

Ultrasonic Measurement Splenic Size Of Normal & Comparison With Various Medical Disorders Involving Spleen In Paediatric Indian Population

Dr Nita A Tanna*, Dr M V Ambiyee**, Dr Vilpa A Tanna***, Dr Himanshu A Joshi****

*Assistant Prof-Anatomy, GMERS MC, Gandhinagar; **Prof & Head-Anatomy, TNMC, Mumbai; ***Assistant Prof-Statistics,PDU MC,Rajkot; ****Associate Prof-Paediatrics,GMERS MC,Gandhinagar.

Abstracts: Introduction:The present study was conducted in the departments of Anatomy, Radiology and Paediatrics at a General Public Charitable Hospital, Mumbai. Method: The study group consisted of 160 children of both sexes, who were referred to the Radiology department for ultrasonography. Out of these 160 children, 80 underwent sonography for abdominal and/or pelvic problems unrelated to the spleen and 80 children were suffering from medical disorders related to spleen i.e. 55 patients of thalassemia major, 13 patients of malaria, 9 patients of typhoid and 3 patients of portal hypertension. The splenic length was measured by using a commercially available real time ultrasound system with a TOSHIBA ECOCEE USG SYSTEM particularly by using the convex probe. Result: In the present study in abnormal spleen group, there is a strong correlation between weight and splenic size, and between age and splenic size, there is a partial correlation between height and the splenic size. In all the children with clinically obvious splenomegaly, the splenic length exceeded at least 2 cm than the normal splenic length at that particular age.Conclusion : This study shall stand as a good reference to Radiologists, Paediatricians, Haematologists and Physicians in an undiagnosed and complicated cases and will also helpful to determine the mode of treatment in thalassemia major with splenomegaly. [Tanna N et al NJIRM 2012; 3(4) : 65-72]

Key Words: : Splenomegaly, splenic size, ultrasonography, medical disorders involving spleen, Indian paediatric population

Author for correspondence: Dr Nita A Tanna, 001, Heerashree-2, Saurashtra Kala Kendra, Main Road-2, Rajkot-360007, Gujarat, India. Email: drnitatanna@gmail.com

Introduction: The fundamental abnormality in thalassemia is impaired production of either the alpha or beta haemoglobin chain. Thalassemia is a difficult subject to explain, since the condition is not a single disorder, but a group of defects with similar clinical effects. More confusion comes from the fact that the clinical descriptions of thalassemia were coined before the molecular basis of the thalassemias was uncovered. As a result, the organizational structure is somewhat disordered.

The thalassemias are a diverse group of genetic blood diseases. Thalassemia is the most common inherited single gene disorder in the world. Scientists and public health officials predict that thalassemia will become a worldwide issue in the next century. With global improvements in childhood disease prevention and treatment, more focus will be given to diagnosing disorders. It is our hope that by providing education about the disease we can raise awareness, encourage people to get tested for the trait, and spread knowledge about comprehensive treatment.

A soft, thin spleen may be palpable in 15% of neonates, 10% of normal children, and 5% of adolescents. However, in most individuals, the spleen must be two to three times its normal size before it is palpable. The spleen is best examined in a supine patient by palpating across the abdomen toward the left costal margin from below as the patient inspires deeply. An enlarged spleen may descend into the pelvis; thus, when splenomegaly is suspected, the abdominal examination should begin at a lower starting point. Superficial abdominal venous distension may be present when splenomegaly is a result of portal hypertension.

Partial splenectomy is followed by rapid regeneration of lost tissue but even total splenectomy has few obvious effects, its functions being largely assumed by the liver. However, especially in the early years of life, splenectomy may entail a general reduction in the rapidity of immune responses and a consequent increased susceptibility to infection. Splenectomy in later life is followed by leucocytosis with increased lymphocytic, neutrophil, eosinophil and platelet

counts in peripheral blood, interpreted as due to removal of humoral factors produced in the spleen, which oppose the formation and release of cells from haemopoietic tissues. These effects fade and disappear within a few weeks.

