

Original Research Article

# MORPHOLOGICAL STUDY OF SPLEEN AND VARIATIONS IN SOUTH INDIAN POPULATION

M.Chelladurai <sup>\*1</sup>, J. Sujitha Jacinth <sup>2</sup>, T.Ramamani <sup>3</sup>, G.Subbulakshmi <sup>4</sup>.

<sup>\*1</sup>Assistant Professor, Department of Anatomy, Institute of Road Transport Perundurai Medical College, Perundurai, India.

<sup>2</sup>Associate Professor, Department of Anatomy, Rajah Muthiah Medical College, Annamalai University, Chidambaram, India.

<sup>3</sup>Deputy Director of Leprosy, Government Head Quarters Hospital, Erode, India.

<sup>4</sup>Professor and Head, Department of Anatomy, Institute of Road Transport Perundurai Medical College, Perundurai, India.

## ABSTRACT

**Background and Aim:** The spleen is the largest lymphoid organ in the human body. It is highly vascular and friable. It is affected in various clinical conditions like infections and storage functions. The aim of the study is to find out the morphological variations of spleen. The present study is undertaken to report the prevalence of variations involving weight, length, breadth, width (thickness) and the number of notches of spleen in the cadavers of South India population.

**Materials and Methods:** The study was done in 50 human adult cadaveric spleens of both sexes preserved in 10% formalin. The weight, length, breadth, thickness were measured and the number of notches present were noted.

**Results:** The weight of fifty spleens studied varied from 80- 200gm in 43(86%), 201-300gm in 6 (12%) and above 300gm in 1(2%) , the length of the spleen on the visceral surface measured from upper pole to lower pole varied from 6-9cm in 25(50%) and 10-15 cm in 25 (50%) .The breadth of the spleen varied from 2-5 cm in 16 (32%) specimen, 6-9 cm in 32 (64%) specimen and 10-13 cm in 2 (4%) specimen respectively. The width (thickness) taken at the midpoint of the spleen varied from 2-4 cm in 48 (96%) specimen and 5-6 cm in 2 (48%) specimen respectively. In the present study the number of notches varied from zero to six, but in most of the specimens there were one or two notches. However accessory spleen was not found at the hilum of the spleen.

**Conclusion:** The findings of the present study will be of fundamental importance to the physicians, surgeons and radiologists. It also furnishes much insights on clinical utility and significance of spleen.

**KEYWORDS:** Spleen, Lymphoid organ, Morphology.

**Address for Correspondence:** Dr. M. Chelladurai, Assistant Professor, Department of Anatomy, Institute of Road Transport Perundurai Medical College, Perundurai, India.

**E-Mail:**

Access this Article online	Journal Information
<b>Quick Response code</b>  DOI: 10.16965/ijar.2019.199	<b>International Journal of Anatomy and Research</b> ICV for 2016 90.30 ISSN (E) 2321-4287   ISSN (P) 2321-8967 <a href="https://www.ijmhr.org/ijar.htm">https://www.ijmhr.org/ijar.htm</a> DOI-Prefix: <a href="https://dx.doi.org/10.16965/ijar">https://dx.doi.org/10.16965/ijar</a> 
	Article Information
	Received: 12 Apr 2019 Peer Review: 12 Apr 2019 Revised: None
	Accepted: 20 May 2019 Published (O): 05 Jun 2019 Published (P): 05 Jun 2019

## INTRODUCTION

In human, the spleen is the largest lymphoid organ and it belongs to the reticulo-endothelial system. It is present in the left hypochondrial

region. The shape of the spleen varies from a slightly curved wedge to a domed tetrahedron. The size and weight of the spleen vary with age and sex. In adults, it is usually 12 cm long, 7cm

broad and 3 to 4 cm wide. Its average adult weight is 150gm, but the normal range is wide, between 80 and 300 gm. 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. 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. Accessory spleen may be found at the hilum of the spleen, gastrosplenic ligament, lienorenal ligament, greater omentum, along the splenic vessels and the pancreas, but rarely in the scrotum[1]. The spleen is normally lobulated in foetus but disappears before birth. In the adults one or more notches may be seen in the superior border near the anterior pole indicating the development from several lobes[2]. Congenital anomalies of the spleen include absence of spleen, lobulation, polysplenia and accessory spleens.

The spleen is the most vascular organ in the human body which is involved in the regulation of circulating blood volume. Approximately 350 liters of blood passes through it per day. The spleen receives approximately 5% of the cardiac output and 40% source of the blood in the portal circulation. The spleen contains about one unit of blood at a given time, 25% of total lymphocytes in the body, 30 to 40 ml of mature RBC and one-fourth of the circulating platelets. The size of the spleen is used as an indicator of disease activity in a variety of reticuloendothelial system. Measurement of the splenic length in the routine clinical practice is a very good indicator of actual splenic size. 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 is protection from blood born sepsis, where its role as a blood filter was found to be very significant. At present total splenectomy is replaced by partial splenectomy by surgeons. Hence this study is carried out to study the morphology of spleen and its variations.

