

Morphometric Study of Spleen in North Indian Adult Population: CT Scan Image Based Study

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ABSTRACT

Introduction : A prospective study was done on 126 patients (72 male and 54 female) whose abdominal CT scan was found normal and no disorder was diagnosed which alters the size of spleen to estimate normal linear dimensions of spleen in North Indian adult population. **Material & Methods :** Collected CT scan were evaluated with the help of Able 3-D doctor software. Body habitus of patients were determined. All linear dimension of spleen – length, width and thickness were calculated and they were analysed with body habitus – Age, height, weight,

BSA (body surface area) and BMI (body mass index) was calculated by linear and non-linear regression model to know exact pattern of correlation. **Result :** The mean length, width and thickness of spleen were 10.67 ± 1.62 cm, 6.26 ± 1.66 cm and 4.86 ± 1.22 cm respectively. **Conclusion :** All linear splenic dimensions have significant positive correlation with height of patients and normative data can be produced with the help of regression formula developed with the help of statistics which can be used as research tool where objective determination of splenomegaly is required.

Key Words: Spleen, Height, CT-scan

INTRODUCTION

Spleen is a reticulo-endothelial and lymphoid organ and sometimes works as hemopoietic organ. Otherwise this organ is graveyard of RBCs. Spleen is enlarged in various clinical disorders e.g. infection, metabolism or storage disorder and haematological abnormalities [1,2]. Spleen is never palpable till it is enlarged two-three times of its own size [3]. There are many modes of investigation to identify the enlarged spleen e.g. – plane radiograph, sonography, computed tomography, MRI and radionuclide scan. Out of these modalities sonography and computed tomography are most reliable for intra-abdominal organs [4]. Various studies were done by sonography to study the linear dimension of spleen – length, width, and thickness. But CT-based linear dimension are still unavailable. Unfortunately, dimensions determined by 2-D USG are limited predominantly by the variable, irregular contour of spleen but also by the difficulty in completely scanning the entire organ or visualizing complete contours as because of the presence of overlying structures such as bone, bowel gas or kidney [5]. CT imaging is more accurate than ultrasonography because this drawback is not seen with computed tomography [6, 7, 8].

Our study was aimed to give CT-based linear dimension of spleen in North Indian adult population which was missing till date and to generate the normative data. India is a malarial endemic zone and its presence in this large geographical area, makes it difficult to get normal data due to splenomegaly. We tried here to observe the correlation of linear dimension of spleen with body habitus.

MATERIALS AND METHODS

CT scans of 126 patients (72 male and 54 female) were used to measure the volume of spleen. The age of patients ranged from 20 to 70 yrs (55.33 ± 17.2 yrs) [Table/Fig-1]. The data was collected from December 2006 to April 2009 with permission of Department of Radio-diagnosis, KGMU Lucknow and informed consent taken from each patient. CT scans were obtained for various clinical indications like follow-up of abdominal trauma, abdominal pain and in a case to exclude an abdominal mass or adenopathy. The patient's body weight and height at or near the time of the CT examination were recorded. Spleen axial and cross sectional image were obtained by CT Helical instrument. The technical parameters were 120 kV potential, 120 mA current, 10mm slice width with identical reconstruction index and a rotation time of 1.5 secs. The medical records of all patients were reviewed. Patients whose spleens appeared abnormal on CT scans were excluded. Additionally, any patients who had clinical, biochemical or imaging evidence of conditions that could affect the size of the spleen, haematological disorders, abdominal malignancies, infection and portal hypertension, splenic trauma, cyst, and autoimmune diseases were excluded from the study.

CT-scan dicom images of each patient were observed in Able-3D-doctor software. Spleen was identified in each cross section and longitudinal section of CT-scan images. The length of spleen was recorded in longitudinal section along 10th rib in cephalo-caudal direction [Table/Fig-2]. Width of spleen was also recorded

Physical Standards of Patients						
	Age (yrs.)	Weight (kg)	Height(cm)	Body surface area (m ²)	Body mass index	Numbers of patients
Male	57.33 ± 12.94	65.8 ± 7.2	165.34 ± 7.4	1.74 ± 0.18	25.32 ± 4.29	72
Female	54 ± 13.32	59.22 ± 8.31	157.2 ± 8.3	1.66 ± 0.13	23.18 ± 1.62	54
Total	No significant difference ($p > 0.05$) 126					

[Table/Fig-1]: Physical standard of patients

in longitudinal direction [Table/Fig-3] and thickness measured in cross-section image [Table/Fig-4]. All dimensions were recorded maximum appreciated in sections for better accuracy.

