

# The Morphological Variations of the Human Spleen

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## ABSTRACT

**Introduction:** The spleen is an important lymphatic organ in the human body. Its immunological and haematological functions are being well realized now-a-days. The aim of this study was to find out the morphological variations of the spleen and to compare them with the findings of previous studies.

**Materials and Methods:** The present study included 111 human cadaveric spleens. 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. Accessory splenic tissues, if they were present, were noted.

**Results:** The lengths of the spleens varied between 5 cm to 13 cm, with an average of 9.66 cm. Their breadth was between 3.5 and 9.5 cm. The average breadth was 6.22 cm. Their widths varied between 1.5 and 5.5 cm, with an average of 3.06 cm. The weights of the spleens showed great variations, ranging between 80 and 300 gm, with an average of 145.76 gm. Various shapes of the spleens were observed in the present study.

Most of the spleens were wedge shaped [61.26%], followed by tetrahedral [21.61%] and triangular [12.61%] shapes. Additional oval and irregular shapes of the spleens were observed in 3.60% and 0.09% cases respectively. 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 [74.76%], the notches were found on the superior border. The number of notches varied from zero to six, but in most of the cases [58.55%], there were 1 or 2 notches. Accessory spleens were found in 4.50% cases, in the form of roundish nodules. They were observed at the hilum of the spleen.

**Conclusion:** The findings of the present study will be of fundamental importance to the physicians, surgeons and radiologists and of course, this knowledge is very important for the anatomists during their routine classroom dissections.

**Key Words:** Spleen, Splenic variations, Accessory spleen

## INTRODUCTION

In humans, the spleen is the largest lymphatic organ. It is connected to the blood vascular system. It consists of a large encapsulated mass of lymphoid and vascular tissues. It is situated in the left hypochondrium and partly in the epigastrium, between the fundus of the stomach and the diaphragm. The shape of the spleen varies from a slightly curved wedge to a domed tetrahedron [1]. The size and weight of the spleen vary with age [1]. In adults, it is usually 12 cm long, 7 cm broad and 3 to 4 cm wide. Its average adult weight is 150 gm, but the normal range is wide, between 80 and 300 gm [1,2]. The spleen has two surfaces; superolateral or diaphragmatic and inferomedial or visceral; it has two poles, the anterior and the posterior; it has two borders, superior and inferior [1,2,3]. The diaphragmatic surface is convex and smooth. The visceral surface is irregular and it is marked by gastric, renal, colic and pancreatic impressions. The posterior pole usually faces the vertebral column. The anterior pole is broad and it is directed laterally. On the superior border, near the anterior pole, there may be one or two notches, persisting from the lobulated form of the spleen in early foetal life. The additional collection of fully functional splenic tissue may exist near the spleen, which is called as accessory spleen [1]. Accessory spleens are found at the hilum of the spleen, in the gastrosplenic ligament and in the lienorenal ligament in the greater omentum,

along the splenic vessels and along the pancreas, but rarely in the scrotum [2,4,5,6].

The filtration of unwanted elements from the blood by phagocytosis is the major function of the spleen [7]. In the foetal life, the spleen manufactures erythrocytes and after birth, it produces lymphocytes. The spleen is the centre where both the B and T lymphocytes multiply and play an important role in the immune responses. The spleen is the only site where an immune response can be started against antigens which are present in the circulating blood [but are not present in the tissues] [8]. Thus, the spleen performs both haematological and immunological functions. However, the importance of the spleen in protection from infection was neglected and it was thought that the other lymphatic organs of the body could take over its functions. But a series of animal experiments and patients' follow up studies revealed its actual importance in protection from blood born sepsis, where its role as a blood filter was found to be very significant [9,10].

Hence, now, despite the overwhelming indications for splenectomy, like traumatic rupture, hypersplenism, neoplasia, splenic cyst, etc., the present tendency of the surgeons is to try for conservative management and to conserve as much splenic tissue as possible. Thus, the knowledge of the variational anatomy of the spleen is of

fundamental importance. So, the aim of this study was to find out the variations in the morphology of the spleen.

