

# Morphometric study of human adult cadaveric spleen

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## Abstract

**Background:** Spleen is a hemolymph organ in the human body. It is the largest and clinically important lymphoid organ. It can show a wide range of variation, the knowledge of which is important for physicians, surgeons and radiologists **Aim of the Study:** The present study was done to perform a morphometric analysis of human cadaveric spleens and compare the results with previous studies. **Materials and Methods:** The present study was done on 41 human adult cadaveric spleens obtained from Department of Anatomy, J.N. Medical College, Belagavi. The morphological features of the spleen like its length, breadth, width and weight were measured. The shape, poles, borders, surfaces and the impressions on the spleen were observed **Results:** The lengths of the spleens varied between 6.8 cm to 14cm, with an average of 9.97 cm. Their breadth was between 5.20 and 10.4cm. The average breadth was 7.21 cm. Their widths varied between 2.1 and 6.4 cm, with an average of 3.65 cm. The weights of the spleens showed great variations, ranging between 51.70 and 369.90 gm, with an average of 132.79 gm. Various shapes of the spleens were observed in the present study. Most of the spleens were wedge shaped [48.78%], followed by tetrahedral [14.63%] and triangular [17.1%]. Additional oval [7.32%], semilunar [7.32%], heart shaped [2.44%], and irregular shapes [2.44%], of the spleens were observed. In all the spleens, two poles, two borders and two surfaces were observed. The diaphragmatic surface of the spleen showed a uniform morphology while its visceral surface showed gastric, renal, colic and pancreatic impressions. The splenic notches were present on the superior as well as on the inferior borders. In most of the cases [85.37%], the notches were found on the superior border. The number of notches varied from zero to six, but in most of the cases [31.71%], there were 1 notch. **Conclusion:** These findings will be helpful for operating Surgeons and interventional Radiologists and for Anatomists too.

**Key Word:** Spleen, shape of spleen, spleen notches.

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## INTRODUCTION

Spleen is the important hemolymph organ in humans. It is largest lymphoid organ in the body. It is situated in the upper left hypochondriac region and partly in the epigastrium. It is covered from all the sides by peritoneum and is closely related to the fundus of the stomach, left kidney, left colic flexure and the diaphragm. It has two poles, i.e. anterior and posterior, two surfaces i.e. diaphragmatic and visceral, and three margins i.e. superior, inferior, and intermediate. Its shape varies from a slightly curved wedge to a domed tetrahedron<sup>1</sup>. The size and weight of the spleen varies with age<sup>1</sup>. On an average it is 12 cm long,<sup>7</sup>

cm broad and 4 cm thick in the adult. Weight of the spleen ranges from 80 to 300 g average being 150 g.<sup>1,2</sup> Splenomegaly is important diagnostic sign in malaria, kalaazar, inflammatory and degenerative disorders<sup>3</sup>. In splenomegaly, the anterior border, anterior part of diaphragmatic surface and notched superior border may become clearly palpable below the left costal margin<sup>4</sup>. Spleen begins to develop during 5<sup>th</sup> week of intrauterine life from a mass of mesenchymal cells originating in the dorsal mesogastrium as a localised thickening of coelomic epithelium.<sup>5</sup> The spleen is nodular in fetus, but the lobules normally disappear before birth. The notches in the superior border of the adult spleen are remnants of the grooves that separated fetal lobules.<sup>5</sup> Spleen assumes clinical importance due to hematological and immunological role. Surgeons also like to conserve splenic tissue during splenectomy due to the same reasons. The present study was undertaken to describe the morphometric variations in spleen and compare it with the available literature which would prove useful to both clinicians and academicians.

