did a study, their results also showed a positive correlation of age with splenic dimension.[19] Tekle *et al*. did research in 2019, there results showed significant negative relation between age and splenic dimension.[20] Another study conducted in 2014 by Caglar *et al*.[21] stated that splenic dimensions showed negative relationship with age. Other studies conducted by kaneko *et al*. in 2002 and 2008 also showed significant negative correlation. According to another study with increasing gestational age, there is a strong overall growth pattern of the spleen area in pregnancy.[8] The findings of the current study have reported changes in spleen width and thickness as pregnancy progresses, but no significant differences in spleen length or volume across different gestational age. More studies conducted on splenic dimensions in pregnant females; similar to our study they also found no significant increase in splenic length throughout pregnancy.[24,25] In a previous study from Pakistan, a significant increase was observed in spleen size with the increase in age.[26]

There are certain limitations in the current study that may not have accounted for all potential confounding factors that could influence the measured outcomes. Factors such as maternal age, body mass index, or other medical conditions might have impacted the results. Despite of these limitations the current study revealed significant differences in width, thickness, and splenic volume between pregnant and non-pregnant women. Incorporating these measurements in clinical assessments can aid in distinguishing between pregnant and non-pregnant individuals. Such comparative assessments can be particularly useful in cases where pregnancy status is uncertain or in specialized medical settings where accurate determina-

tion of pregnancy status is crucial.

CONCLUSION

In conclusion during pregnancy, the splenic thickness and splenic volume was seen to be increased when compared to non-pregnant women. With an increase in gestational age splenic width and splenic thickness was seen to be increased. With an increase in age, only splenic thickness was increased. With increasing gestational age, a significant overall growth pattern of the spleen area was seen.

ETHICAL APPROVAL: The study was approved by the Research Ethical Committee, The University of Lahore (Reference Number: REC-UOL-92-04-2023).

AUTHORS' CONTRIBUTIONS: FSM: Manuscript writing. SMYF: Article Writing / Data Analysis. NA, SA, AH, ZS: Data Collection. SZ: Plagiarism and grammar corrections. UHR: Results. LKJ: Discussion writing and English corrections. All authors gave final approval to submit the manuscript.

CONFLICT OF INTEREST: The authors declared no conflict of interest.