Splenomegaly in Paediatric age group is commonly associated with typhoid, malaria, and portal hypertension, thalassemia major, haemolytic anaemia, leukemia, lymphoma etc. Therefore, it becomes important to evaluate spleen size when clinicians evaluate patients. By ultrasonographic estimation of the spleen size, we found that a high percentage of cases with various diseases had enlarged spleen.

The splenic length at the hilum is considered the most reproducible linear measurement. Ultrasound is an established safe, quick, and reliable method for the assessment of splenic dimensions. Thus, the ultrasonography is very much useful in estimating spleen size in estimating of unpalpable spleens.

Materials and Methods: The study was approved by ethical committee of TNMC & B.Y.L. Nair Hospital, Mumbai. The relevant information of the child like age, sex, height, weight, immunization history and general medical history was noted and due consent of the parent was taken.

The height in children was measured in centimeters by using a measuring tape. In infants, height (length) was taken with the help of an infantometer. The weight was taken by electronic weighing scale.

All examinations were performed by a radiologist using a commercially available real time ultrasound system with a TOSHIBA ECOCEE USG SYSTEM OR SIEMENS USG SYSTEM particularly by using the convex probe.

The splenic size (splenic length) was measured sonographically by obtaining an oblique coronal view which included the hilum, during quiet breathing; in the older children, measurements were made while they were holding their breath.

The patient was lying in a supine or in a slightly right lateral decubitus position during ultrasonography. The 5 MHZ curvilinear transducer was placed posteriorly along the long axis of lower left intercostal spaces. The spleen was seen as a uniform homogenous echo pattern. The statistical analysis was done by using the 't' test.

Figure 1: Gray scale, B mode sonogram of the spleen showing normal dimensions of the spleen (splenic length) in a 6.5yrs child.

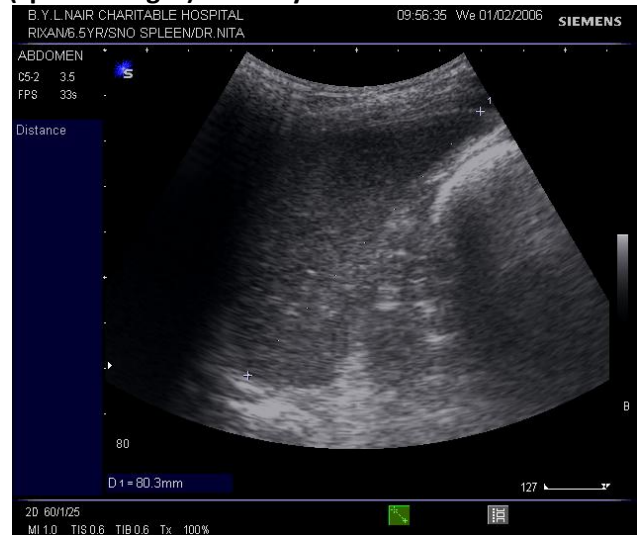


Figure 2 : Gray scale, B mode sonogram of the spleen in a patient of thalassemia major showing splenomegaly.



Result: Result obtained during study are tabulated in table 1 and shown graphically in graph 1 and 2

Table 1: Comparison Of The Splenic Size In Normal And Abnormal Spleen Groups With Age, Height And Weight.