STATISTICAL ANALYSIS

All statistics were generated by SPSS version 10. The student t-test was used for comparison of means. $p < 0.05$ was considered significant for comparison of means and for regression analysis. Association between splenic dimensions and physical standards of patients was assessed with the Pearson correlation coefficient; to identify the exact pattern of relationship, non-linear regression as well as linear regression was applied. Multiple regression analysis was applied in backward stepwise fashion to test the independent effect of all physical standards on splenic parameters.

RESULTS

The average ages of male and female patients were 57.33 ± 12.94 years and 54 ± 13.32 years respectively. Mean weight and height in male and female were 65.8 ± 7.2 kg, 165.34 ± 7.4 cm and 59.22 ± 8.31 kg and 157.2 ± 8.3 cm respectively. No significant difference of physical standards was found in both sexes [Table/Fig-1]. The mean splenic dimensions were 10.67 ± 1.62 cm in length, 6.26 ± 1.66 cm in width, 4.86 ± 1.22 cm in thickness [Table/Fig-5].

DISCUSSION

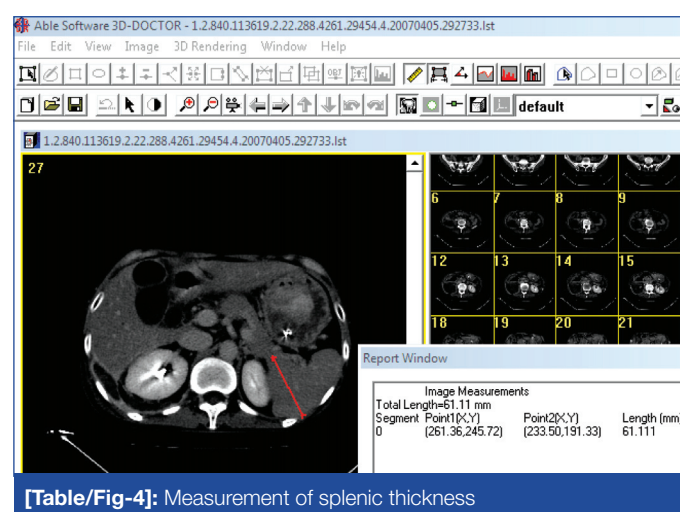
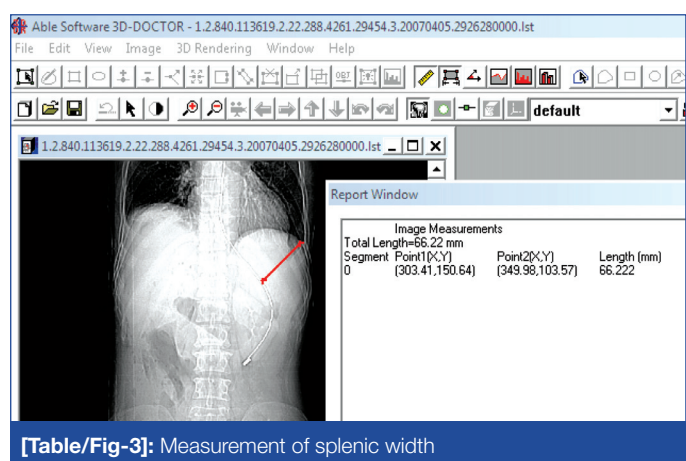
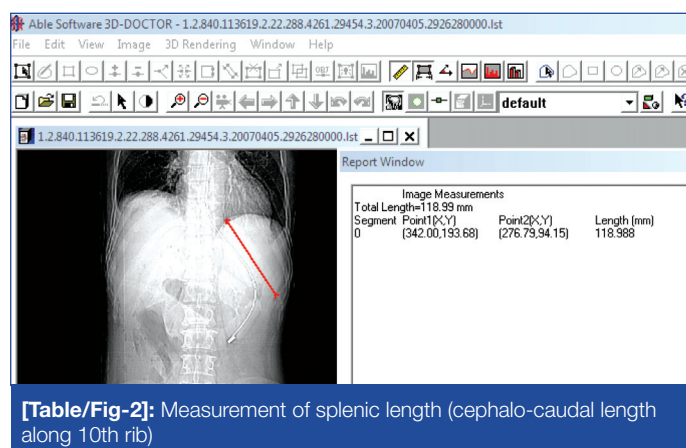
Frank et al used conventional sonography to evaluate 793 healthy patients (17-82yrs.) and found out that 95% of patients had splenic length < 11 cm, width < 7 cm and thickness < 5 cm [9]. Niederau et al studied 915 healthy subjects using sonography and found that mean longitudinal and transverse diameter of spleen to be 5.8 ± 1.8 cm and 5.5 ± 1.4 cm respectively. These dimensions were much

