VARIATIONS OF SPLEEN MORPHOLOGY: A STUDY OF ADULT HUMAN CADAVERIC SPLEENS IN A MEDICAL INSTITUTE IN NORTH EAST INDIA

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Abstract

Background: The shape, size and weight of the spleen in human vary with age, sex, and under different conditions in the same individual. The idea of morphological variations is important to avoid misinterpretation of the splenic variants.

Objective: The objective is to assess and document variations of spleen morphology in human cadavers in a Medical Institute in North-East India.

Methods: A cross sectional study of a total of 34 adult human cadaveric spleens was done in the Anatomy Department, Regional Institute of Medical Sciences (RIMS), Imphal, India. The study observed the morphological features such as shape, number of notches, anomalous fissures, and morphometric measurements such as length, breadth, thickness and weight of all the spleen specimens.

Results: The wedge shaped spleen constituted 41.18% followed by triangular (23.53%), irregular (17.64%), oval (11.76%) and round (5.89%) shaped spleens. The maximum number of notches was present in the anterosuperior border and the number varied from 0-4 notches. There was no notch in 2.94% of the specimens. Mean values of splenic length, breadth and thickness were 9.91 cm, 6.14 cm and 3.35 cm respectively. The mean weight of the spleens was 149.09 g. Anomalous fissures were found on the diaphragmatic (2.94%) and visceral (2.94%) surfaces of the spleens.

Conclusion: The study highlights morphological variations of spleens and such variations should be kept in mind by the radiologists and surgeons to avoid misinterpretation of splenic variants and unnecessary invasive procedures.

Keywords: Spleen, Cadaver, Splenic variations

Introduction

Spleen is the largest lymphoid organ in the human body and is located in the left hypochondrium resting on the left colic flexure opposite to the 9th - 11th ribs.¹ It is one of the frequently damaged organs in blunt abdominal trauma and also in penetrating injury to the left upper abdominal quadrant.² Spleen has superior and inferior poles, superolateral diaphragmatic and inferomedial visceral surfaces, anterosuperior and posteroinferior borders. The superior pole corresponds to the posterior extremity and usually faces the vertebral column. The inferior pole which is less angulated than the superior pole connects the anterosuperior and posteroinferior borders anteriorly. The diaphragmatic surface is smooth and convex, faces mostly superiorly and laterally, although the posterior part may face posteriorly. The visceral surface is irregular, faces inferomedially towards the abdominal cavity. The anterosuperior border is usually convex and inferiorly, it may bear one or two notches. The size and weight of the spleen vary with age, sex, and can also vary slightly in the same individual under different conditions. The adult

spleen is usually 9-14 cm long, 6-8 cm wide and 3-5 cm thick. It reaches its largest dimension in puberty and diminishes thereafter. The average adult weight depends on the amount of blood in it. The weight ranges from 150 to 350 g in vivo and when emptied of blood, it weighs between 70 and 120 g.³ Congenital anomalies of the spleen are believed to be rare and include spleen lobulation, wandering spleen, accessory spleen, polysplenia and absence of the spleen.⁴

Prenatally, the spleen is a hematopoietic organ, but after birth it is involved primarily in identifying, removing, and destroying worn out red blood cells (RBCs) and platelets. Moreover, this organ also acts as a reservoir of blood, stores RBCs and platelets.¹ The spleen participates in many different pathological processes e.g. generalised haematopoietic and lymphopoietic disorders, systemic infection, sepsis and immunologic-inflammatory processes. Despite its clinical significance, spleen seems to be "the forgotten organ" unless enlarged, traumatized, or infarcted.⁵ Many researchers feel that radiologists and clinicians should be well aware of the normal spleen

variants, as well as relevant congenital and acquired abnormalities so that they interpret correctly the variable spectrum of findings that may involve the organ.⁶⁻⁹ Realising the occurrence of morphological variations and the importance in clinical decision making, we took up the presenting study to assess and share the morphologic variations of the spleen in cadaveric bodies donated in the RIMS, Imphal, one of the premier Medical Institutes in the North-East India.

MATERIALS AND METHODS

The study was a cross sectional study conducted in the Department of Anatomy, RIMS, Imphal. A total of 34 formalin fixed intact spleens were included. The spleens were collected during routine dissection of the donated adult human cadavers for the undergraduate medical teaching. The shape of the spleen, splenic notch and anomalous fissure on the surfaces were observed. In addition, the length, breadth, thickness and weight of the spleens were recorded using measuring tape, sliding caliper and weighing machine respectively.