## RESULTS

Measurements of 41 spleens are shown in table-1

Table 1: showing measurements of 41 spleen

Specimen no.	Weight (gms)	Length (mm)	Breadth (mm)	Width (mm)	Presence of notches	Shape	Accessory spleen	Accessory lobe
1	158.9	110.02	59.30	41.81	Sup.br.(+)1 Inf.br.(+)1	Oval		
2	201.45	107.62	82.58	41.76	Sup.br.(+)1	Wedge		
3	142	103.59	69.73	35.11	Inf.br.(+)3 Sup.br.(+)1	Tetrahedral	Present	
4	100.25	82.23	65.34	32.38	Inf.br.(+)1 Post.pole (+) 1	Wedge	present	
5	149.9	105.39	64.47	41.50	Inf.br.(+)1	Triangular with tongue shaped projection		
6	276	131.98	96.11	47.66	Sup.br.(+)1 Inf.br.(+)1	Triangular with tongue shaped projection		
7	64.75	82.63	55.85	21.72	Sup.br.(+)1 Inf.br.(+)1 Post.pole (+)1	Wedge		
8	369.90	114.35	104.27	63.76		Irregular		
9	191.20	103.77	84.71	39.04	Sup.br.(+)2	Wedge		
10	108.20	82.65	65.5	43.43	Sup.br.(+)1 Inf.br.(+)2	Wedge		
11	93.40	86.70	62.68	35.02	Sup.br.(+)3 Inf.br.(+)3	Wedge		
Specimen no.	Weight (gms)	Length (mm)	Breadth (mm)	Width (mm)	Presence of notches	Shape	Accessory spleen	Accessory lobe
12	86.25	77.98	63.67	37.6	Sup.br.(+)1	Tetrahedral	Present	
13	106.35	104.51	61.95	27.28	Sup.br.(+)3	Triangular with		

## MATERIALS AND METHODS

This study was done on 41 formalin fixed human adult cadaveric spleens of both sexes obtained during routine dissection classes of undergraduate medical students in Anatomy department of J. N. Medical College, Belagavi and USM-KLE University, Belagavi. The morphological features of the spleen which includes its length, breadth, width (mm) and weight (gms) were measured by using digital Vernier caliper and electronic weighing machine respectively. The shape, poles, borders, surfaces and the impressions on the spleen were observed. The notches on the borders of the spleen were observed carefully. Pictures were taken wherever necessary. As in the study which was done by Michels *et al*<sup>6</sup>,

**Length** (mm)- the greatest distance between the two poles of the spleen,

**Breadth** (mm)- the greatest distance between two points at the same level on the superior and inferior borders and

**Width** (mm)- the greatest width of the spleen.

Specimen no.	Weight (gms)	Length (mm)	Breadth (mm)	Width (mm)	Presence of notches	Shape	Accessory spleen	Accessory lobe
14	82.80	78.19	58.49	27.49	Inf..br.(+)2 Sup.br.(+)1	tongue shaped projection Oval		
15	51.70	92.16	52.02	20.94	Sup.br.(+)4	Triangular with tongue shaped projection		
16	110.25	102.87	68.59	28.53	Sup.br.(+)1 Inf..br.(+)1	Triangular		
17	110.30	87.32	71.34	27.89	Sup.br.(+)1	Wedge		
18	45.50	68.19	49	25.31	_____	Triangular		
19	102	75.63	65.94	33.34	Sup.br.(+)1	Wedge		
20	99.30	88.87	66.46	29.01	Sup.br.(+)1	Wedge		
21	114.25	84.63	72.21	37.81	Sup.br.(+)2 Inf..br.(+)1	Wedge		
22	199.40	113.75	63.75	37.41	Sup.br.(+)2 Inf..br.(+)1	Tetrahedral		
23	140.55	93.46	73.58	45.98	Sup.br.(+)3 Inf..br.(+)1	Wedge		
24	159.10	111.82	81.62	36.77	Sup.br.(+)3 Inf..br.(+)1	Semilunar		
25	85.70	73.58	59.47	43.23	Sup.br.(+)1	Semilunar		
26	165.20	99.91	80.27	36.15	Sup.br.(+)2 Inf..br.(+)1	Wedge		
27	243	107.92	86.95	37.81	Sup.br.(+)2 Inf..br.(+)1	Heart shaped		
28	336.70	135.75	90.16	48.09	Sup.br.(+)1 Inf..br.(+)1	Wedge		
29	75.6	84.66	54.3	30.66	Intermediate .br.(+)1	Wedge		
30	145	107.38	73	35.83	Sup.br.(+)2 Inf..br.(+)1	Wedge		
31	130	113.26	71.89	36.26	Sup.br.(+)1	Triangular		
32	192	140.05	81.78	46.51	Sup.br.(+)2 Inf..br.(+)2	Tetrahedral		
33	175	119.50	87.7	44.98	_____	Oval		
34	186	125.34	81.3	42.71	Sup.br.(+)1 Inf..br.(+)1	Tetrahedral		
35	160	100.76	84.6	48.15	Sup.br.(+)3 Inf..br.(+)1	Wedge		
36	149	110.23	79.47	40.81	Sup.br.(+)1	Wedge		
37	138	118.19	75.49	56.24	Sup.br.(+)2 Inf..br.(+)1	semilunar		Present
38	113.0	87.32	71.34	27.89	Sup.br.(+)1	Wedge		
39	190.4	103.54	83.61	40.86	Sup.br.(+)2	Wedge		
40	141.45	93.56	73.62	45.1	Sup.br.(+)3 Inf..br.(+)1	Wedge		
41	86.4	78.2	64.1	38.8	Sup.br.(+)1	Tetrahedral		

