

Ultrasonographic measurements of spleen: A prospective study in adults of Bihar

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Abstract

Background: The spleen, also known as "lien," is the largest ductless gland in the body and, as it is made up of lymphoid tissue, is also a haemo-lymph organ. It is the R.B.C. womb and tomb. It also creates lymphocytes and a burial ground for the R.B.C.s who have lived their lives. The spleen may thus be regarded as a purifier of blood. **Methods:** Total 160 cases were taken for the present study. With the help of ultrasound the length, breadth and the thickness of the spleen were measured. The dimensions of the spleen measured with the help of the ultrasound in eighty (80) male and eighty (80) female subjects. The height of the patient was recorded with the help of the stadiometer and weight was measured with the help of the weighing machine. Study was conducted in the Department of Anatomy, Nalanda Medical College Patna (Bihar) during the period of January 2018 – October 2019. **Results:** In the present study, it was observed that the splenic length decreased with age in both males and females. The splenic length decreased at a slow rate up to the age of 50 years after which it decreased rapidly, it was revealed that the splenic length of males was found to be 0.2 cm longer than the splenic length of the females. **Conclusion:** The length of the spleen increased with increase in the body height, body weight and body surface area in both male and female. The splenic width did not show any correlation with body weight in both male and female. No significant correlation was found between the splenic width and the body surface area in both male and female.

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INTRODUCTION

The estimation of the splenic size in vivo is often important in the diagnosis, treatment and prognosis of a variety of disorders. The precise measurements of the spleen by palpation is not reliable since in some of the cases a normal sized spleen is palpable where as a nonpalpable spleen is not always normal sized. Images of the spleen can be obtained by simple X-ray (Schindler *et al.* 1976)¹ but it exposes the patient to the radiation which could be avoided and further if there is a left upper quadrant mass, then it is more often not helpful to differentiate the visible soft tissue arising from the spleen or the adjacent organs. *Radionuclide imaging* is also used

for estimating the splenic size its accuracy depends upon the vascular integrity of the organ and it unduly exposes the patients to the gamma radiations (1-10) (Frank 1970)². *Angiography* is another method but it exposes the patients to the radiations and the allergic reactions of the dye and is also invasive. *Sulfur colloid and Scintigraphy* (Roberts *et al.* 1976)³ can also be used for measuring the splenic size but these procedures are time consuming and have the potential hazard of the radiation. *C.T. Scan and M.R.I.* can also be used but they are very costly. Ultrasound has been found to be both accurate and reliable (Petzoldt *et al.* 1976)⁴. The basis of the diagnostic ultrasound application are the detection and display of the acoustic energy reflected from the interfaces within the body. The interaction provides the information needed to generate the high resolution, two dimensional gray-scale images of the body as well as display, if low parameter. Ultrasound imaging uses high frequency sound wave to produce cross sectional images of the body/organs/visera/or structures. The spleen shows a homogenous echo pattern and few highly echogenic blood vessels in the ultrasound. The splenic hilum is seen highly echogenic. The ultrasound is useful to assess the response of the spleen to radiotherapy and chemotherapeutic regimens in patients with lymphoma

and haematological disorders. The ultrasound scan may be useful to detect the spleen size reduction following allogenic Bone Marrow Transplantation (Picardi *et al.* 1999)⁵

METHODOLOGY

Total 160 cases were taken for the present study. With the help of ultrasound the length, breadth and the thickness of the spleen were measured. The dimensions of the spleen measured with the help of the ultrasound in eighty (80) male and eighty (80) female subjects. The height of the patient was recorded with the help of the stadiometer and weight was measured with the help of the weighing machine. Study was conducted in the Department of Anatomy, Nalanda Medical College Patna (Bihar) during the period of January 2018 – October 2019.

Stadiometer

The instrument measures the height in cm with an accuracy of 0.1 cm. Later on height was converted into meters.

Weighing scale

This instrument was used to measure the weight in kilogram (kg) with an accuracy of 0.1 kg. The brand name of scale was Krups manufactured by Doctor Beli Ram and Son's. Its maximum capacity was 130 kg.

Ultrasound machine

Ultrasound scanner consists of following basic components to perform the key functions – a transmitter or pulsar to energize the transducer, the ultrasound transducer itself, a receiver and processor to detect and amplify the back scattered energy and manipulate the reflected signals for display that present the ultrasound images or data in a form suitable for analysis and interpretation and finally, a method to record or store the ultrasound images.