### MATERIALS AND METHODS

The present study was conducted in the anatomy departments of Shree Vasantrao Naik Government Medical College, Yavatmal and Indira Gandhi Government Medical College, Nagpur. The study included 111 human adult cadaveric spleens. Apparently normal human cadaveric spleens of both the sexes were selected. Out of the 111 spleens, only 15 specimens of the spleen belonged to female cadavers. As only very less number of spleens of female cadavers were available, it was difficult to do a comparative study between the males and females. So, spleens from both sexes were added together and a statistical analysis was done, without considering the sexual dimorphism.

To remove the spleens from the abdominal cavity, they were detached from their various attachments and the splenic vessels were cut near the hilum after ligation. Then they were washed with tap water to clean the debris and the fatty tissue. The shapes of all spleens were noted. They were weighed on an electronic weighing machine and their lengths, breadths and widths were measured. As in the study which was done by Michels [3], we considered the greatest distance between the two poles of the spleen as its length, the greatest distance between two points at the same level on the superior and inferior borders as its breadth and the greatest width as the width of the spleen. We measured these values with the help of spreading and sliding calipers. The borders, surfaces and poles of the spleen were determined. The notches on the borders and the impressions on the surfaces of the spleen were observed carefully. Accessory spleens, if they were present, were searched for at the hilum of the spleen. The data which was thus obtained, was tabulated, statistically analyzed and compared with that of previous studies.

### RESULTS

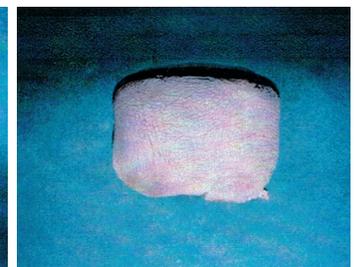
In the present study, out of 111 spleens, 68 [61.26%] were wedge shaped [Table/Fig-1] and [Table/Fig-6], 24 [21.62%] were tetrahedral [Table/Fig-2] and [Table/Fig-6], 14 [12.61%] were triangular [Table/Fig-3] and [Table/Fig-6], 4 [3.60%] were oval [Table/Fig-4] and [Table/Fig-6], and 1 [0.90%] was irregular [Table/Fig-5] and [Table/Fig-6] in shape. 104 [93.69%] spleens had weights in the range of 80 to 300 gm, with a maximum number i.e. 73 [65.76%] of specimens with weights in the range of 80 to 150 gm [Table/Fig-7]. The average weight of the spleens was 145.76 gm.

In the present study, the lengths of the spleens varied between 5 cm and 13 cm, with an average length of 9.66 cm. But in most of the spleens i.e. in 78 specimens [70.27%] the length was in the range of 9 cm to 12 cm [Table/Fig-8] and [Table/Fig-11]. Their breadth was observed to vary between 3.5 cm and 9.5 cm, with an average breadth of 6.22 cm. But in 69 spleens [62.16%], the breadth was in the range of 5.5 cm to 7 cm [Table/Fig-9] and [Table/Fig-11]. It was found that the widths of the spleens varied from 1.5 cm to 5.5 cm, with an average width of 3.06 cm. In most of the spleens i.e. in 80 [70.07%] specimens, the width was in the range of 2.5 cm to 3.5 cm [Table/Fig-10].

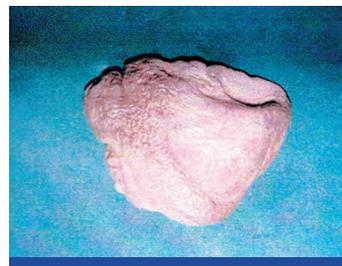
In all the spleens two poles, two borders and two surfaces were observed. The diaphragmatic surface of the spleen showed a uniform morphology, while its visceral surface showed gastric, renal, colic and pancreatic impressions due to their pressure on the spleen. In most of the specimens i.e. in 83 spleens [74.76%],