In the present study, out of 41 spleens, 20(48.78%) were wedge shaped,7( 17.1%) were triangular shaped, 6 (14.63%) were tetrahedralshaped,3(7.32%) were oval shaped ,3 (7.32%)semilunar shaped,1(2.44%) heart shaped and 1 (2.44%) were irregular in shape. (table 2)

**Table 2:** variations in shapes of spleens

Shape of spleen	No. of spleens	Percentage %
Wedge	20	48.78
Triangular	07	17.1
Tetrahedral	06	14.63
Oval	03	7.32
Semilunar	03	7.32
heart shape	01	2.44
Irregular	01	2.44



Figure 1:



Figure 2:



Figure 3:



Figure 4:

**Figure 1:** Wedge shape of spleen; **Figure 2:** Tetrahedral shape of spleen; **Figure 3:** Triangular shape of spleen; **Figure 4:** Triangular with tongue shaped projection shape of spleen



Figure 5:



Figure 6:



Figure 7:

**Figure 5:** Semilunar shape of spleen; **Figure 6:** Heart shaped spleen; **Figure 7:** Oval shape of spleen.



**Figure 8:** showing changes in size of spleen

Weight of 41 spleens ranged between 45.5 to 369.90gm, with an average of 132.79 gm. The maximum number of specimens i.e. 22 (53.66%) have weights in the range of 80 to 150 gm. (table 3)

**Table 3:** variations in weight of spleens

Weight range (gms)	No. of spleens	Percentage %
Below 80	04	9.76
81-150	22	53.66
151-200	10	24.4
201-250	02	4.88
251-300	01	2.44
301-350	01	2.44
351-400	01	2.44

In the present study, the lengths of the spleens varied between 6.8 cm and 14 cm, with an average length of 9.97 cm. Most of the spleens were in the range of 10 cm to 12 cm in length (43.9%) (Table 4)

**Table 4:** variations in length of spleens

Length (cm)	No. of spleens	Percentage %	Average
6-8	06	14.63	
8-10	13	31.7	
10-12	18	43.9	<b>9.97</b>
>12	04	9.76	

The breadth was spleen varied between 5.2 cm and 10.4 cm, with an average breadth of 7.21 cm. Most of the spleens were in the range of 5.6 cm to 7.5 cm in breadth (56.12%) (Table 5)

**Table 5:** variations in Breadth of spleens

Breadth (cm)	No. of spleens	Percentage %
3.5-5.5	03	7.32
5.6-7.5	23	56.12
7.6-9.5	12	29.27
>9.5	03	7.32

