

## Normal Spleen Length by Ultrasonography in Adults of Tripura

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**Abstract:** The human spleen is an organ demanding constant attention from the anatomical, immunological and clinical point of view. Ultrasonography is used routinely to evaluate visceral organs in adults of Tripura. So, this study was conducted with the aim to measure the spleen length by ultrasonography, find out the reference values of spleen length in different age groups in adults of Tripura, to find out possible correlations with the age and gender distribution. The mean spleen length in adults was  $8.8 \pm 1.32$  Cm. In males and females the length was  $8.85 \pm 1.54$  Cm  $8.72 \pm 0.89$  Cm respectively. All the spleen length (100%) was found below 12.33 cm and most of the cases (91.1%), the spleen length was within the range of 7-11cm. It was observed that, the spleen length decreased with increasing age, which was found to be statistically significant. Significant change was observed with increased age in between Group I and Group V. The present study was an attempt to determine the normal range of the spleen length which correlated variably with different age in groups. So, our study had provided anthropometric parameter of spleen length by ultrasonography which will be useful for reference value of spleen length in our set up.

**Key Words:** Spleen, Spleen Length, Ultrasonography.

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### I. Introduction

The human spleen is an organ demanding constant attention from the anatomical, immunological and clinical point of view.<sup>1</sup> It is a large encapsulated mass of vascular and lymphoid tissue situated in the upper left posterior region of the abdominal cavity between the fundus of the stomach and the diaphragm.<sup>2</sup>

Sonographically, the spleen is crescent in shape with smooth outer convexity. The inner margin may be indented or nodulous. The echogenicity is homogenous which is slightly more echogenic than healthy liver tissue and markedly hyperechoic compared to kidney tissue.<sup>3</sup>

The spleen is affected by several groups of diseases. Gross splenomegaly can be detected both clinically and sonographically.<sup>4</sup> 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.<sup>5</sup> 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 of normal sized.<sup>6</sup> So, the scanning of the viscera is carried out to know the normal dimensions, echo patterns and deviations from normal leading to diagnosis or prediction of pathological conditions.<sup>7</sup>

The variation in the anthropometric features of various population, races and regions were an established fact.<sup>8</sup> In the literature, normal spleen sizes in different age groups have been reported.<sup>9</sup> So, the standard normal range of spleen size in the population is prerequisite for correct interpretation.<sup>10</sup> In a sonographic study of adult spleen showed that spleen size decreased with increasing age.<sup>11</sup> The size of the spleen during autopsy in adults, showed variation according to sex and age. The spleen size in females was smaller than males in all age groups.<sup>12</sup>

Splenomegaly is one of the oldest known clinical manifestations of malaria, having been recognized before the discovery of the Plasmodium parasite.<sup>13</sup> The rate of palpable splenomegaly can provide an indication of the intensity of malaria transmission in endemic areas when blood smears are unavailable.<sup>14,15</sup>

Racial differences in splenic length could result in incorrect interpretation of the spleen size. So, population specific spleen normogram would provide more accurate standards. Especially for the area where sickle cell disease and malaria were prevalent.<sup>16</sup>

Visceral organs change with age and disease processes. Tripura is an endemic zone for malaria affecting the children as well as adults causing various ranges of splenomegaly. There is no comprehensive study for the standard measurement of spleen in this region. So, it is utmost important to know the normal range of spleen length in adults of Tripura to assess splenomegaly in cases of malaria as well as in case of other disease conditions affecting the spleen. The measurements need to be correlated with age, sex.

Though ultrasonography is used routinely to evaluate visceral organs in adults in Tripura, very few studies were found to measure spleen length by ultrasonography to co-relate with age and sex distribution. So, the objectives of the present study were: to measure the spleen length by ultrasonography in adults of Tripura, to find out the reference values of spleen length in different age groups in adults of Tripura and to find out possible correlations with the age and sex.

## II. Material and Methods

This was a cross-sectional study conducted in the department of Anatomy and Department of Radiodiagnosis in Tripura Medical College & Dr. B.R.A.M. Teaching Hospital, Hapania, West Tripura within a period of 2 months (from 26.06.2015 to 26.08.2015). The study was conducted among 146 healthy individuals or patients (males=89, females=57) attending the Radiodiagnosis Department, TMC & BRAM Teaching Hospital for conditions other than the conditions affecting the spleen. The inclusion criteria were: the individuals willing to participate; individuals suffering from diseases which did not affect the spleen directly or indirectly; individuals with demonstrated normal homogenous echopattern of the spleen without evidence of any focal splenic abnormality. The exclusion criteria were: the individuals not willing to participate; history of medical disorders affecting spleen, liver; history of splenic, hepatic or upper abdominal surgery; history of oncologic, haematologic or abdominal traumatic condition, pregnant woman. The study variables were age, sex and splenic length (in centimeters). The individuals were classified into following age groups: Group I- 15 to 30 years, Group II- 31 to 45 years, Group III- 46 to 60 years, Group IV- 61 to 75 years and Group V- >75 years.

