

Spleen Size in Chhattisgarhi Adult Population with Relation to Age using Ultrasonography: A Cross-sectional Study

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ABSTRACT

Introduction: Spleen, a vital organ of reticuloendothelial system, which helps in degradation of old red blood cells and secretes properdin, tuftsin and immunoglobulin-G. Spleen known to show variation in shape and size with respect to age, sex, height, weight and ethnicity. Ultrasonography is a non magnetic radiation, easily performed and cost-effective diagnostic procedure which can be used for accurate measurement of spleen.

Aim: To evaluate and correlate splenic dimensions by Ultrasonography (USG) in Chhattisgarh population with respect to age.

Materials and Methods: This cross-sectional study was conducted over a period of one year, from August 2015 to July 2016 in the Departments of Anatomy and Radiodiagnosis at Pt. Jawahar Lal Nehru Memorial (Pt. JNM) Medical College, Raipur, India. A total of 400 subjects were recruited for study, of which 239 were females and 161 were males. The subjects were selected amongst the adult patients, in the age groups of 25-60 years, who had come for abdominal USG. Spleen length, breadth and thickness of these were evaluated using USG. Descriptive analysis was carried out using Microsoft (MS) Excel version 2010 and Statistical Package

for the Social Sciences (SPSS) version 23.0 was used to derive mean, standard and Pearson's correlation coefficient (r). Statistical significance was considered at p-value <0.05.

Results: A total of 400 subjects were studied with a mean age of 39.23±10.03 years. Spleen length, breadth and thickness in age groups 25-30 years were 95.34±8.73 mm, 49.42±9.19 mm and 34.93±4.62 mm, in age group 31-40 years was 92.25±7.13 mm, 45.95±7.86 mm and 33.9±3.88 mm, in age group 41-50 years was 90.7±7.69 mm, 45.01±7.31 mm and 33.5±3.99 mm and in 51-60 years was 88.39±5.25 mm, 41.39±6.64 mm and 27.67±2.8 mm was noted in females. Whereas in males, in age group 25-30 years was 105.43±10.42 mm, 53.87±8.01 mm and 41.56±6.16 mm, in age group 31-40 years was 101.8±7.66 mm, 48.73±6.1 mm and 37.65±4.27 mm, in age group 41-50 years was 98.48±7.03 mm, 45.81±6.14 mm and 36.16±3.98 mm and in age group 51-60 years was 94.38±7.09 mm, 42±5.94 mm and 34.3±4.46 mm, respectively was observed.

Conclusion: Spleen length, breadth and thickness were observed to decrease in size with increase in age, of which spleen breadth in males showed a moderately significant negative correlation (r=-0.451) with age.

Keywords: Red blood cells, Reticulo-endothelial system, Splenic dimensions

INTRODUCTION

Spleen is an integral organ of the reticulo-endothelial system of human body. It is responsible for removal of old and deformed red blood cells and secretion of properdin, tuftsin and immunoglobulin-G [1]. Spleen varies in size according to sex, height, weight, age and ethnicity [2-5]. Hence, it becomes important to evaluate the size of spleen and correlate it with these variables.

Spleen size can be very easily assessed by palpation. As spleen is physiologically not palpable, therefore, a palpable spleen can apprise us of splenomegaly, but some studies suggest that not always a palpable spleen is splenomegaly [6]. Also, the exact size of the spleen cannot be evaluated using palpation.

Computerised Tomography (CT) scan and Magnetic Resonance Imaging (MRI) although very accurate, are not practical for evaluation of size of spleen, unless warranted. Because of the highly expensive procedural cost of both CT scan and MRI, and side-effects of radiation exposure in CT scan, both these modalities of investigation are not feasible [7-10].

The USG, thereby, is one such diagnostic tool which is relatively cheap and accurate [11-14]. Moreover, USG machines are widely in practice and are available at almost all levels of healthcare system.

The present study was aimed to correlate all the dimensions of spleen, i.e., spleen length, spleen breadth and spleen thickness with age in male and female subjects in Chhattisgarhi population, as no similar study has been performed previously in this region.