It was found that the widths of the spleens varied from 2.1 cm to 6.4cm with an average width of 3.65 cm. In most of the cases spleens width was in the range of 2 cm to 4 cm (58.54%). (table 6)

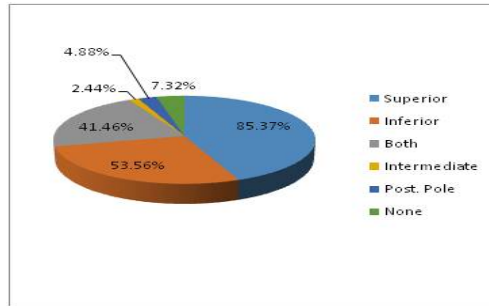
**Table 6:** variations in Width of spleens

Width (cm)	No. of spleens	Percentage %
2-4	24	58.54
4-6	16	39.02
6-8	01	2.44

The splenic notches were present on the superior as well as on the inferior borders. In most of the cases [85.37%], the notches were found on the superior border. The number of notches varied from zero to six, but in most of the cases (31.7%), there were 1 notch. (table 7 and 8)

**Table 7:** borders of spleen showing presence of notches

Border of spleen	Presence of notch	Percentage %
Superior	35	85.37
Inferior	22	53.66
Both (superior and inferior)	17	41.46
Intermediate	01	2.44
Posterior pole	02	4.88
None	03	7.32



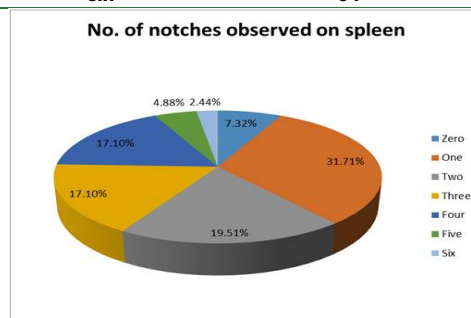
**Figure 1:** borders of spleen showing presence of notches



**Figure 9:** showing notch on both inferior order; **Figure 10:** showing notches both superior and inferior order; **Figure 11:** showing multiple notches on superior border; **Figure 12:** showing notch on posterior pole; **Figure 13:** showing notch on inferior border; Fig.14- showing no notch

**Table 8:** No. of notches present on spleen

No. of notches observed on spleen	No. of spleens	Percentage %
Zero	03	7.32
One	13	31.71
Two	08	19.51
Three	07	17.10
Four	07	17.10
Five	02	4.88
Six	01	2.44



**Graph 2:** Number of notches observed on spleen

**Table 9:** showing mean values of measurements of spleen

Measurements of spleen	Range	Mean value
Weight (gm)	51.70-369.90	132.79
Length(cm)	6.8- 14.0	9.97
Breadth(cm)	52.02- 10.4	7.21
Width(cm)	2.1- 6.4	3.65

**Table 11:** Variation in shapes of spleen

Measure- ment	Textbook ofGreys anatomy <sup>1</sup>	Michels NA <sup>6</sup>	Rao <i>et al</i> <sup>7</sup>	Chaware <i>et al</i> <sup>8</sup>	Chaudhari <i>et al</i> <sup>9</sup>	Sangeetaetal <sup>10</sup>	Present study
Length (cm)	12	11	10.15	9.66	9.59	9.68	<b>9.97</b>
Breadth (cm)	7	7	8.3	6.22	6.59	6.84	<b>7.21</b>
Width (cm)	3 to 4	3	3.96	3.06	4.54	3.61	<b>3.65</b>
Weight (gm)	150	-	138.4	145.76	-	145	<b>132.79</b>

**Table 12:** variations in notches of spleen

study	% of notch on superior border	% of notch on inferior border	% of notch on both sup. And inf. border	% of notch on intermediate border	% of notch on post.pol e	none
Chaware <i>et al</i> [8]	74.76	24.32	19.81	-	-	5.4
Chaudhari <i>et al</i> <sup>9</sup>	50	16.12	9.67	-	-	24.19
Sangeeta <i>et al</i> <sup>10</sup>	100	-	-	-	-	-
Present study	85.37	53.66	41.66	2.44	4.88	7.32