FUNDING: None

Received: April 26, 2023
Accepted: July 27, 2023

REFERENCES

1. Cesta MF. Normal structure, function, and histology of the spleen. Toxicol Pathol 2006; 34:455-65. doi:10.1080/01926230600867743
2. Zainab SD, John A, Ali A, Abbas SN, Kiran W. Evaluation of Normal Spleen Volume using Ultrasonography: Evaluation of Normal Spleen Volume using Ultrasonography. Pak J Health Sci 2022; 30:21-4. doi:org/10.54393/pjhs.v3i01.52
3. Suttie AW. Histopathology of the spleen. Toxicol Pathol 2006; 34:466-503. doi:10.1080/01926230600867750
4. Izranov V, Palvanova U, Gordova V, Perepelitsa S, Morozov S. Ultrasound criteria of splenomegaly. Radiologist 2019; 1:3-6.
5. Chapman J, Bansal P, Goyal A, Azevedo AM. Splenomegaly 2021. StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.
6. Akinlaja O. Hematological changes in pregnancy-The prepa-ration for intrapartum blood loss. Obstet Gynecol Int J 2016; 4:00109. doi:10.15406/ogij.2016.04.00109
7. Udoh BE, Ukpong EV, Paulinus SO, Okokon C, Erim AE. Sonographic evaluation of maternal splenic dimensions in normal pregnancy. Niger J Med 2021; 30:17-20. doi:10.4103/NJM.NJM_92_20
8. Maymon R, Strauss S, Vaknin Z, Weinraub Z, Herman A, Gayer G. Normal sonographic values of maternal spleen size throughout pregnancy. Ultrasound Med Biol 2006; 32:1827-31. doi:10.1016/j.ultrasmedbio.2006.06.017
9. O'Malley C, Cunningham AJ. Physiologic changes during laparoscopy. Anesthesiol Clin North Am 2001; 19:1-19. doi:10.1016/s0889-8537(05)70208-x
10. Badran DH, Kalbouneh HM, Al-Hadidi MT, Shatarat AT, Taraw-neh ES, Hadidy AM, et al. Ultrasonographic assessment of splenic volume and its correlation with body parameters in a Jordanian population. Saudi Med J 2015; 36:967-72. doi:10.15537/smj.2015.8.11809
11. Andrews MW. Ultrasound of the spleen. World J Surg 2000; 24:183-7. doi:10.1007/s002689910031
12. Nayak BS, Somayaji S, Soumya KJIJoM. A Study on the Variati-ons of Size, Shape and External Features of the Spleen in South Indian Population. Intl J Morphol 2011; 29:675-7.
13. Ehimwenma O, Tagbo MT. Determination of normal dimen- sion of the spleen by ultrasound in an endemic tropical environment. Niger Med J 2011; 52:198-203. doi:10.4103/0300-1652.86141
14. Fernandez Llario P, Parra A, Cerrato R, Hermoso de Mendoza J. Spleen size variations and reproduction in a Mediterranean population of wild boar (Sus scrofa). Eur J Wildl Res 2004; 50:13-7.
15. Gayer G, Ben Ely A, Maymon R, Hertz M. Enlargement of the spleen as an incidental finding on CT in post-partum females with fever. Br J Radiol 2012; 85:753-7. doi:10.1259/bjr/92126864
16. Okoye IJ, Agwu KK, Ochie K. Sonographic splenic sizes in nor-mal adult Nigerian population. West Afr J Radiol 2005; 12:37-47.
17. Imo AO, Eze JC, Udoh BE. Ultrasonographic Evaluation of Splenic Volumes in Normal Subjects in South-East, Nigeria. West Afr J Radiol 2011; 18:42-7. doi:10.4314/wajr.v18i1.71040
18. Ugboma E, Ugboma H. Sonographic evaluation of the splenic length in normal pregnancy in a tertiary hospital in southern Nigeria: a pilot study. Ann Med Health Sci Res 2013; 3:330-3. doi:10.4103/2141-9248.117928
19. Demissie S, Mergu P, Hailu T, Abebe G, Warsa M, Fikadu T. Morphometric assessment of spleen dimensions and its determinants among individuals living in Arba Minch town, southern Ethiopia. BMC Med Imaging 2021; 21:186. doi:10.1186/s12880-021-00719-9
20. Tekle Y, Gudadhe DR, Abreha M, Muche A, Tegegne Z, Hiware SD. Morphometric assessment of the normal dimensions of the adult spleen in North-west Ethiopia Region—a radiological study. Ann Int Med Dent Res

2018; 4:34. doi:10.21276/aimdr.2018.4.4.AT7

21. Caglar V, Alkoc OA, Uygur R, Serdaroglu O, Ozen OA. Deter-mination of normal splenic volume in relation to age, gender and body habitus: a stereological study on computed tomography. Folia Morphol (Warsz) 2014; 73:331-8. doi:10.5603/FM.2014.0038
22. Kaneko J, Sugawara Y, Matsui Y, Ohkubo T, Makuuchi M. Normal splenic volume in adults by computed tomography. Hepatogastroenterology 2002; 49:1726-7.
23. Kaneko J, Sugawara Y, Matsui Y, Makuuchi M. Spleen size of live donors for liver transplantation. Surg Radiol Anat 2008; 30:515-8. doi:10.1007/s00276-008-0364-z
24. Lamb PM, Lund A, Kanagasabay R, Martin A, Webb JA, Reznek RH. Spleen size: how well do linear ultrasound measurements correlate with three-dimensional CT volume assessments? Br J Radiol 2002; 75:573-7. doi:10.1259/bjr.75.895.750573
25. Hosey RG, Mattacola CG, Kriss V, Armsey T, Quarles JD, Jagger J. Ultrasound assessment of spleen size in collegiate athletes. Br J Sports Med 2006; 40:251-4. doi:10.1136/bjsm.2005.022376
26. Khan SA, Yasmeen S, Adil H, Adil SO, Huda F, Khan S. Sonographic evaluation of normal liver, spleen, and renal parameters in adult population: A Multicenter Study. J Coll Physicians Surg Pak 2018; 28:834-9. doi: 10.29271/jcpsp.2018.11.834.