## MATERIALS AND METHODS

The present study was carried out on 50 embalmed cadavers of both sexes in the Department of Anatomy, Institute of Road Transport Perundurai Medical College, Perundurai. Specimens with destructed surface and margins by any mechanical, pathological and other conditions were excluded from the study. Dissection was done following Cunningham's manual of practical anatomy[3]. Spleen is detached from various attachments and splenic vessels were cut near the hilum after ligation. Then splenectomy was done. They were washed with tap water to clean the debris and fatty tissue. The specimens were preserved in 10% formalin. The weight, length, width, breadth, were measured and the number of notches present were noted. The weight of the spleen was measured using the electronic weighing machine. The length was the greatest distance between the two poles of the spleen. The greatest distance between two points at the same level on the superior and inferior borders is its breadth and the thickness of the spleen was measured at the midpoint of both the visceral and parietal surfaces[4]. These values were measured with the help of unstretchable inch tape and Vernier caliper. The number of notches on the borders and impressions on the surfaces of the spleen were also observed. Presence of accessory spleen at the hilum was also noted. The data collected were tabulated, statistically analysed and compared with previous studies.

## RESULTS

The weight taken from 50 specimens varied from 50-200 gm in 43 specimens (86%) and from 201-350 gm in 6 specimens (12%) and above 350 gm in 1 specimen (2%) as shown in Table 1. In the present study the length of the spleens varied from 6-9 cm in 25 (50%) and 9-15 cm in 25 (50%) specimen as shown in Table-2. The

breadth of the spleen varied from 2-5 cm in 16 (32%) specimen, 5-9 cm in 32 (64%) specimen and 9-13 cm in 2 (4%) specimen respectively as shown in Table 3. The thickness of the spleen varied from 2-4 cm in 48 (96%) and 4-6 cm 2 (4%) specimen respectively as shown in the Table 4. In the present study the number of notches present in superior border varied from one to two in 43 specimens (86%) and 3 to 6 in 7 specimens (14%) as shown in Table 5 and Fig.1. Impression of rib as deep groove was noticed in diaphragmatic surface of spleen in one specimen Fig.2. No accessory spleen was observed in the present study.

**Fig. 1:** Showing notches on superior border of spleen.



**Fig. 2:** Showing rib impression in diaphragmatic surface of spleen.



**Table 1:** Weight of spleen.

Weight	No of Specimens	%
50-200 gm	43	86
201-350 gm	6	12
Above 350 gm	1	2
Total	50	100

**Table 2:** Length of spleen.

Length (cm)	No of Specimens	%
6-9 cm	25	50%
9-15 cm	25	50%
Total	50	100

**Table 3:** Breadth of spleen.

Breadth (cm)	No of Specimens	%
2-5 cm	16	32%
5-9 cm	32	64%
9-13 cm	2	4%
Total	50	100

**Table 4:** Width of spleen.

Width (cm)	No of Specimens	%
2-4 cm	48	96%
4-6 cm	2	4%
Total	50	100

**Table 5:** Number of notches.

No of Notches	No of Specimens	%
1 - 2	43	86%
3 - 6	7	14%
Total	50	100

## DISCUSSION

The spleen is a haemo-lymph organ because of the following reasons: (a) Spleen filters blood by taking out worn-out erythrocytes or any microbial antigens from the circulation, where as lymphnode filters lymph (b) In foetal life spleen manufactures erythrocytes and after birth it manufactures lymphocytes (c) Each splenic lymphatic follicle is traversed eccentrically by an arteriole and is surrounded by the red pulp. The spleen is the major repository of mononuclear phagocytic macrophage cells in the red pulp and of lymphoid cells in the white pulp [5].

The spleen is developed from mesoderm within the dorsal mesogastrium, where it appears at first as a number of lobules of the splenic tissue. These lobules join together to form a single splenic mass which projects under cover of the left layer of the dorsal mesogastrium. The presence of the splenic notches affecting the upper border of the adult organ indicates the lobulated development of the spleen. The appearance of the spleen in the dorsal mesogastrium divides the latter into the gastro-splenic ligament in front and the lienorenal ligament behind. Regarding the histogenesis of the spleen the primordium of the splenic tissue differentiates into a number of the branching



trabecular cords and numerous free cells which are entangled between the trabeculae. The isolated free cells are subsequently differentiated into the erythroblasts, myeloblasts and lymphoblasts. The haematopoietic function of the spleen continues during foetal life, and regresses after birth. Production of lymphocytes, however, continues in the post-natal period. The appearance of the splenic vessels and the formation of the sinusoids allow elimination of the worn-out erythrocytes, leucocytes and platelets from the circulating blood by the phagocytic activities of the reticulo-endothelial cells of the splenic sinusoids [6].