The length of the spleen was recorded as the greatest distance between the two poles of the spleen. The greatest distance between two points at the same level on the anterosuperior and posteroinferior borders was taken as its breadth.¹⁰ The thickness of the spleen was taken with the help of a slide caliper at the maximum dimension of the spleen between the diaphragmatic and visceral surfaces.¹¹

The observations relating to the shape, splenic notch and anomalous fissures were expressed as percentages. The length, breadth, thickness and weight were summarised by descriptive statistics (numerical) and the mean values were compared with the findings of other workers by One-sample T test. $P < 0.05$ was considered statistically significant. IBM SPSS statistics version 21 was used for data analysis.

RESULTS

In the study, the spleen specimens revealed different shapes and sizes. The wedge shaped spleen constituted 41.18% followed by triangular (23.53%), irregular (17.64%), oval (11.76%) and round (5.89%) shaped spleens (Table 1, Figure 1 - A, B, C, D & E). The maximum number of notches was present in the anterosuperior border and the number varied from 0-4. Two notches in the border made up 41.18%, followed by single notch (26.47%), three notches (17.65%) and 4 notches (8.82%). In 5.89% of the anterosuperior border, there was no notch. The splenic notches in the posteroinferior border comprised of single notch (26.47%) and 2 notches (11.76%). In 23.58% of the specimens, the notches were present on both the borders. There was no notch in 2.94% of the spleens. The presence of a single notch in the superior pole was noticed in one

spleen i.e. (2.94%) of the specimens (Table 2, Figure 2 - A, B & C). The anomalous fissures were found on the diaphragmatic (2.94%) and visceral (2.94%) surfaces of spleen specimens (Table 3, Figure 3).

In this study, the length of the spleens varied from a minimum of 7.60 cm to a maximum of 12.70 cm with a mean value of 9.91cm. The breadth was observed to vary from 4.00 cm to 7.20 cm with a mean value of 6.14 cm. The mean thickness was 3.35 cm with the minimum and maximum limits of 2.70 cm and 4.30 cm respectively. A mean value of 149.09 g was observed for the weight of the spleens (Table 4).

Table 1: Splenic shape, number and percentage (n = 34)

Shape	Number	%
Wedge	14	41.18
Triangular	8	23.53
Irregular	6	17.64
Oval	4	11.76
Round	2	5.89

* n = Total number of specimens.

Table 2: Splenic notches: sites and percentages (n=34).

Sites	Notch	Spleen	%
Anterosuperior	0	2	5.89
border	1	9	26.47
	2	14	41.18
	3	6	17.65
	4	3	8.82
Posteroinferior	0	21	61.76
border	1	9	26.47
	2	4	11.76
Both borders		8	23.58
Superior pole		1	2.94

Table 3: Anomalous fissures on the splenic surfaces (n=34)

Surface	Number	%
Diaphragmatic	1	2.94
Visceral	1	2.94

Table 4: Measurements of length, breadth, thickness and weight (n=34)

Parameter	Minimum	Maximum	Mean	SD
Length (cm)	7.60	12.70	9.91	1.23
Breadth (cm)	4.00	7.20	6.14	0.76
Thickness (cm)	2.70	4.30	3.35	0.43
Weight (g)	60.00	210.00	149.09	33.88

Table 5: Splenic shapes in some Indian studies

Author(s)	Wedge	Triangular	Oval	Tetrahedral	Irregular	Round
Chidambaram RS et al. ⁶	73.33%	13.33%	6.67%	6.67%		
Srivani D et al. ⁹	35%	10%	2.5%	52.5%		
Agrawal D et al. ¹⁰	41.67%	8.33%	16.67%	27.7%	5.56%	
Biswal R et al. ¹¹	52%	10%	2%	30%	6%	
Chaware PN et al. ¹²	61.26%	12.61%	3.6%	21.62%	0.90%	
Setty SRS et al. ¹³	40%	32%	8%	20%		
Khade A et al. ¹⁴	62.5%	6.25%	9.37%	18.75%	3.13%	
Anusha D et al. ¹⁵	31.66%	11.6%	5%	8.3%	8.3%	10%
Swargam N ¹⁶	15%	40%	30%	15%		
Present study	41.18%	23.53%	11.76%		17.64%	5.89%