A formal permission was obtained from the Institutional Ethics Committee of TMC & BRAM Teaching Hospital, Hapania to take up this study. After getting permission from the concerned authority, the informed consent from the respective individual was taken after fully explaining the purpose of the research work in their own language. Full confidentiality of the individual was maintained. The data was collected from inpatients as well as outpatients fulfilling the inclusion criteria and attending the Department of Radiodiagnosis, TMC & BRAM Teaching Hospital, Hapania, Agartala.

An elaborate history was taken for each individual regarding present & previous history of illness suggesting of splenic diseases, any abdominal surgery, and menstrual history in females to exclude pregnancy. Individuals were physically examined, lying in supine position in relaxed conditions. The identification data of each individual was entered in the identification profile of the ultrasound machine. The abdomen was exposed after taking verbal permission, and a cloth was put beneath the abdomen to make the patient comfortable.

The sonographic examination was performed on Medison SONOACE X8 with 3.5 MHz sector curvilinear transducer probe for trans-abdominal Ultrasonography. The ultrasonographic gel was applied on the left hypochondriac region and upper abdomen to visualize spleen. Then the patient was asked to lie in right lateral position with the left sided elevated. The individual was made to take a deep breath and hold it for a few seconds to evaluate the spleen and its echogenicity and related structures in general to exclude any diseased conditions. The mean splenic length was taken by measuring three times from the dome of the spleen through the hilum to the tip of spleen during deep inspiration. After finishing the examination, the individuals were cleaned off the gel with cotton pads. All the measurements and images were saved in the ultrasound machine. Afterwards the data was collected and was entered in the master chart and statistical analysis was performed with Microsoft Office Excel 2007 and Statistical Package for the Social Science (SPSS) version 20 software.

## III. Observations and Results

The present study was conducted on 146 adult individuals of 17 to 95 years of age. The 146 number of individuals were divided into 5 groups according to age distribution.

Table 1: Showing group wise gender distribution of individuals.

Parameters	Adults n=146		Group I to V					Total (n=146)
			Group I (15-30 years)	Group II (31-45 years)	Group III (46-60 years)	Group IV (61-75 years)	Group V (> 75 years)	
Male	89		18	21	20	24	6	89
Female	57		19	23	7	4	4	57
Total	146		37	44	27	28	10	146
Percentage (%)	Males	females	25.38	<b>30.14</b>	18.49	19.18	6.85	100
	60.96	39.04						

The above table showed in Group II, the number of cases was the highest (30.14%) followed by Group I. The least number of cases was found in group V (6.85%). In three of the groups the number of male cases was more except in Group I and Group II where females were found more than male cases.

Table 2: Minimum and Maximum of age and spleen length in adults, males and females and in Groups (I to V).

Parameters	Parameters				
	Age (Years)		Length of spleen (Cm)		
	Minimum	Maximum	Minimum	Maximum	
Adults (n=146)	17	95	4.51	12.33	
Males (n=89)	20	95	4.51	12.33	
Females (n=57)	17	85	7.05	11.50	
Groups I to V	Group I	17	30	7.07	11.43
	Group II	31	45	4.51	12.33
	Group III	46	60	7.19	11.56
	Group IV	62	75	5.64	11.70
	Group V	78	95	5.84	9.20

Table 3: Independent Samples Test.

Variable	male		female		Independent Sample Test	P value (P<0.05)
	Mean	SD	Mean	SD		
Splenic length (Cm)	8.85	1.54	8.72	0.89	0.578	0.000

The Independent Sample Test shows that, in present study, significant changes in spleen length was found in between males and females.

Table 4: Showing means and standard deviations of body parameters and spleen length in all the groups.