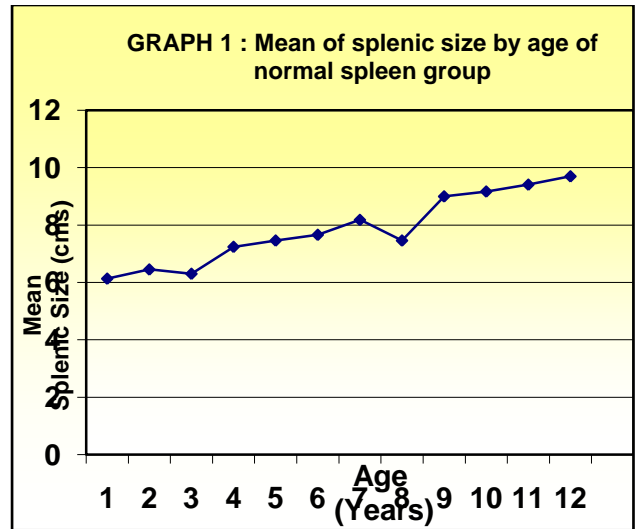
Age Group (Years)	PRESENT STUDY											
	Normal Spleen Group						Abnormal Spleen Group					
	Splenic Size (cm)		Height (cm)		Weight (kg)		Splenic Size (cm)		Height (cm)		Weight (kg)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
0-1	6.13	0.13	70.25	6.65	8.68	1.81	9.00	0.16	59.67	1.53	6.00	0.26
1-2	6.45	0.17	81.25	5.56	11.45	1.33	9.35	0.07	75.50	0.71	7.30	0.00
2-3	6.30	0.21	92.23	5.51	13.67	1.53	9.70	0.00	80.00	0.00	9.00	0.00
3-4	7.24	0.08	102.08	4.35	16.27	2.1	10.31	0.23	89.20	4.32	11.66	0.43
4-5	7.46	0.16	110.14	4.71	18.21	2.96	11.06	2.13	97.55	5.70	13.60	0.84
5-6	7.66	0.27	117.67	4.06	19.90	3.11	10.46	0.33	100.71	1.80	11.66	0.74
6-7	8.18	0.17	126.50	7.18	20.42	2.87	10.99	0.42	111.00	3.38	19.17	1.32
7-8	7.46	1.16	124.14	2.41	24.36	1.55	11.84	2.50	108.27	7.55	17.71	2.31
8-9	9.00	0.25	128.38	2.77	27.44	1.99	11.22	1.24	117.83	12.19	18.38	3.66
9-10	9.17	0.10	132.14	2.34	30.36	1.95	14.53	2.93	125.25	4.56	20.08	1.92
10-11	9.41	0.11	138.00	2.39	33.99	1.91	12.00	0.09	121.33	0.82	20.33	0.45
11-12	9.70	0.15	145.50	5.13	35.44	3.61	14.00	1.52	137.70	15.29	29.91	9.37

N = Total number of children, SD = Standard Deviation

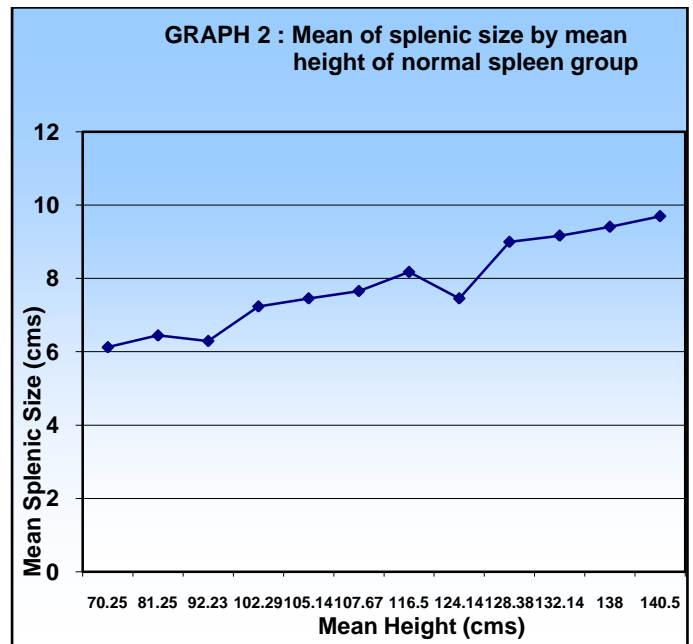
Table 2: R = Pearson Correlation Coefficient

Variables	CORRELATION COEFFICIENT (r)	
	Normal spleen group	Abnormal spleen group
Age with splenic size	0.9	0.82
Splenic size with height	0.8	0.70
Splenic size with weight	0.6	0.86

Graph 1 shows that as the age increases, the splenic size increases in normal spleen group. So there is a **strong positive relationship** between the two variables.