MATERIALS AND METHODS

This cross-sectional study was conducted over a period of one year, from August 2015 to July 2016 in the Department of Anatomy and Radiodiagnosis at Pt. JNM Medical College, Raipur. After ethical approval from the Institute Scientific Committee, a total of 400 subjects were recruited for study, of which 239 were females and 161 were males. The sample size had been calculated by statistical committee, for the facilitation of the research project.

Inclusion criteria: Subjects in an age range of 25-60 years, who were advised abdominal USG and gave their consent for the study were included. It was made sure that they were domicile holder residents of Chhattisgarh, by cross checking it with Aadhaar/Ration card/Below Poverty Line (BPL) card.

Exclusion criteria: Gravid females or patients with any diseases related to spleen, any haemoglobinopathy, any lymphoproliferative disorder, history of splenectomy or any lesion on the skin over the spleen were excluded from the study.

Once history and examination was over, these subjects were asked to sign a hand written proforma, as a proof of consent for examination. They were explained the investigation procedure. Thereafter, asked to lie down on the examination table in right lateral decubitus position. Scanning was done using a 3.5 MHz probe along the anterior, mid and posterior axillary line at the level of nine to eleven ribs. Repeated measurements were made through hilum of spleen, which served as a reference point throughout the study [15,16].

Splenic length, defined as the maximum distance between the dome of the spleen and the splenic tip, measured on the longitudinal section. Splenic width defined as the maximum distance between the medial and lateral borders of the spleen, measured on a plane perpendicular to the length. Transverse scans were obtained with the transducer rotated through 90°. Splenic thickness was defined as the maximum antero-posterior dimension was measured on the transverse section. Each dimension, rescanned and recorded three different times to the nearest millimetre and the mean value obtained for accuracy of result [17]. Throughout the entire period of study, the observations were made by four different observers.

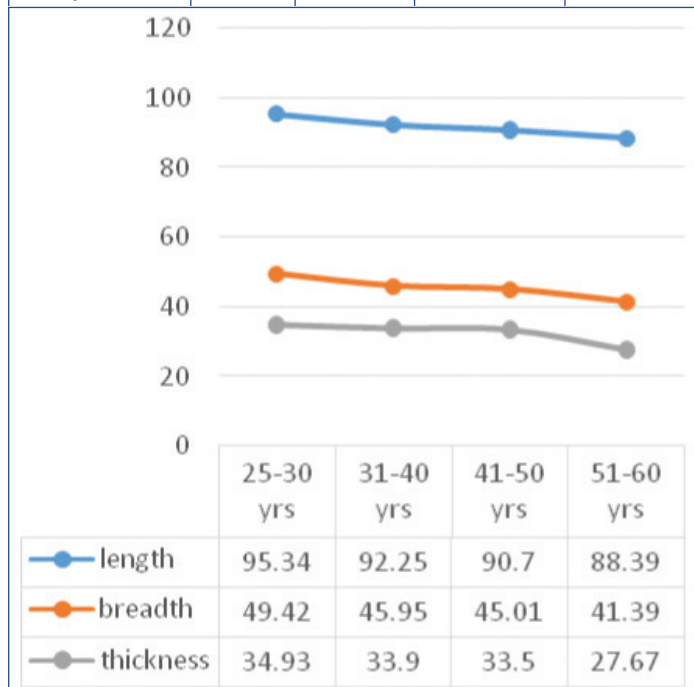
STATISTICAL ANALYSIS

Descriptive analysis was carried out using MS Excel 2010 version and SPSS version 22.0 (2013) in which mean, standard and Pearson's correlation coefficient (r) and p-value were calculated. A p-value <0.05 was considered statistically significant.

RESULTS

The total number of subjects included in the study were 400 with a mean age of 39.23±10.03 years. The mean age of females who underwent the study was 38.47±10.04 years, whereas in males it was 40.35±9.96 years. The mean values of splenic length, breadth and thickness in females according to age are shown in [Table/Fig-1]. Pearson's correlation coefficient (r) of age in females with spleen length was (r=-0.275, p<0.001), spleen breadth was (r=-0.283, p<0.001) and spleen thickness was (r=-0.371, p<0.001). Whereas, in males, the mean values of splenic dimensions are shown in [Table/Fig-2]. Pearson's correlation coefficient (r) of age in males with spleen length was (r=-0.368, p<0.001), spleen breadth was (r=-0.451, p<0.001) and spleen thickness was (r=-0.393, p<0.001).