Inclusion Criteria were Volunteers aged between 20-60 years. No apparent Splenic or related pathology ruled out by taking detailed history. And patient with a history of splenectomy, age younger than 20 years, a history of malignancy, hematologic disorders, prolonged febrile illness were excluded in the study. After screening, the patient and his attendant were asked to sign the consent form. After signing, the patient was examined for any splenomegaly. After confirming it by physical examination, the patients were taken for the study. Weight and height of the patient were taken. The body surface area was calculated with the help of Mosteller formula. For ultrasound examination of spleen, first the patients were placed in supine position and coupling gel was applied on abdominal wall in the left hypochondric region in order to assure optimal transmission of energy between the patient and the probe. The subject did not need prior preparation. Now the subject was asked to lie in the right lateral position with the left side elevated. The transducer of 3.5 MHz was then placed at right angle to the skin between 8th and 9th ribs and contact compound scanning was performed from the back towards the front parallel to the ribs. Splenic measurement was taken during deep inspiration, to minimize masking by the lung. As the upper part of the spleen was partly masked by air in the lung so the margin between the lung and the spleen served as a limit of transverse and longitudinal diameter. Splenic length was measured on longitudinal coronal image from dome to tip through the hilum. On transverse coronal plane, measurement of the width of spleen was made at the hilum, followed by thickness measurement taken in the longitudinal coronal plane at a point bisecting the line indicating length. To determine reproducibility, each measurement was repeated at least three times and most repeated value was recorded.

RESULTS

Table 1: Comparison of spleen length in males and females in different subgroups of height, body weight and body surface area

Height	Male		Female		t	p
	N	Mean ± S.D.	N	Mean ± S.D.		
151-155	12	92.90±10.56	22	89.45±14.83	0.71	N.S.
156-160	13	95.65±15.64	16	91.89±13.93	0.68	N.S.
161-165	18	98.77±15.07	11	94.68±10.58	0.81	N.S.
166-170	21	101.34±14.15	17	98.98±12.61	0.53	N.S.
Weight	N	Mean ± S.D.	N	Mean ± S.D.	t	p
41-47	10	96.11±14.48	19	89.76±13.84	1.20	N.S.
48-54	17	98.31±14.86	16	90.48±12.53	1.56	N.S.
55-61	20	99.14±16.69	17	92.17±10.31	1.46	N.S.
62-68	17	101.55±12.92	16	96.35±14.63	1.10	N.S.
Surface area	N	Mean ± S.D.	N	Mean ± S.D.	t	P
1.31-1.4	4	93.25±16.24	21	89.78±12.43	0.49	N.S.
1.41-1.5	14	97.82±17.62	13	90.91±15.69	1.07	N.S.
1.51-1.6	18	98.27±11.84	19	93.39±11.79	1.26	N.S.
1.61-1.7	19	99.83±17.68	17	97.65±15.63	0.39	N.S.

It was observed that the splenic length was greater in the males than the females and the difference was statistically not significant.

Table 2: Comparison of spleen width in males and females in different subgroups of height, body weight and body surface area

Height	N	Male		Female		t	P
		Mean ± S.D.	N	Mean ± S.D.	N		
151-155	12	73.72±8.85	22	41.80±9.13	22	0.59	N.S.
156-160	13	45.01±9.93	16	42.58±13.12	16	0.55	N.S.
161-165	18	48.41±7.50	11	44.63±8.41	11	1.35	N.S.
166-170	21	49.72±10.66	17	47.08±11.39	17	0.74	N.S.
Weight	N	Mean ± S.D.	N	Mean ± S.D.	N	t	p
41-47	10	47.48±10.46	19	41.54±9.06	19	1.59	N.S.
48.54	17	44.04±8.79	16	43.65±10.96	16	0.11	N.S.
55-61	20	48.63±10.26	17	43.03±8.08	17	1.82	N.S.
62-68	17	47.33±5.64	16	45.85±11.02	16	0.52	N.S.
Surface area	N	Mean ± S.D.	N	Mean ± S.D.	N	t	p
1.31-1.4	4	44.78±9.67	21	38.93±7.51	21	1.51	N.S.
1.41-1.5	14	47.21±10.29	13	44.44±9.60	13	0.78	N.S.
1.51-1.6	18	44.18±9.85	19	43.14±9.77	19	0.32	N.S.
1.61-1.7	19	49.44±8.11	17	45.91±10.51	17	1.13	N.S.

It was observed that the difference of the splenic width in the males and females was statistically not significant but the splenic width of the males was greater than that of the females with each corresponding groups of the height, body weight and body surface area.

Table 3: Comparison of spleen thickness in males and females in different subgroups of height, body weight and body surface area

Height	N	Male		Female		t	P
		Mean ± S.D.	N	Mean ± S.D.	N		
151-155	12	33.47±3.83	22	33.15±6.26	22	0.59	N.S.
156-160	13	35.99±4.22	16	32.71±7.07	16	0.55	N.S.
161-165	18	37.93±5.02	11	34.38±4.85	11	1.35	N.S.
166-170	21	39.28±7.50	17	35.61±6.88	17	0.74	N.S.
Weight	N	Mean ± S.D.	N	Mean ± S.D.	N	t	p
41-47	10	37.66±9.23	19	32.34±5.12	19	1.59	N.S.
48.54	17	36.86±6.88	16	34.71±7.17	16	0.11	N.S.
55-61	20	37.56±5.01	17	34.21±5.31	17	1.82	N.S.
62-68	17	37.18±4.93	16	35.66±8.54	16	0.52	N.S.
Surface area	N	Mean ± S.D.	N	Mean ± S.D.	N	t	p
1.31-1.4	4	44.78±9.67	21	38.93±7.51	21	1.51	N.S.
1.41-1.5	14	47.21±10.29	13	44.44±9.60	13	0.78	N.S.
1.51-1.6	18	44.18±9.85	19	43.14±9.77	19	0.32	N.S.
1.61-1.7	19	49.44±8.11	17	45.91±10.51	17	1.13	N.S.