smaller than other studies because author did not measure the maximum dimension [10]. Picardi et al. found mean longitudinal dimension of spleen ranged from 8 to 11 cm (median: 9.5 cm)[11]. Mittal et al. performed pilot study of normal measurement of spleen by ultrasonography on Rajasthani population and found average length of spleen 9.40 ± 0.91 cm in males and 9.34 ± 0.95 cm in females[12]. In older subjects they found mean length of spleen 9.64 ± 0.64 cm. Spielmann et al, average length of spleen was found to be 11.4 ± 1.7 cm in males and 10.3 ± 1.3 cm in females [13]. Konus et al. found mean longitudinal dimension: 10.1 ± 1.03 cm[14]. In our study mean splenic length in North Indian population was 10.67 ± 1.62 cm (female: 10.34 ± 1.58 and male 10.91 ± 1.67 cm, $p > 0.05$). Mittal et al. measured average width of spleen in male as well as female 3.45 ± 0.59 cm and 3.59 ± 0.55 cm respectively. Average width of spleen measured by Spielmann was 5.0 ± 0.8 in males and 4.2 ± 0.7 cm in females. In our study mean width of spleen 6.26 ± 1.66 cm (male: 6.74 ± 1.62 cm and female 5.61 ± 1.58 cm, $p > 0.05$) and mean thickness of spleen 4.86 ± 1.22 cm (female: 4.70 ± 1.19 cm and male: 4.97 ± 1.29 cm, $p > 0.05$). All these dimension of spleen are best correlated with height of the patients [Scatter Plot-1, 2, 3]. Age of person had significant negative correlation with cephalo-caudal length of spleen but rest of splenic dimension did not have significant correlation with age [Scatter Plot-4, 5, 6].

CONCLUSION

Finally we conclude that the length, width and thickness of spleen are correlated with height and age (20-70 yrs). Dimensions of spleen measured by ultrasonography were slightly less than the CT-measurements most probably because of overlapping of ribs or bowel gas. Difference may arise due to maximum dimension taken into consideration.