## DISCUSSION

The spleen is an important haemolymph organ. As reported by Michels<sup>6</sup> and as mentioned in Gray's anatomy<sup>1</sup>, in the present study also, so many variations were found in the morphology of the spleen. The values for the length, breadth, width and weight of the spleen in the present study were slightly lower than previous studies done in western countries compared to Indian studies.<sup>1,6,7,8,9,10</sup> This may be due to the differences in the genetic factors, body constitution, geographical conditions, feeding habits and the better socioeconomic status, in the western countries where these studies were done. Presence of Notches on spleen- The spleen develops from the mesoderm. During its development, different lobules are formed, which fuse with each other later on. The indication of the lobulation in adult spleen is its notched upper border.<sup>11</sup> Sometimes, this lobulated appearance may persist in the spleen which indicates improper fusion of spleen and causes many notches on the spleen, which can be seen most commonly on the superior as well as on the inferior borders. In the present study, the splenic notches were found on the superior as

well as on the inferior borders. The number of notches varied from zero to six, but commonly, there were only one or two notches. These findings of the study in accordance with previous studies.<sup>2,6</sup> Presence of notches on the superior margin is useful for the physician to palpate the spleen during enlargement of spleen<sup>9,12</sup>. Presence of notches in the inferior border may be important for surgeons attempting splenic surgeries and radiologists interpreting CT scans.

## CONCLUSION

The knowledge on the anatomical variations of the spleen is of fundamental importance to the clinicians during the routine clinical examinations of the abdomen, to the surgeons while they perform surgical procedures which are related to the spleen, to the radiologists for their diagnostic procedures and of course The detailed knowledge on spleen is important to avoid and prevent any complications and to obtain a good operative, as well as diagnostic intervention. This knowledge is also very important for anatomists during their routine dissection procedures.

## REFERENCES

1. Standring S: Gray's Anatomy: The Anatomical Basis of the Clinical Practice, 39th edition. Edinburg: Elsevier Churchill Livingstone, 2006; 1239-44.
2. Hollinshead WH. Anatomy for Surgeons. 3rd ed. vol-2. New York: Harper and Row, 1982; 436-45.
3. Joanne M .Willey, Linda M .Sherwood, Christopher J .Woolverton. Prescott's Microbiology, 9th edition: MacGraw Hill Education 2013 Aug; 742.
4. John Macleod. Macleod's clinical examination, 12th edition: Churchill Livingstone 2009 June; 202.
5. Keith L. Moore, T. v. n Persaud. The digestive system. The developing Human: Clinically oriented Embryology. Eighth Edition. Newyourk. New delhi, Elsevier publication, 2008; 224.
6. Michels NA. The variational anatomy of the spleen and the splenic artery. American Journal of Anatomy 1942; 70: 21-72.
7. Rao S, Setty S, Katikireddi RS. Morphometric Study of Human Spleen. Int J Biol Med Res. 2013
8. Charware PN, Belsare SM, Kulkarni YR, Pandit SV, Ughade JM. The Morphological Variations of the Human Spleen. Journal of Clinical and Diagnostic Research. 2012 April, Vol-6(2): 159-162
9. Choudhari ML, *et al.* Morphological variations of human spleen and its clinical significance, IJMRR, January – February ,2014, vol.2, issue1
10. Sangeeta M, Varalakshmi KL, Sahana BN. Cadaveric study of morphometry of spleen. J Med Sci Health 2015; 1(3):14-17
11. Moore KL. Clinically Oriented Anatomy. 3rd ed. Baltimore: Williams and Wilkins, 1992; 187.
12. Asghar A, Naaz S, Agharwal D, Sharma PK. Morphometric study of spleen in North Indian adult population: CT scan image based study. J ClinDiagn Res 2011; 5: 974-7.

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