It was observed that the difference of the splenic width in the males and females was statistically not significant but the splenic width of the males was greater than that of the females with each corresponding groups of the height, body weight and body surface area.

Table 4: Correlation table of the splenic dimensions with height, body weight and body surface area in the males

	r	t	P
Spleen length			
With height	0.28	2.61	P < 0.05
With weight	0.17	1.54	N.S.
With surface area	0.18	1.64	N.S.
Spleen width			
With height	0.30	2.78	P < 0.01
With weight	0.25	2.28	P < 0.05
With surface area	0.28	2.58	P < 0.05
Spleen thickness			
With height	0.35	3.30	P < 0.01
With weight	0.11	0.98	N.S.
With surface area	0.17	1.54	N.S.

The males, a positive statistically significant correlation was found between the splenic length and height. A positive correlation of the splenic width was found with the height, body weight and body surface area in the males. The splenic thickness was also found to be statistically significantly correlated with height in the males.

Table 5: Correlation table of the splenic dimensions with height, body weight and body surface area in the females

	r	t	P
Spleen length			
With height	0.29	2.73	P<0.10
With weight	0.19	1.74	P=0.10.
With surface area	0.23	2.13	P<0.05
Spleen width	r	t	P
With height	0.23	2.13	P<0.05
With weight	0.13	1.18	P=0.20
With surface area	0.16	1.46	P=0.15
Spleen thickness	r	t	P
With height	0.19	1.74	P=0.10
With weight	0.16	1.46	P=0.15
With surface area	0.18	1.65	P=0.15

The females, a positive statistically significant correlation of the splenic length was found with the height, body surface area. A significant positive correlation was found between the splenic width and height in the females. The splenic thickness did not have any statistically significant correlation with any of the body dimensions in the females.

DISCUSSION

This was similar to the findings of Loftus and Metreweli (1997)⁶. They observed a rapid growth in the splenic length up to the age of 20 years followed by a mild decrease up to the age of 50 years and then rapid fall after the age of 50 years. In the present study, it was revealed that the splenic length of males was found to be 0.2 cm longer than the splenic length of the females. This was different to the findings of Loftus and Metreweli (1997)⁶. They observed that the splenic length of the males was 0.5 cm longer than the splenic length of the female. Perhaps this may be due to the difference in height, weight, surface area and the generic factors. In the Present study it was observed that the splenic length was found to be less than 11 cm in most of the subjects. This was similar to the finding of Frank *et al.* (1986)⁷. In the present study the splenic width and thickness were observed to be less than 6 cm and 4 cm respectively in most of the subjects. This was different from the findings of Frank *et al.* (1986)⁷, who observed the splenic width below 7 cm and thickness below 5 cm in most of the subjects.

Rosenberg *et al.* (1991)⁸ demonstrated that the upper normal limit of the splenic length was observed to be 12 cm for girls of 15 years or more and 13 cm for boys of 15 years or older. These findings were slightly different from the findings of the present study. This difference may be due to the generic factors, nutritional factors or the environmental factors. Niederau *et al.* (1983)⁹ demonstrated that the mean longitudinal diameter of the

spleen was found to be 5.8 ± 1.8 cm and transverse diameter 5.5 ± 1.4 cm. These dimensions were much smaller than those of present study because the authors did not measure the maximum length of the spleen. This study further found that the splenic size did correlate weakly with height in the general population. Konus *et al.* (1998)¹⁰ proposed that the splenic length correlated best with the body height. This was similar to the findings of the present study. Megremin *et al.* (2004)¹¹ revealed that the body height, weight and surface area has a significant positive correlation with the splenic length. Their findings were similar to the findings of the present study. In the present study, it was observed that in the females, the body height did not show any relation with the splenic thickness, but in the male there was a positive correlation between the splenic thickness and the body height. The similar finding was observed by Spielmann *et al.* in (2006)¹². proposed that the body height was correlated with the length and width of the spleen in males and females. Their findings were in favour of the present study. They also proposed that all the splenic dimensions correlated better with the height than the weight. This was similar to the findings of the present study. In the present study it was observed that the splenic width and the splenic thickness did not show any relation with the body weight and the surface area. It was also revealed that the splenic width decreased with increase in age. In spite of the extensive search, we could not find out any study showing the relation of the splenic width and thickness with the age, weight and body surface area.

CONCLUSION

With an increase in body height, body weight and body surface area, the length of the spleen increased in both men and women. In both men and women, the splenic width increased with an increase in body height. In both males and females, splenic width did not show any association with body weight. No important association was found between both male and female splenic width and body surface area. The splenic thickness increased in males with body height, while there was no association between the splenic thickness and height in females. The splenic thickness did not show any association with both male and female body weight and body surface area. All the measurements of the spleen with the corresponding age, body height, body weight, and body surface area were less in females than in males. The splenic length was found to be lower than 11 cm in most of the subjects. Splenic width and thickness were found to be lower than 6.

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