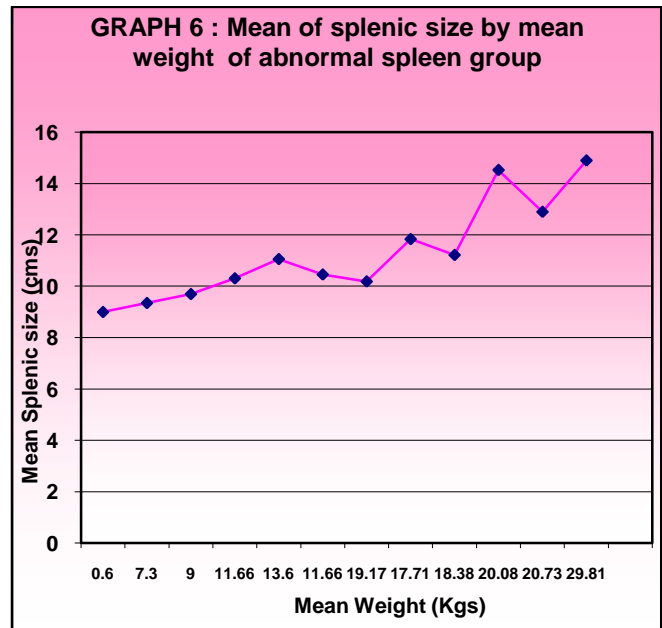
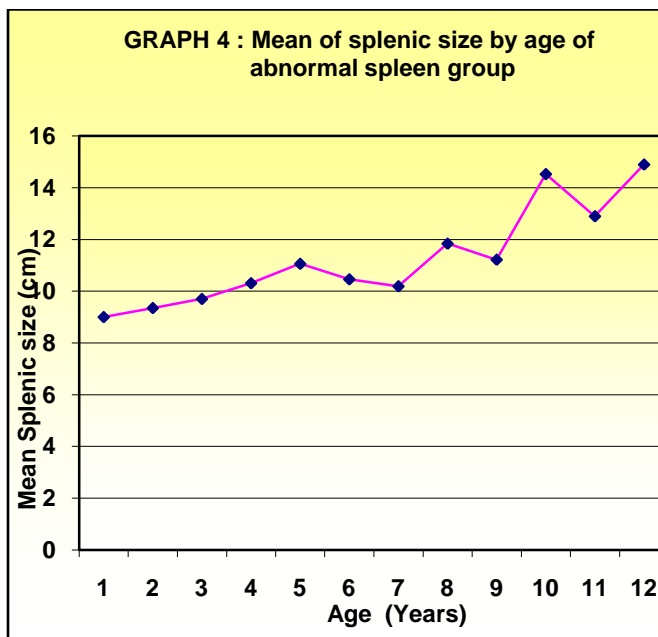
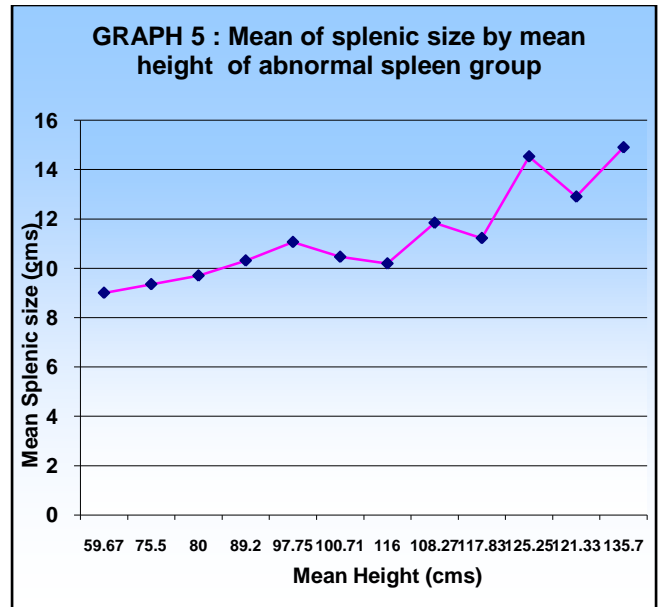
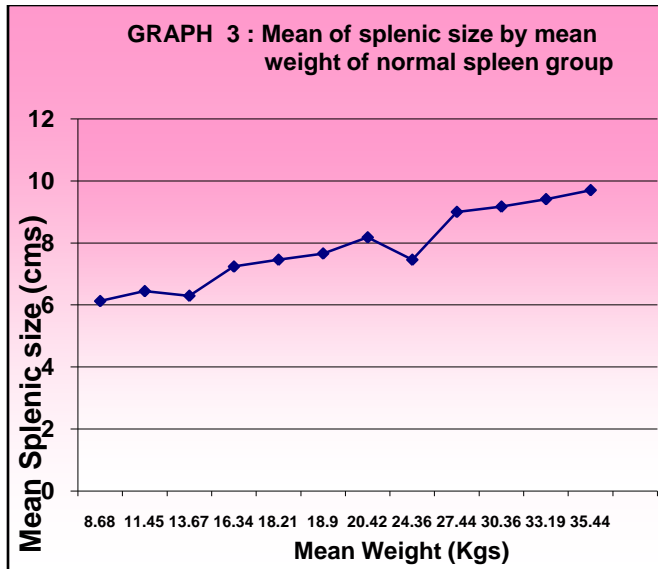