	Means and standard deviations in adults					
	Total		Males		Females	
	Age (years)	Spleen length (cm)	Age (years)	Spleen length (cm)	Age (years)	Spleen length (cm)
Group I	24.70±4.07	9.00±1.07	22.53±3.16	9.35±1.18	24.10±4.78	8.67±0.85
Group II	39.02±4.6	8.79±1.44	30.90±4.55	9.04±1.84	39.13±4.74	8.55±0.93
Group III	52.89±4.63	9.15±1.04	53.35±4.94	9.13±1.15	51.57±3.55	9.21±0.68
Group IV	67.46±3.86	8.63±1.55	67.88±3.96	8.51±1.62	65±2.16	9.30±0.91
Group V	82.5±5.04	7.64±1.06	84±5.69	7.07±0.68	80.25±3.30	8.49±0.98

From the above table, it was observed that spleen length was decreased in older age (Group V) in all adults as well as males and females. In adults, spleen length was the highest in Group III (45 to 60 yrs) and then decreased abruptly in Group IV (60 to 75 yrs of age) & V (>75 yrs of age). In case of males, similar observation was found. But in females, though the change was found similarly, but observed gradual increase from Group II to Group IV and then decreased abruptly in Group V.

Table 5: Correlation of spleen length and age.

Parameters	Spleen length (in Cm)					
	Total Adults (n=146)		Male (n=89)		Female (n=57)	
	Pearson Correlation	P value (P<0.05)	Pearson Correlation	P value (P<0.05)	Pearson Correlation	P value (P<0.05)
Age (Years)	-0.049	0.013	-0.309	0.003	0.003	0.982

Correlation is significant at P< 0.05 level (2-tailed).

Correlation analysis showed that, spleen length was negatively correlated with the age in all adults. So, with increasing age spleen length was found to be decreasing which is significant (P<0.05). Similar observations were found with males. In females, no correlation was observed with increasing age.

Table 6: Showing ANOVA Test

Ratio	F	Significant Value
Between the groups	2.899	0.024
Within the groups		

Correlation is significant at P< 0.05 level.

The above table depicted that, there was significant difference of spleen length in adults. Correlation analysis (by Tukey HSD test; P<0.05) of spleen length of adults among the groups was found to be changed significantly (P=0.028) in between Group I and Group V.

The minimum and maximum length of the spleen in adults varied from 4.41 cm to 12.33 cm. Most of the spleen length were found within the range of 7 cm to below 11 cm except in six cases (4.11%) where spleen length was found below 7 cm and in seven cases (4.79%), the length were found above 11 cm. Only in one case spleen length was found above 12 cm. Though, only in seven cases the length of the spleen was found more than 11 cm but they were distributed among all the groups except Group V. The splenic length below 7 cm were

found mostly in Group IV and Group V (05 or 3.42%) individuals. Most of the cases (95.2%), the spleen length was below 11 cm. It was observed that with increased age the spleen length was decreased.

#### IV. Discussion

Diagnostic imaging techniques were superior to clinical examination in determining the sizes of the organs.<sup>17,18</sup> Sonography was one of the most common imaging methods, which were used in routine practice.<sup>19</sup>

The size of the spleen varies with age, with the individual and in the same individual under different conditions. In adult it is usually about 12 cm and diminished size is observed in older people.<sup>2</sup> The normal spleen size on sonography in adults was about 10 to 12 cm in length and a spleen size of about 12 cm was considered the edge of normal.<sup>3,20</sup> Thus splenic length more than 12 cm was considered as enlarged spleen.<sup>3</sup>

In a sonographic study of spleen length in 793 male and female adult patients with healthy spleen showed that, spleen length to be less than 11 cm.<sup>21</sup> It was reported that, a splenic length of 12 cm at the age of 15 to 20 years in girls and 13 cm in 15 to 20 years of boys.<sup>22</sup> No significant difference was found for splenic length measured by removing the spleens and by ultrasound.<sup>23</sup>

The splenic length in both males and females decreases with increasing age.<sup>5</sup> So, knowledge of the normal range of spleen size in the population was a prerequisite.<sup>24</sup>

Sonological evaluation of the craniocaudal length of spleen showed the length of spleen 9.82±1 cm and 9.12±1.22 cm for males and females respectively. Spleen size was larger in males than females. A significant difference was observed between the genders.<sup>12</sup>

The splenic length of both sexes increased with age until middle age with a maximum of 12 cm and thereafter a gradual diminuation was observed.<sup>25</sup>

Table 7: Showing the comparison of spleen length in present study with various authors' studies.