Table 6: Splenic length, breadth, thickness and weight in some Indian studies

Author(s)	Length (cm)	Breadth (cm)	Thickness(cm)	Weight (g)
Agrawal D et al. ¹⁰	10.15	6.01	3.23	156.01
Biswal R et al. ¹¹	11.92 [†]	7.08 [†]	3.08 [*]	103.95 [†]
Anusha D et al. ¹⁵	9.82	8.24 [†]	2.85 [†]	131.00 [*]
Agarwal KK et al. ¹⁹	9.20 [*]	6.70 [†]	3.90 [†]	114.70 [†]
Present study	9.91	6.14	3.35	149.09

Values are expressed in Mean; ^{*}P<0.01 and [†]P<0.001 as compared to present study (One-sample T test).

Figure 1: A - Wedge shaped, B - Triangular shaped, C - Irregular shaped, D - Oval shaped, E - Round shaped. **Figure 2: A - Deep notches on the anterosuperior border, B - Notches on both borders, C - Notch on the superior pole.** **Figure 3: Splenic fissure on the diaphragmatic and visceral surface**

DISCUSSION

The present study noticed five different shapes of the spleen. The most common shape was the wedge shape followed by triangular, irregular, oval, and round shapes. The observation of wedge shaped spleen as the commonest shape is in agreement with the findings of many other studies in India,^{6,10,11-15} but differs from Srivani D et al.⁹ and Swargam N¹⁶ who observed tetrahedral and triangular shapes respectively as the commonest shapes. The tetrahedral shaped spleen was not found in our study, but the round shaped spleen constituted 5.89% of the total of 34 spleens observed. These findings were in contradiction to many studies in India. In a study of a total of 60 cadaveric spleens, Anusha D et al.¹⁵ reported round shaped spleen in 10% of the specimens. The variations in the shapes are mostly determined by the relationships of the organ to neighbouring structures during development.³

The notches were found more frequently on the anterosuperior border and the maximum number was four in the current study. Different workers documented the superior border bearing more notches than the inferior border.^{4,10,17} We observed the notches on both the borders as reported by previous workers.^{4,18} In 2.94% of the specimens, there was no notch found, and the absence of the notch was also reported in other studies.^{4,6,9} The presence of notch on the superior pole could be a rarity. The notches in the spleen indicated incomplete fusion between lobules of splenic tissue.¹⁵ The presence of splenic notch could be helpful in palpating the spleen clinically, but variations in the number of notches could be misleading the clinicians in differentiating the renal tumours from splenomegaly.¹⁶

The anomalous fissures were seen on both the diaphragmatic and visceral surfaces in the current study and Anusha D et al.¹⁵ reported similar findings. The anomalous fissures might be due improper fusion of the splenic nodules during development or mechanical pressure by the adjacent viscera.⁶

The comparative assessment of the shapes (Table 5) and the mean values of the morphometric measurements (Table 6) of our study were attempted with the findings of some Indian studies. The assessment revealed that the mean value of the observed lengths of the current study was comparable with the those of previous workers.^{10,15} The value was less than that of Biswal R et al.¹¹ but greater than the observations of Agarwal KK et al.¹⁹ significantly. The mean breadth was comparable with the finding of Agrawal D et al.¹⁰ However, it was found to be significantly less ($P < 0.001$) as compared to findings of other Indian studies.^{11,15,19} In terms of the thickness, the mean was significantly greater than the observations of some authors,^{11,15} but comparable with the finding of a study in Andhra Pradesh.¹⁰ Although the mean splenic weight of

current study was in agreement with the observation in the above study, it was significantly different from the observations of some other workers in India.^{11,15,19} The variations in the average weight of the adult spleen could be due to the blood volume it contained or emptied.³

LIMITATION

Our study had an obvious limitation of having small sample size which could have been increased if more cadavers were available.

CONCLUSION

The literature reports and the findings in the present study support the view that there are morphological variations of the spleen in different individuals. Therefore, such idea of possible morphological variations should be kept in mind by the radiologists and the clinicians, especially the surgeons to avoid misinterpretation of the splenic variants and avoid unnecessary invasive procedures.

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