Graph 2 shows that as the height increases the splenic size increases in normal spleen group. So there is a **strong positive relationship** between the two variables.



Graph 3 Shows that as the weight increases, the splenic size increases in normal spleen group. So there is a **positive relationship** between the two variables.

Graph 4 shows that as the age increases, the splenic size increases in abnormal spleen group. So there is a **positive relationship** between the two variables.



Graph 5 shows that as the height increases, the splenic size increases in abnormal spleen group. So there is a **positive relationship** between the two variables.

Graph 6 It shows that as the weight increases, the splenic size increases in abnormal spleen group. So there is a **strong positive relationship** between the two variables.

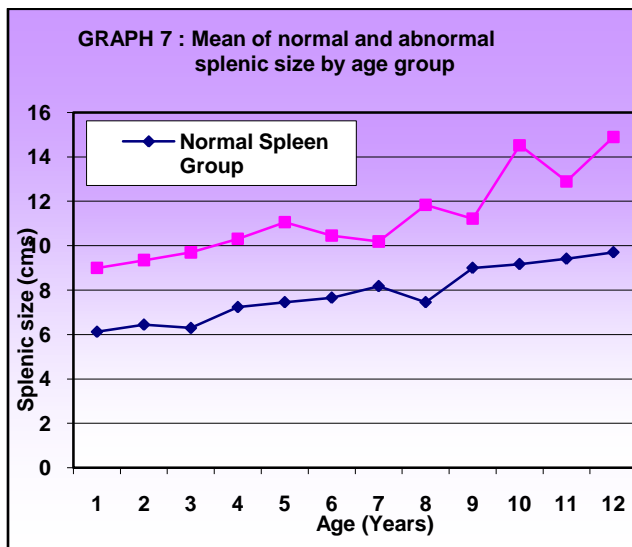
Graph 7 shows that as the age increases, the splenic size increases by 2 cms in the abnormal spleen group as compared to the normal spleen group.

Discussion: No two individuals are alike in this world, not even identical twins. Although the spleen in general has common anatomical features, they widely differ in their measurement (according to age) in paediatric age group.

Ultrasonography provides probably the most dependable information for assessing the splenic length because of its relatively established safe, quick and reliable method⁷.

Very few studies in the past have been done by performing a normogram analysis of the splenic size in childhood. They were either exclusively concerned with spleen or included more parenchymal organs⁷.