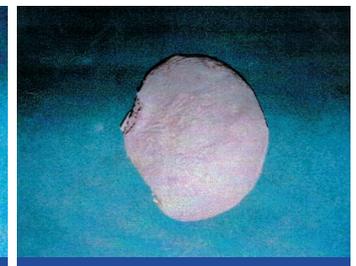
[Table/Fig-1]: Wedge shaped spleen



[Table/Fig-2]: Tetrahedral spleen



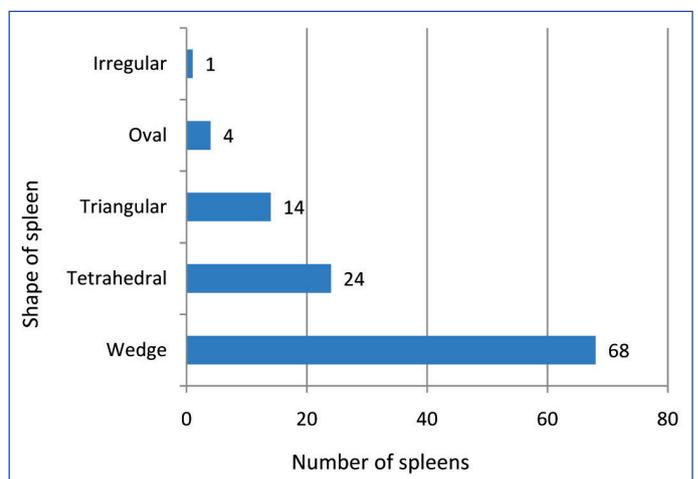
[Table/Fig-3]: Triangular spleen



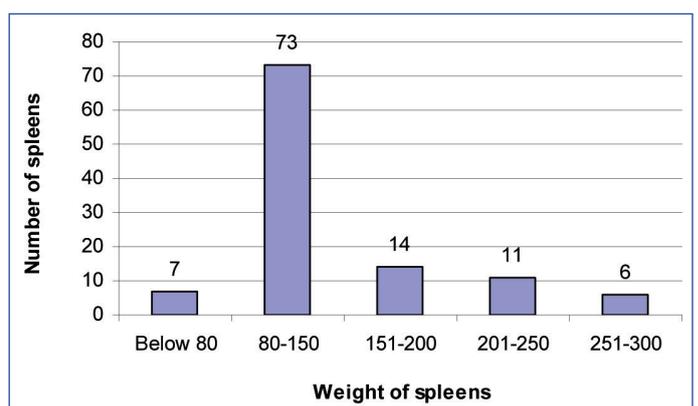
[Table/Fig-4]: Oval spleen



[Table/Fig-5]: Irregular spleen



[Table/Fig-6]: Variations in the shape of spleen



[Table/Fig-7]: Variations in the weight of spleen

Sr. No.	Length (cm)	No. of specimen	Percentage
1	5.0	1	0.90
2	5.5	2	1.80
3	6.0	2	1.80
4	6.5	3	2.70
5	7.0	4	3.60
6	7.5	7	6.30
7	8.0	4	3.60
8	8.5	6	5.40
9	9.0	12	10.80
10	9.5	11	9.90
11	10.0	6	5.40
12	10.5	10	9.00
13	11.0	17	15.31
14	11.5	13	11.71
15	12.0	9	8.10
16	12.5	3	2.70
17	13.0	1	0.90

**[Table/Fig-8]:** Variations in length of spleen  
 Mean=9.66 cm, Mode=11cm, Standard deviation=1.79

Sr. No.	Breadth [cm]	No. of specimen	Percentage
1.	3.5	2	1.80
2.	4.0	7	6.30
3.	4.5	6	5.40
4.	5.0	6	5.40
5.	5.5	16	14.41
6.	6.0	26	23.42
7.	6.5	19	17.11
8.	7.0	8	7.20
9.	7.5	4	3.60
10.	8.0	7	6.30
11.	8.5	4	3.60
12.	9.0	4	3.60
13.	9.5	2	1.80

**[Table/Fig-9]:** Variations in breadth of spleen  
 Mean = 6.22cm, Mode = 6 cm, Standard Deviation = 1.33

Sr. No.	Width [cm]	No. of specimen	Percentage
1.	1.5	8	7.20
2.	2.0	10	9.00
3.	2.5	41	36.93
4.	3.0	23	20.72
5.	3.5	16	14.41
6.	4.0	5	4.50
7.	4.5	3	3.60
8.	5.0	4	3.60
9.	5.5	1	0.90

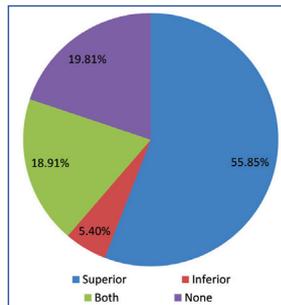
**[Table/Fig-10]:** Variations in width of spleen  
 Mean = 3.06 cm, mode = 2.5 cm, Standard Deviation = 0.93