Spleen phylogeny is highly complex. It was proposed from a primitive type with a closed circulation, characteristic of monotremes, insectivores and tree shrews, to archetypal type with open circulation, peculiar to mice, gerbils, bats and marsupials. Further evolved into blood-storing spleens (ungulates and carnivores) and defensive spleens (old world monkeys and rodents). Xenarthra group of placental mammals which are represented by anteaters, sloths, armadillos show haemopoiesis with open circulation. With the appearance of blood-forming bone marrow, splenic erythropoiesis was no longer essential. This resulted in the spleen to become more involved in immunological processes and developed a specialized white pulp. In mammalian spleens the white pulp reached the highest degree of specialization among all vertebrates. Thus spleen further evolved in man to defensive and sinusoidal type. Defensive type was characterized by the predominance of white pulp in comparison to red pulp [7].

The weight of spleen varied between 80 to 250 grams according to Bergman et al [8], Kawale Sugat G et al [9], Hollinshead [10]. Kharat Vidhya Shankarrao and Garud Rajendra [11] in their study on 50 spleens showed the weight from 54 grams to 583 grams with a mean value of 143.74 grams. In a study done by Sivanageswara Rao et al [12] the weight of spleen was reported to be from 80 to 250 grams. Sangeetha et al [13] reported the range of weight of spleen from 53 to 444 grams. According to Bahiru Tenaw et al [14] the weight varied from 45.72 to 331.41 grams with an

average of 147.40 grams. Lizamma Alex et al studied the weight of spleen in 70 spleens out of which 45 males and 25 females. They plotted the weight changes in a graph. It was observed that the weight of males ( $88.29 \pm 36.65$ ) exceeded that in females ( $71.60 \pm 29.67$ ) in all age groups [15]. Chaware et al quoted that the weight of spleen varied from 80 to 150gms with an average of 145.76gms in their study on 111 spleens. [16].

In a study on 50 spleens the length of spleen was in range of less than 5cm in 2, 5cm to 7cm in 8, 7.1cm to 9cm in 32 and more than 9cm in 8. Breadth was observed to be less than 4cm in 4, 4.1cm to 6cm in 41 and more than 6cm in 5 spleens. Width of spleen was less than 2cm in 1, 2.1cm to 4cm in 40 and more than 4cm in 9 [9]. In another study on 50 spleens the length of spleen varied from 7.5cm to 14.7cm with a mean value of 11cm. Breadth of spleen varied from 6cm to 11cm with an average of 8.5cm. Width varied from 3cm to 8.5cm with a mean value of 5.7cm [11]. Chaware et al reported the length of spleen from 5 to 13 cm with a mean of 9.66cm, breadth from 3.5cm to 9.5cm with an average of 6.22cm and width of spleen from 1.5cm to 3.5cm with a mean of 3.06cm [16].

Das et al [17] showed the presence of notches on the superior border of spleen in 98%. Skandalakis et al [18] quoted it as 78.6%, in 50% by Sateesha et al [19]. The percentage incidence of spleens with absence of notches as reported by Girish et al and Kharat Vidya et al [11] were 1.67% and 6% respectively. In the present study no such variation is observed.

Presence of notches on the superior margin is useful for the physician to palpate the spleen during enlargement of spleen [20]. Splenomegaly in unnotched spleens may be misdiagnosed as renal swelling on left costal margin by surgeons suggesting the importance of splenic notches in clinical practice. But renal swelling has resonant sound on percussion, slight movement on respiration, ballotability, bimanually palpable and insunation of hand in between renal swelling and anterior abdominal wall. The spleen is less notched in anthropoids but more common in lower monkeys. Carnivores have been found to have notches on all its borders and some animals like ox, sheep, goat and horse have no

notches. The unnotched spleens are a feature of Rodentia.

As seen in the earlier studies, in this study also, the weight varied between 80 and 300gm, except in 2% of the specimens, in which it was above 300gm. The values of the length, breadth, weight and width of the spleen in the present study had variations. This may be due to the differences in the genetic factors, body constitution, geographical conditions, feeding habits and the better socioeconomic status. 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.

## 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. 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.

**Conflicts of Interests: None**

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**How to cite this article:** M.Chelladurai, J. Sujitha Jacinth, T. Ramamani, G. Subbulakshmi. MORPHOLOGICAL STUDY OF SPLEEN AND VARIATIONS IN SOUTH INDIAN POPULATION. Int J Anat Res 2019; 7(2.3): 6663-6667. DOI: 10.16965/ijar.2019.199