The present study entitled : "Ultrasonic measurement of normal splenic size in infants and children and its comparison with the size in various medical disorders involving spleen in Paediatric Indian Population" was aimed to evaluate splenic length with ultrasonography as a reliable and reproducible measurement and correlation of splenic size in medical disorders like malaria, typhoid, portal hypertension and thalassemia major.



In splenomegaly, the anterior border, anterior diaphragmatic surface and notched superior border may become clearly palpable below the left costal margin; the notches are often exaggerated and may be clearly palpable. The transverse colon and splenic flexure are displaced downward³.

In individuals suffering chronic breakdown of erythrocytes, for example in malaria and other haemolytic diseases, the splenic tissues may be

permanently hypertrophied and the spleen greatly enlarged (splenomegaly). These changes involve the distension of the reticular spaces of the red pulp with macrophages loaded with damaged red cells or their breakdown products, the proliferation of reticular cells, increase in macrophage numbers and hypertrophy of the fibrous framework³.

In thalassemia major, there is extramedullary haemopoiesis, which leads to splenomegaly⁶. When there is venous congestion, for example in portal hypertension and other congestive diseases, there also occurs splenomegaly⁶.

In the present study, the splenic length was measured ultrasonographically in 160 children of both sexes in 0-12 years. Out of these, in 80 children the spleen was not affected while the other 80 children were suffering from medical disorders like malaria, typhoid, portal hypertension and thalassemia major, which affect the splenic size.

In the present study, the coronal measurements of the spleen were obtained in 80 patients with clinically apparent and explainable splenomegaly- 55 patients had thalassemia major, 13 had malaria, 9 had typhoid and 3 had portal hypertension. The maximal coronal measurement of each enlarged spleen was compared with the maximal coronal measurement of the normal spleen in the same age group in Indian population.

Rosenberg Henrietta Kotlus et al 1991¹² used data from 230 healthy children of all ages and suggested upper limit guidelines for splenic length in 11 definite age groups without mention of somatometric factors. A roughly logarithmic correlation between the splenic length and age ($r=0.7$) was found. A good correlation was found between the splenic length and patient's height ($r=0.73$) and weight ($r=0.78$).

In the present study, for normal spleen group There is a strong correlation between the splenic length and age ($r=0.9$) and between the splenic length and patient's height ($r=0.8$).

There is a partial correlation between the splenic length and weight ($r=0.6$).

The observations of the present study were almost similar to the above author¹².

Stylianos D. Megremis et al 2004⁷ used data from 512 healthy children (274 girls) with ages ranging from 1 day to 17 years. In their study, they have calculated mean and standard deviation in different age groups. They observed that the splenic length was highly correlated with age and all body parameters (height, weight and body surface area).

In the above study⁷, the mean and standard deviation (SD) in different age groups are as follows:

- In 0-1 year age group: Mean was 6.4 cm with SD 0.78 cm
- In 1-2 year age group: Mean was 6.8 cm with SD 0.72 cm
- In 2-4 year age group: Mean was 7.6 cm with SD 1.70 cm
- In 4-6 year age group: Mean was 8.1 cm with SD 1.10 cm
- In 6-8 year age group: Mean was 8.9 cm with SD 0.91 cm
- In 8-10 year age group: Mean was 9 cm with SD 1.02 cm
- In 10-12 year age group: Mean was 9.80 cm with SD 1.05 cm.

In the present study, the mean and standard deviation were calculated in different age groups. In the present study, for normal spleen group there is a strong correlation between the splenic size and age and there is also a strong correlation between the splenic size and height and partial correlation between the splenic size and weight.