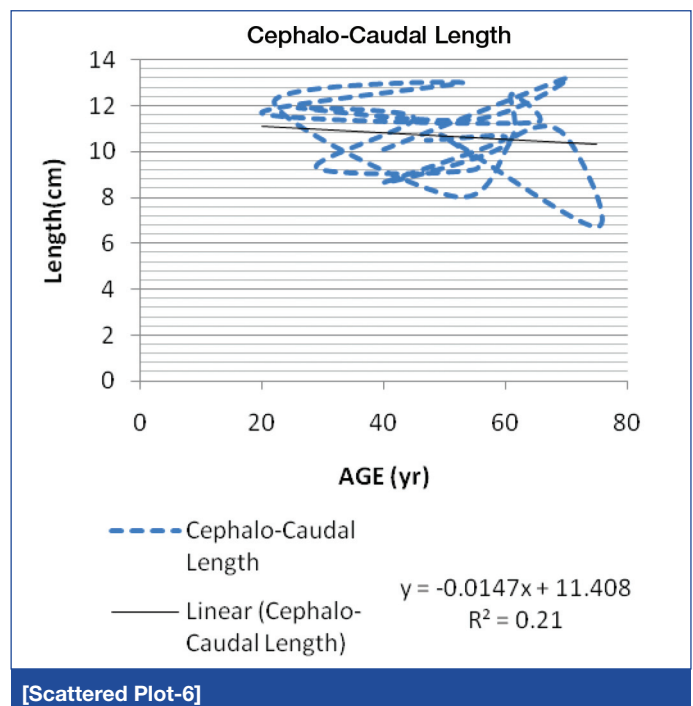
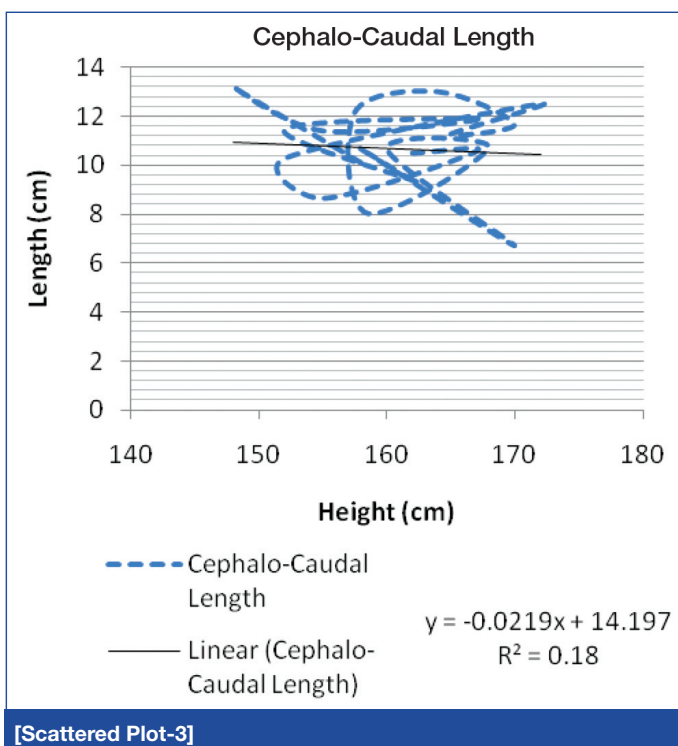
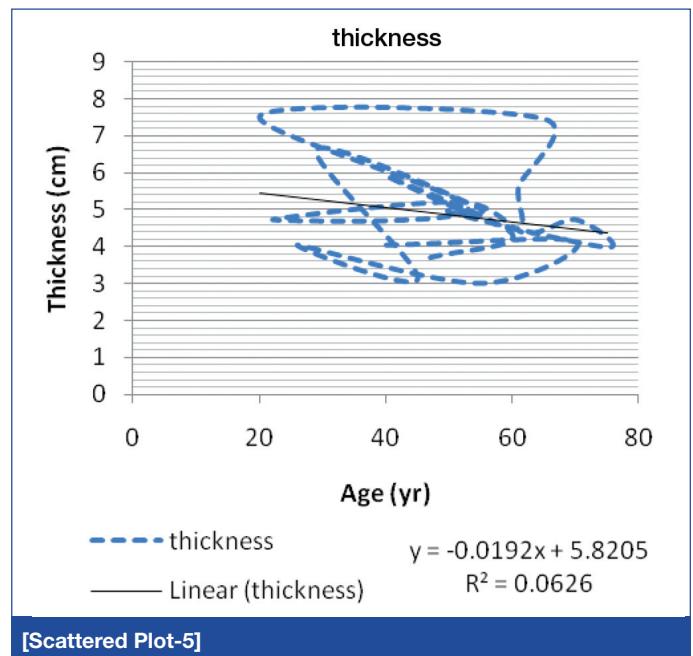
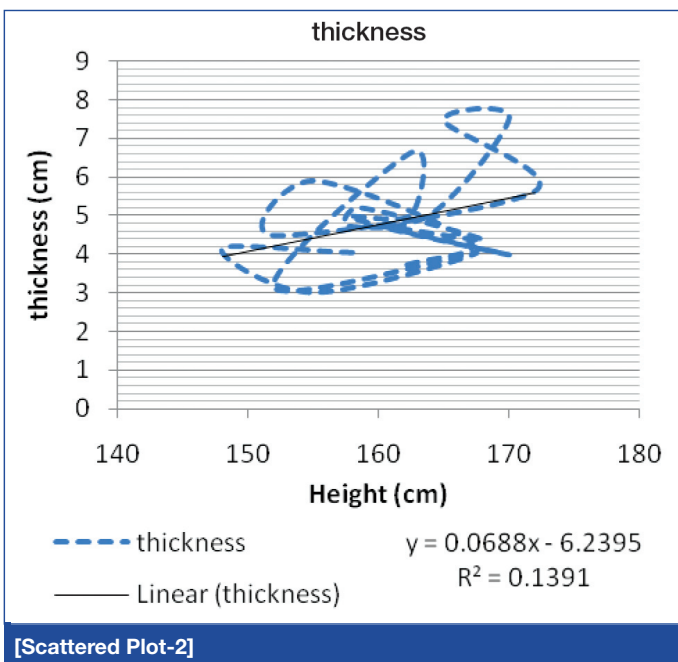
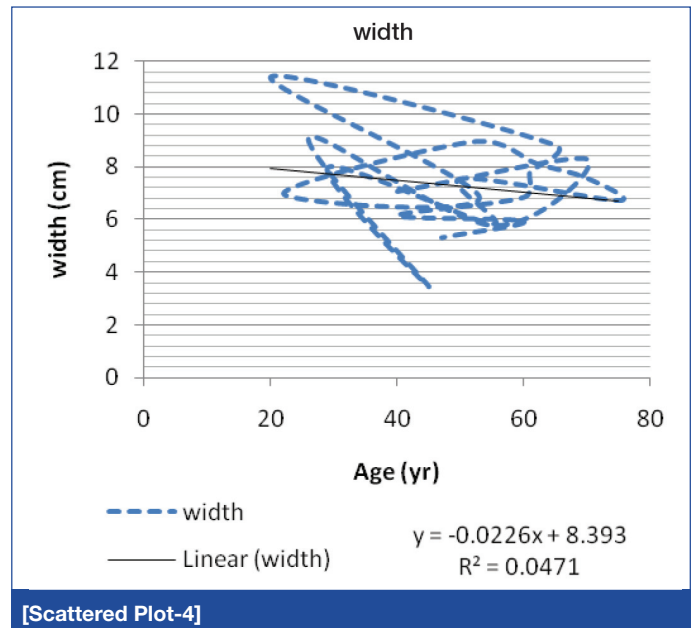
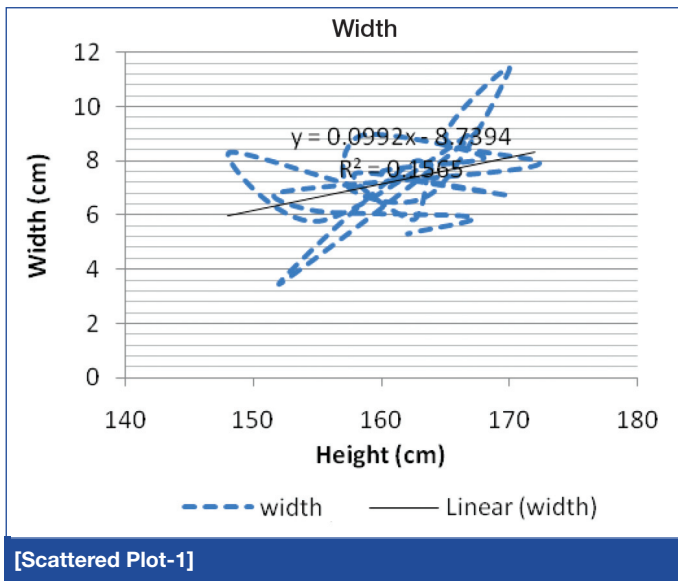
All dimensions of spleen have significant positive correlation with height but length of spleen (cephalo-caudal) has significant negative correlation with age. Other splenic dimensions – width and thickness does not have significant correlation with age.



Parameters	Length (cm)	Width (cm)	Thickness(cm)
Mean ± SD (Total)	10.67 ± 1.62	6.26 ± 1.66	4.86 ± 1.22
Mean ±SD (Male)	10.91 ± 1.67	6.74 ± 1.62	4.97 ± 1.29
Mean ±SD (Female)	10.34 ± 1.58	5.61 ± 1.58	4.70 ± 1.19

No significant sexual differences recorded ($p > 0.05$)

[Table/Fig-5]: Different linear dimensions of Spleen (Mean ± SD).



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