Study conducted by various authors.	Splenic length with Standard Deviation (in cm) or in range			If any Significant change in the value between males and females (p<0.05) were found.
	Adult	Male	Female	
Present Study	<b>8.8±1.32</b>	<b>8.85±1.54</b>	<b>8.72±0.89</b>	<b>0.000</b>
Gray's <sup>2</sup>	12	-	-	-
Mittal R et al. <sup>26</sup>	8.69±0.93	9.40±0.91	9.34±0.95	-
Spielmann AL et al. <sup>27</sup>	-	11.4±1.7	10.3±1.3	-
Marco P et al. <sup>7</sup>	8 - 11	-	-	-
Machálek L et al. <sup>28</sup>	-	12.3	11.2	Not significant
Chaware PN et al. <sup>29</sup>	9.66 (5 - 13)	-	-	-
Serter S et al. <sup>10</sup>	10.76±1.84	-	-	-
Niederau C et al. <sup>11</sup>	5.5±1.4	-	-	-
Arora N et al. <sup>5</sup>	-	8.785±1.215 To 10.724±1.318	8.506±1.009 to 9.709±1.616	Significant
Odorico ID et al. <sup>19</sup>	9.11±1.24 (5.96-12.36)	-	-	-
Okoye IJ et al. <sup>25</sup>	10.9±0.7	11.1±0.7	10.6±0.07	Significant
Udoaka AI et al. <sup>30</sup>	9.23±1.52	9.82±1.82	9.12±1.22	Significant

The above table depicted the spleen length in adults, both in males and females. It was found that, the mean spleen length in present study was lesser than most of the other studies except the study conducted by Mittal R et al,<sup>26</sup> where the spleen length is found to be almost similar. The spleen length in males was found to be higher than the values in females. Similar findings were observed in other studies mentioned above, though the values of spleen length for male and female were not comparable to the present study. The increase values in males than in females were due to general development of the organs in males or the differences in weight, height, body surface area and genetic factors.<sup>31</sup>

In the present study, strong statistically significant difference was observed in spleen length of males and females, which were also observed statistically significant in study done by other authors.<sup>5,25,30</sup> No statistically significant value was found in the study conducted by Machálek L et al.<sup>28</sup>

The splenic length decreased at a slower rate up to the age of 50 years, after that it decreased abruptly.<sup>5,25</sup> In present study, the spleen length decreased in older age (Group V) in all adults and in both males and females. In adults, spleen length decreased abruptly in >75 years of age and significant change was observed in between Group I and Group V. In case of males, similar observation was found. But in females, though significant changes were found similarly, but observed gradual increase from Group II to Group IV and then abrupt decrease in Group V was observed.

The spleen length was greater in males than in the females by 0.2 cm.<sup>5</sup> This difference was found to be significant.<sup>30</sup> In present study, the spleen length in males were more (8.85±1.54 cm) than in females (8.72±0.89) cm.

The spleen length in different age groups in adults and males showed that, it decreased from Group I to Group II, then increased in Group III and abruptly decreased in older age groups. The increase in spleen length in adults and males of Group III might be due to greater height and body weight of individuals in this group. Gradual increase in spleen length was observed in females from Group I to Group II with an abrupt increase in Group III and Group IV. But in Group V, the length decreased abruptly. Variability of the results in all the groups might be due to less number of persons under observation.

The spleen was developed from mesoderm. During the development, different lobules were formed, which fused to each other later on.<sup>32</sup> Failure of the fusion of splenic tissue results in the formation of accessory spleens.<sup>10</sup> Awareness for accessory spleen is very important<sup>32</sup> for proper detection to the disorders of spleen.<sup>10</sup>

In present study, 92.2% of the cases, spleen length were below 11 cm and 4.79% cases, the spleen length was below 7 cm except one case, and all were distributed in older age groups with less body parameters. The spleen length of the case was 4.51 cm in a male. This observation could be assessed to other body parameters or due to accessory spleen present somewhere else in the abdomen which was not visualized during examination.

In the present study, 91.1% cases, the spleen length was with a range of 7-11cm. The base line spleen length was found very low in present study with the lowest 4.51 cm. The splenic length was found below 8.7 cm with mean and SD, 5.5±1.4 cm in study conducted by Niederau C et al.<sup>11</sup> 95.2% cases, the splenic length was below 11 cm. Similar findings was observed by Frank K et al. 95% of the cases spleen length was less than 11 cm.<sup>21</sup> The splenic length was below 12.80 cm in 95% subjects.<sup>10</sup> But in present all spleen length (100%) were below 12.33 cm.

## V. Conclusion

Spleen is frequently involved in various systemic and local diseases. Clinically spleen is an important organ as it becomes enlarged and reduced in many diseases. The present study was an attempt to determine the normal range of the spleen length which correlated variably with different age in groups, sex, body weight, height, body mass index in adults of Tripura.

This study had provided normal reference value of the spleen length for the adults of Tripura which will be useful in assessing the spleen for any pathological enlargement or reduction of size in clinical practice in our set up. To get a comprehensive and conclusive data, we need to accommodate much larger sample size covering the population of the cross section of the state.

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