William K. Loftus et al 1998¹⁴, sonographically measured both the splenic length and the kidney length in 256 healthy Chinese children and they compared the splenic lengths with the results of the study of Henrietta Kotlus Rosenberg et al. They have found that the splenic length in Chinese children upto the age of 15 years was similar to that of Western children. They have also suggested

that splenomegaly should be suspected in children if the spleen is 1.25 times longer than the adjacent kidney. For this, they have calculated the median of splenic size in different age groups which is as follows:

- In 0-1 year age group: 6.10 cm
- In 1-2 years age group: 6.20 cm
- In 2-4 years age group: 6.70 cm
- In 4-6 years age group: 7.20 cm
- In 6-8 years age group: 7.70 cm
- In 8-10 years age group: 8.00 cm
- In 10-12 years age group: 8.40 cm

Both the values i.e. mean and standard deviation are measures of central values. In the present study, the mean is used as a central value and standard deviation is also calculated. By comparing the median values of the above study¹⁴ with mean and standard deviation of the present study, there is not much difference in these values as such. So both the results are almost similar.

Oznur L. Konus et al 1998¹, sonographically evaluated normal liver, spleen and kidney dimensions in 307 paediatric patients (169 girls and 138 boys). The relationships of the dimensions of these organs with sex, age, body height, weight, and body surface area were assessed. They have proposed that body height should be considered the best criteria to correlate with longitudinal dimensions of these organs.

In the present study, it is observed that it is the age which is the best criterion to correlate with the splenic length ($r=0.9$) and not the body height.

In the present study, there is a strong correlation between the splenic size and age and other body parameters like height and weight i.e. as the age, height and weight of the child increases, the splenic size increases.

In the present study, the comparison was done between the normal splenic size and the splenic size in medical disorders like malaria, typhoid, portal hypertension and thalassemia major. In the present study, for abnormal spleen group

There is a strong correlation between weight and splenic size, and between age and splenic size.

There is a partial correlation between height and the splenic size.

In all the children with clinically obvious splenomegaly, the splenic length exceeded at least 2 cm than the normal splenic length at that particular age.

Conclusions:

- In normal spleen group, there is a strong correlation between age and the splenic size i.e. as the age increases, the splenic size increases. There is also a strong correlation between height and the splenic size i.e. as the height increases, the splenic size increases. There is a partial correlation between weight and the splenic size i.e. as the weight increases the splenic size increases.
- In abnormal spleen group, there is a strong correlation between weight and the splenic size i.e. as the weight increases, the splenic size increases. There is also a strong correlation between age and the splenic size i.e. as the age increases, the splenic size increases. There is a partial correlation between height and the splenic size i.e. as the height increases, the splenic size increases.
- It also shows that at a particular age, the splenic size exceeded at least 2 cm in the abnormal spleen group as compared to the normal spleen group.
- This splenic size measurement would be of great help in determining the final mode of treatment in thalassemia major.

References:

1. Bailey and Love's Short Practice of Surgery: 22nd edition, Page No. 721-730.
2. Wheater's Functional Histology: A text and colour atlas, 4th edition, Page No. 216-221.
3. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 38th edition, Page No. 1437-1442.
4. Zhang B, Lewis SM: A study of the reliability of clinical palpation of the spleen. Clin. Lab Haematol 1989; 11: 7-10 (Medicine).
5. Francis Mimouni, MD, Paul Merlob, MD: Palpable spleens in newborn term infants. Clinical Paediatrics April 1985; 197-198.
6. Nelson essentials of paediatrics. Textbook of Paediatrics: 17th edition, Page No. 1675-1676.
7. Stylianos D. Megremis, MD, PhD, Ioannis G., Vlachonikolis, MA, D Phil and Amalia M. Tsilimigaki, MD: Spleen length in childhood with US: Normal values based on age, sex and somatometric parameters. Radiology 2004; 231: 129-134.
8. McGregor L. Synopsis of Surgical Anatomy 12th edition. Page No. 106-113.
9. Chaurasia B. D. Human Anatomy: 4th edition, vol. 2, Page. No. 279-283.
10. Moore K. L.: The developing human, clinically oriented embryology, , PhD, FIAC, FRSM : 7th edition, Page No. 276-279.
11. Palmer P.E.S. Manual of diagnostic ultrasound. Published by the World Health organization in collaboration with the World Federation for Ultrasound in Medicine and Biology : 1995. Page No. 3-287.
12. Rosenberg HK, Markowitz RI, Kolberg H, Park C, Hubbard A, Bellah RD : Normal splenic size in infants and children : onographic measurements. AJR 1991; 157 : 119-121.
13. Oznur L. Konus, Aysegul Ozdemir, Alaadin Akkaya, Gonca Erbas, Hacl Celik, Sedat Isik : Normal liver, spleen and kidney dimensions in neonates, infants and children : Evaluation with sonography. AJR (Dec 1998) 171: 1693-1698.
14. William K. Loftus Constantine Metreweli. Ultrasound assessment of mild splenomegaly : spleen / kidney ratio. Paedtr Radiol (1998) 28 : 98-100.
15. Rumack C. M. : Diagnostic ultrasound. 3rd edition, Page No. 3-34, and 147-170.
16. Niederau C, Sonnenberg A. Muller JE Erckenbrecht JF, Scholten T, Fritsch WP: Sonographic measurements of the normal liver, spleen pancreas and portal vein. Radiology 1983; 149: 537-540.