Age (Mean age=38.47±10.04 years)	No. of cases (n=239)	Spleen length (mm)±SD	Spleen breadth (mm)±SD	Spleen thickness (mm)±SD
25-30 y	75	95.34±8.73	49.42±9.19	34.93±4.62
31-40 y	71	92.25±7.13	45.95±7.86	33.9±3.88
41-50 y	65	90.7±7.69	45.01±7.31	33.5±3.99
51-60 y	28	88.39±5.25	41.39±6.64	27.67±2.8

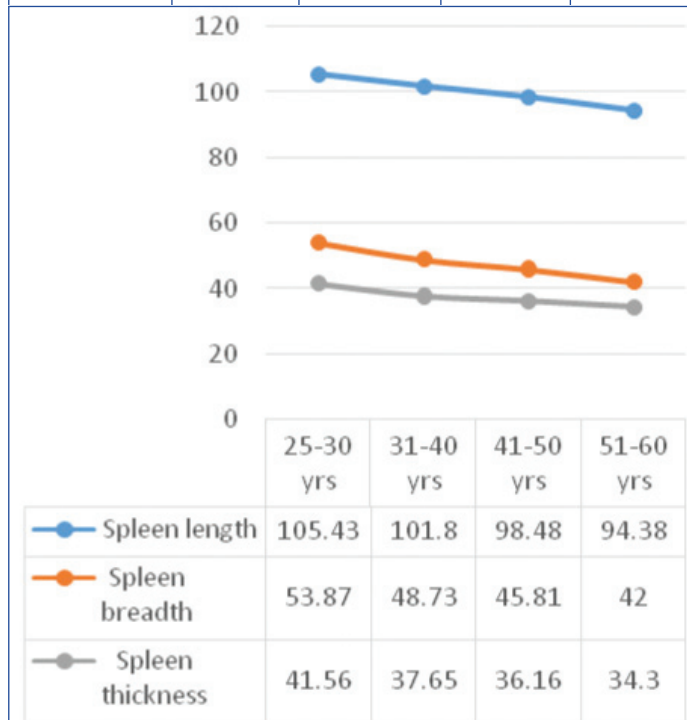


[Table/Fig-1]: Mean splenic dimension according to age in females.

DISCUSSION

Due to its important role in the haemopoietic system of the human body, estimation of size of spleen becomes an important mode in order to evaluate its proper functioning [18]. In order to evaluate

Age (Mean age=40.35±9.96 years)	No. of cases (n=161)	Spleen length (mm)±SD	Spleen breadth (mm)±SD	Spleen thickness (mm)±SD
25-30	32	105.43±10.42	53.87±8.01	41.56±6.16
31-40	60	101.8±7.66	48.73±6.1	37.65±4.27
41-50	43	98.48±7.03	45.81±6.14	36.16±3.98
51-60	26	94.38±7.09	42±5.94	34.3±4.46



[Table/Fig-2]: Mean splenic dimension according to age in males.

size of spleen, researchers from time to time have studied spleen in cadaver. Some researchers have also correlated spleen size and volume observed in cadaver with age, sex, body height, weight, BMI and Body Surface Area (BSA). Chowdhury Al et al., noted average spleen volume to be 75.27±3.78 mL in males and 60.51±4.90 mL in females, which increased with age during childhood and adolescence remains stable in young adult and declined in older age groups [19]. Mohammadi S et al., noted the mean values of the spleen length, width, thickness, notch, weight and index in the cadavers which were 11.32±3.10 cm, 8.05±2.35 cm, 20.12±9.21 mm, 0.84±1.35, 123.87±82.46 g, and 2.01±1.40, respectively [20]. Caglar V et al., noted the splenic dimensions in adult autopsies to be 11.3±1.1 cm long, 3.8±1 cm thick and 6±0.8cm wide, and found a strong correlation with body height, weight, BMI, and BSA [21].