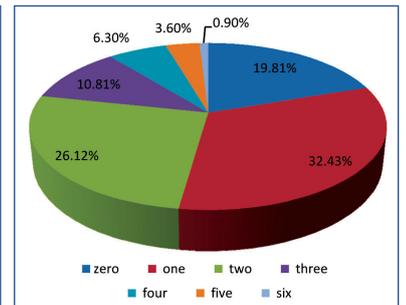
**[Table/Fig-11]:** Variations in the size of spleens



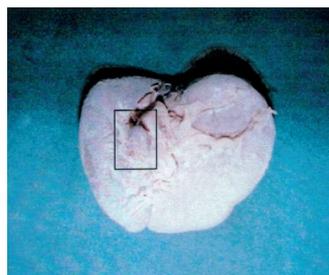
**[Table/Fig-12]:** Exaggeration of notches on spleen



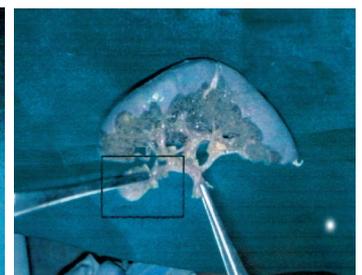
**[Table/Fig-13]:** Border of spleen showing presence of notch



**[Table/Fig-14]:** The number of notches observed on spleen



**[Table/Fig-15]:** Accessory spleen



**[Table/Fig-16]:** Blood supply of accessory spleen

form of roundish nodules, approximately of the size of a peanut and they were supplied by one of the branches from the splenic artery [Table/Fig-16].

**DISCUSSION**

The spleen is a mystery organ whose structural and functional relationships have started being realized only now. As reported by Michels [3] and as mentioned in Gray's anatomy [1], in the present study also, so many variations were found in the morphology of the spleen.

In the present study, five different shapes of the spleen were observed. Amongst those, the most common one was the wedge shape (61.26%), followed by the tetrahedral (21.62%) and the

triangular (12.61%) shapes. This was not in accordance with the findings of previous studies [2,3] in which the wedge shape was found in 44% specimens, the tetrahedral shape in 42% and the triangular shape in the remaining 14% specimens. As opposed to the findings of previous studies, additional oval (3.60%) and irregular shapes (0.90%) of the spleen were also observed in the present study.

The present study has shown similar observations for the size of the spleens as in previous studies. In the present study, the length of the spleen varied from 5 to 13 cm, with an average of 9.66 cm. The breadth varied from 3.5 to 9.5 cm, with average of 6.22 cm and the width was between 1.5 cm and 5.5 cm, with an average of 3.06 cm. The mean values of the length, breadth, and width of the spleen in our study were, 9.66 cm, 6.22 cm and 3.06 cm respectively, which were 11cm, 7cm and 3cm in the study which was done by Michels [3]. In the Textbook of Gray's Anatomy [1], these values have been mentioned as 12 cm, 7 cm and 3 to 4 cm respectively.

As was seen in the earlier studies [2], in our study also, the weight varied between 80 and 300 gm, except in 6.30% of the specimens, in which it was below 80 gm. The average adult weight of the spleen is 150 gm, which varies from 80 to 300 gm [1]. In our study, the average weight of the spleens was 145.76% gm. The values for the length, breadth, width and weight of the spleen in the present study were slightly lower than those which were reported from previous studies. 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.

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 [4]. Sometimes, this lobulated appearance may persist in the spleen. That is why we can get many notches on the spleen, which can be seen 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 present study were in accordance with those of the earlier studies [2,3]. During the development of the spleen, small masses of the splenic tissue may become detached from the main mass and may develop into accessory spleens [11]. In the

present study, accessory spleen was found in 4.50% specimens. But some research workers [2,5,6] reported the incidence of the accessory spleen to vary from 10 to 35% specimens. They found the accessory spleen at the hilum of the spleen, in the gastrosplenic ligament, in the greater omentum, along the splenic vessels, along the pancreas and in the scrotum also. But in the present study, only the hilar region was taken into consideration, which may be the reason why we found only a small number of accessory spleens. Awareness on the possible presence of the accessory spleen is of importance, because if they are not removed during splenectomy, they may result in the persistence of the symptoms which indicated the removal of the spleen (eg. splenic anaemia) [12].

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, this knowledge is very important for anatomists during their routine classroom dissections.

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