17. Dittrich M. Milde S, Dingkel E, Baumann W, Weitzer D: Sonographic biometry of liver and spleen size in childhood. *Paediatr Radio*, 1983; 13: 206-211.
18. Frank H. Deland M.D.: Normal spleen size. *Radiology* December 1970; 97: 589-592.
19. Hiromi Ishibashi, MD, Noriaki Higuchi, MD, Sonographic assessment and grading of spleen size. *J Clin Ultrasound* January 1991; 19: 21-25.
20. Takashi Koga, M.D., and Yuklo Morikawa M.D.: Ultrasonographic determination of the splenic size and its clinical usefulness in various liver diseases. *Radiology* April 1975; 115: 157-161.
21. Junqueira L. S.: *Basic Histology*. 9th edition, Page No. 263-269.
22. Singh Inderbir, Pal G. P.: *Human Embryology*, 7th edition, Page No. 190 and 197.
23. Singh Inderbir: *Textbook of Anatomy with colour atlas*, 3rd edition, volume-2. Page No. 653-654.
24. Singh Inderbir: *Textbook of Human Histology*. 14th edition, Page No. 184-186.
25. Ross M. H. Ph. D.: *Histology – A text and atlas*, 3rd edition, Page No. 349-353.
26. Last's *Anatomy, Regional and applied*, 10th edition, Page No. 264-265.
27. Moore K. L.: *Clinically oriented anatomy*, 4th edition, Page No. 256-257.
28. Snell R. S. MD, Ph. D.: *Clinical Anatomy*, 7th edition, Page No. 276-279.
29. Datta A. K. (2004). *Essential of Human Anatomy*. Vol. 2 current books. International Ltd. Page No. 238-244.
30. *Cunningham's Manual of Practical Anatomy*: 15th edition, Vol. 2 : Page No. 117-126.
31. *Langman's Medical Embryology*: 8th edition, Page No. 279.
32. J.A. Markisz, ST Treves and R.T. Davis - Normal hepatic and splenic size in children : Scintigraphic determination. *Paediatr Radiol* (1987) 17: 273-276.
33. Nimeh W.: New method for the determination of the size of the liver and spleen. *Am J gastroenterol* 1955, 23: 147-156.
34. P. Prassopoulos and D. Cavouras. CT assessment of normal splenic size in children. *Acta Radiologica* (1994) 35: 152-154.
35. Di Fiore's *Atlas of Histology with Functional Correlations*. 8th edition. Page No. 132- 133.
36. Dameshek w: Hypersplenism. *Bull Hy Acad Sci* 31: 113. 1955.
37. Bowdler AJ: Splenomegaly and Hypersplenism. *Cli Haematol* 12:467, 1983.
38. Sheth Sg, Amarapurkar DN, Chopra KB, Mani SA, Mehta PJ. *J Clin Gastroenterol*. 1996 Jan; 22 (1): 28-30.