Many researchers have made the use of CT scans in their effort to evaluate and correlate size of spleen with age of participants. Kaneko J et al., observed the mean volume of the spleen to be 112 cc, ranging from 32-209 cc using CT scan in 150 individuals. The spleen volume significantly correlated with age (R=0.36, p=0.0002), but not with body weight or surface area [22]. Srisajakul S et al., noted the average splenic volume to be 124.1±51.8 cm³, ranging from 27.60-430.85 cm³ with a significant correlation with age, height, weight and BMI (age: r=-0.151, p<0.001; height: r=0.187, p<0.001; weight: r=0.248, p<0.001 and BMI: r=0.159, p<0.05) [23]. A CT based study, by Harris A et al., observed average splenic volume of 230 subjects to be 127.4±62.9 cm³, ranging from 22 to 417 cm³ [24]. Prassopoulos P et al., noted the mean splenic volume to be 214.6 cm³ with a range from 107.2-314.5 cm³, using CT scan in 140 patients [25]. In the past, researchers have also used to study and analyse splenic dimensions and age with the help of USG, but in children [26-28].

This study was undertaken to evaluate and correlate splenic dimensions with age of participants. In this study, a decrease in all the dimensions of spleen with increasing age, in both males and females, was noted. Using Pearson's formula, correlation coefficient (r) of

Spleen dimensions	Age group (in years)	Present study (n=239) ^α	Gujarat (n=250) ^β [29]	North India (n=80) ^β [30]	Tripura (n=57) ^{δ, °} [31]	Nepal (n=160) ^δ [32]	Bangladesh (n=84) ^γ [33]	Pakistan (n=251) ^γ [34]
Spleen length (mm)	Age group I	95.34±8.73	93.80±11.25	97.09±16.16	86.7±8.5	98.3±5.3	~	~
	Age group II	92.25±7.13	95.74±9.86	94.69±13.67	85.5±9.3	95.8±5.8	~	~
	Age group III	90.7±7.69	92.88±11.27	92.88±12.77	92.1±6.8	92.0±6.4	~	~
	Age group IV	88.39±5.25	92.41±11.83	85.06±10.09	93.0±9.1	88.0±3.6	~	~
	Average	92.35±7.98	93.6±11.0	~	87.2±8.9	~	76.0±10.0	96.1±16.9
Spleen breadth (mm)	Age group I	49.42±9.19	41.74±6.82	47.27±13.05	~	~	~	~
	Age group II	45.95±7.86	43.32±7.85	43.09±8.33	~	~	~	~
	Age group III	45.01±7.31	41.38±11.27	44.54±11.46	~	~	~	~
	Age group IV	41.39±6.64	40.78±6.93	38.65±6.90	~	~	~	~
	Average	46.25±8.43	~	~	~	~	60.5±11.9	~
Spleen thickness (mm)	Age group I	34.93±4.62	32.24±6.06	35.45±7.50	~	4.1±0.5	~	~
	Age group II	33.9±3.88	33.34±6.45	34.37±6.77	~	4.05±0.58	~	~
	Age group III	33.5±3.99	33.52±7.27	34.87±5.60	~	3.43±0.38	~	~
	Age group IV	27.67±2.8	32.52±5.64	30.90±5.58	~	3.0±0.36	~	~
	Average	33.38±4.59	~	~	~	~	36.3 ±7.5	~

[Table/Fig-3]: Comparison of splenic dimensions in females in various studies.

α=Age groups I-IV are 25-30, 31-40, 41-50, 51-60 years respectively; β=Age groups I-IV are 21-30, 31-40, 41-50, 51-60 years respectively; δ=Age groups I-IV are 15-30, 31-45, 46-60, 61-75 years respectively; °=75+ years age group (not included in table); Range χ=(21-80 years) γ=(15-87 years)

Spleen dimensions	Age group (in years)	Present study (n=161) ^α	Gujarat (n=250) ^β [29]	North India (n=80) ^β [30]	Tripura (n=89) ^{δ, °} [31]	Nepal (n=160) ^δ [32]	Bangladesh (n=84) ^γ [33]	Pakistan (n=276) ^γ [34]
Spleen length (mm)	Age group I	105.43±10.42	100.84±9.83	107.24±13.18	93.5±11.8	100.7±7.0	~	~
	Age group II	101.8±7.66	99.97±10.18	103.50±10.12	90.4±18.4	101.0±5.4	~	~
	Age group III	98.48±7.03	99.38±7.39	100.23±14.11	91.3±11.5	95.0±7.0	~	~
	Age group IV	94.38±7.09	94.82± 12.12	87.85±12.15	85.1±16.2	90.0±4.3	~	~
	Average	100.44±8.80	98.7± 9.8	~	88.5±15.4	~	86.6±7.4	101.3±17.7
Spleen breadth (mm)	Age group I	53.87±8.01	45.75±7.12	55.07±10.97	~	~	~	~
	Age group II	48.73±6.1	44.64±6.67	46.53±6.77	~	~	~	~
	Age group III	45.81±6.14	45.90±7.39	49.00±18.80	~	~	~	~
	Age group IV	42±5.94	42.79±7.60	42.64±7.26	~	~	~	~
	Average	47.88±7.52	~	~	~	~	76.7±3.5	~
Spleen thickness (mm)	Age group I	41.56±6.16	35.3±6.80	39.60±7.51	~	40.6±4.7	~	~
	Age group II	37.65±4.27	34.25±6.16	38.79±5.30	~	37.8±4.8	~	~
	Age group III	36.16±3.98	35.86±6.78	38.93±5.50	~	33.8±3.5	~	~
	Age group IV	34.3±4.46	34.05±6.37	34.41±6.47	~	22.9±2.3	~	~
	Average	37.49±5.22	~	~	~	~	40.1±3.4	~

[Table/Fig-4]: Comparison of splenic dimensions in males in various studies.

α= Age groups I-IV are 25-30, 31-40, 41-50, 51-60 years respectively; β= Age groups I-IV are 21-30, 31-40, 41-50, 51-60 years respectively; δ= Age groups I-IV are 15-30, 31-45, 46-60, 61-75 years respectively; °= 75+ years age group (not included in table); Range χ= (21-80 years) γ= (15-87 years)

subject age with spleen length was ($r=-0.275$), spleen breadth was ($r=-0.283$) and spleen thickness was ($r=-0.371$), in females; and spleen length was ($r=-0.368$), spleen breadth was ($r=-0.451$) and spleen thickness was ($r=-0.393$), in males. The negative correlation coefficient shows a decrease in splenic dimensions with increase in age.

In the present study, spleen length in both, females and males, decreased at a slow and constant rate with growing age. As shown in the [Table/Fig-3,4], this finding was similar to a study conducted on Gujarati population [29]. Although it differed with a study on north Indian population and a study on Chinese population, in which they observed that splenic length decreased slowly upto the age of 50 years after which there was a rapid decrease in spleen length [30,32]. Similar findings were also noted in studies conducted in Tripura, Nepal and Bangladesh [32,33,34]. Whereas, a study conducted in Pakistan observed weak positive correlation of spleen length with age [35].

Spleen breadth, in females, showed a slow decrease upto the age of 40 years, thereafter it is constant upto 50 years, after which there was a slow decrease noted again, in the present study, whereas in males, spleen breadth showed a constant but slow decrease with

increasing age. These findings were similar to the findings of study in north Indian population [30].

In the current study, spleen thickness, in females, was constant upto the age of 50 years, beyond which, there was a steep decrease noted. This finding is very similar to the studies conducted on north Indian population and Gujarati population [29, 30]. However, in males, there was a constant decrease observed with increasing age.

Limitation(s)

Although, this study did not involve paediatric and geriatric age groups, which was its limitation, it still can serve as a database for further researches on adult spleen, in the region of central India, which is endemic to diseases like Sickle Cell Anaemia, Thalassemia and Malaria, which can affect the size of spleen.

CONCLUSION(S)

Spleen size often varies in various physiological and pathological conditions. Hence, estimation of size according to age is necessary in order to avoid incorrect assessment, which may lead to false diagnosis. The present study shows a decline in all the splenic dimensions, i.e., splenic length, breadth and thickness, in both

female and male population of Chhattisgarh. Spleen breadth in males showed a moderately (0.451) negative correlation with age, while spleen length and thickness in males and spleen length, breadth and thickness in females showed low negative correlation with age.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Feb 11, 2021
- Manual Googling: May 26, 2021
- iThenticate Software: Jun 22, 2021 (7%)

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AUTHOR DECLARATION:

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