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Original Research Article

A Morphological Study of Spleen and Variations in the Population of Assam

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ABSTRACT

Background
The largest and most significant lymphatic organ in the human body is the spleen. These days, its hematological and immunological actions are fully appreciated. 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.

Methods
The present study was conducted on 65 human spleens after getting the ethical clearance. Specimens were collected depending on the availability of cadavers or unclaimed autopsy bodies. The morphological features of the spleen like its length, breadth, width and weight were measured. The shape, poles, borders, surfaces, notches and the impressions on the spleen were observed. Accessory splenic tissues, if they were present, were noted. The sample size was calculated using mobile app nCalculator Application.

Results
Out of 65 spleens, 40(61.54%),14 (21.53%),8(12.61%),2 (3.08%) 1(1.50%) were wedge, tetrahedral, triangular, oval and irregular in shape respectively. Most of the spleens had weights in the range of 80 to 300 gm, the lengths varied between 7.4 cm and 14.3 cm, the breadth varied between 3.3 cm and 9.9 cm, the widths varied from 2

cm to 8 cm. In all the spleens two poles, two borders and two surfaces were observed. In 54(83.08%) specimens, splenic notches were found on the superior border but in 11(16. 92%) on the inferior border. Accessory spleen was found in 6(9.23%) specimens.

Conclusions

The findings of the present study will be 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

The spleen is an important and largest lymphatic organ in the human body[1]. Its immunological and haematological functions are being well realized these days. The spleen is a capsulated mass of rich vascular and lymphoid tissue that is situated in the left hypochondrium below the left 9th, 10th and 11th ribs. The splenic artery supplies spleen, which typically arises from celiac artery via hepatolieno-gastric trunk[2]. 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[3]. 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[2,3,4]. 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[2,3,4,5]

The filtration of unwanted elements from the blood by phagocytosis is the major function of the spleen[6]. 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 not present in the tissues[7]. 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[8,9].

Blunt abdominal trauma and road traffic accidents may cause splenic injury, resulting in internal haemorrhage. A total or partial splenectomy can be done depending upon the severity of the case. It is better to do a partial splenectomy to preserve the immunity and haematological functions, particularly in children. At present, partial splenectomy is preferred because it preserves immunity. During splenic surgery, particularly in resection of segment of spleen, ligation of branches of splenic artery is necessary. The knowledge of the morphological variational anatomy of the spleen is of fundamental importance for surgeons, physicians and radiologists. The morphological study of the spleen is very less in the North-East India, particularly in Assam. So, the present study was done to find out the variations in the morphology of the spleen in the population of Assam.

MATERIALS AND METHODS

The study was carried out in Lakhimpur Medical College, North Lakhimpur, Assam and Gauhati Medical College, Guwahati, Assam. Sixty five cadaveric spleens were studied by dissection method[10]. The retrieval of spleen from the abdominal cavity was done by standard dissection method[10]. During retrieval of specimens, we also looked for accessory spleens. Then, the spleen was washed under tab water and the debris and the fatty tissue were cleaned. The blood clots were also washed out and removed by using plain forceps. The specimen was again washed with normal saline. The spleen was dissected meticulously to find out its borders, notches, accessory spleens in the hilum, in the lienorenal and gastrosplenic ligament along the course of the splenic vessels and paraspenic areas. The shapes of spleen and splenic notches were observed. Morphometric measurements like weight, length, breadth and width was measured and noted. The Spleens were preserved in 10% formalin solution.

Inclusion criteria

- Normal specimens of cadaveric/autopsies spleens with intact splenic vessels.

Exclusion criteria

- Injured or lacerated spleen.
- Congenital malformations of the spleen
- Pathological abnormalities of the spleen.

RESULTS

In the present study, out of 65 spleens, 40 [61.54%] were wedge shaped [Fig-1], 14 [21.53%] were tetrahedral [Fig-2] and 8 [12.61%] were triangular [Fig-3], 2 [3.08%] were oval [Fig-4] and 1 [1.50%] was irregular Fig-5] in shape [table 1, fig. 9]. Most of the spleens had weights in the range of 80 to 300 gm, with a maximum number i.e. 53 [81.52%] of specimens with weights in the range of 100 to 200 gm [Table 2 and Fig-10]. The average weight of the spleens was 148.3 gm. The lengths of the spleens varied between 7.4 cm and 14.3 cm, with an average length of 10.55 cm. But in most of the spleens i.e. in 47 specimens [72.3%] the length was in the range of 9 cm to 12 cm [Table 3 and Fig- 11]. Their breadth was observed to vary between 3.3 cm and 9.9 cm, with an average breadth of 6.18 cm. But in 56 spleens [86.30%], the breadth was in the range of 4.0 cm to 7.9 cm [Table 4 and Fig- 11] It was found that the widths of the spleens varied from 2 cm to 8 cm, with an average width of 4.85 cm [Table 5 and Fig.1]). In most of the spleens i.e. in 56 [86.157%] specimens, the width was in the range of 3.0 cm to 5.9 cm [Table 5]. In all the spleens two poles, two borders and two surfaces were observed. In most of the specimens i.e. in 54 spleens [83..08%], splenic notches were found on the superior border, but in 11 spleens [16. 92%], the notches were found on the inferior border also [Fig- 7]. The number of notches varied from zero to six, but in most of the specimens [58.55%] there were one to three notches [Fig-7, 8 and 12]. Among the 65 specimens, accessory spleen was found in 6 (9.23%) specimens [Fig-2,6]. They were in the form of roundish nodules, approximately of the size of a peanut and they were supplied by one of the branches from the splenic artery [Fig-6]. The accessory spleens were observed at the hilum of the spleen, along the superior and inferior borders of the spleen and also within lienorenal ligaments.

Sr. No.	Shapes of spleen	No. of specimens	Percentage
1	Wedge	40	61.54

2	Tetrahedral	14	21.53
3	Triangular	8	12.31
4	Oval	2	3.08
5	Irregular	1	1.54
Table 1- Variations in shapes of spleens			
Sr. No	**Weight (gm)**	**No. of specimens**	**Percentage**
1	50-99	5	7.69
2	100- 149	30	46.16
4	150- 199	23	35.38
5	200- 249	4	6.15
6	250- 299	3	4.62
Table 2- Weight of the spleens			

Sr. No	**Length (cm)**	**No. of specimens**	**Percentage**
1	7.0 – 7.9	3	4.62
2	8.0 – 8.9	4	6.15
3	9.0- 9.9	20	30.77
4	10.0 -10.9	15	23.08
5	11.0 -11.9	12	18.46
6	12.0 -12.9	6	9.23
7	13.0- 13.9	3	4.62
8	14.0- 14.9	2	3.07
Table 3-: Variations in length of spleen			

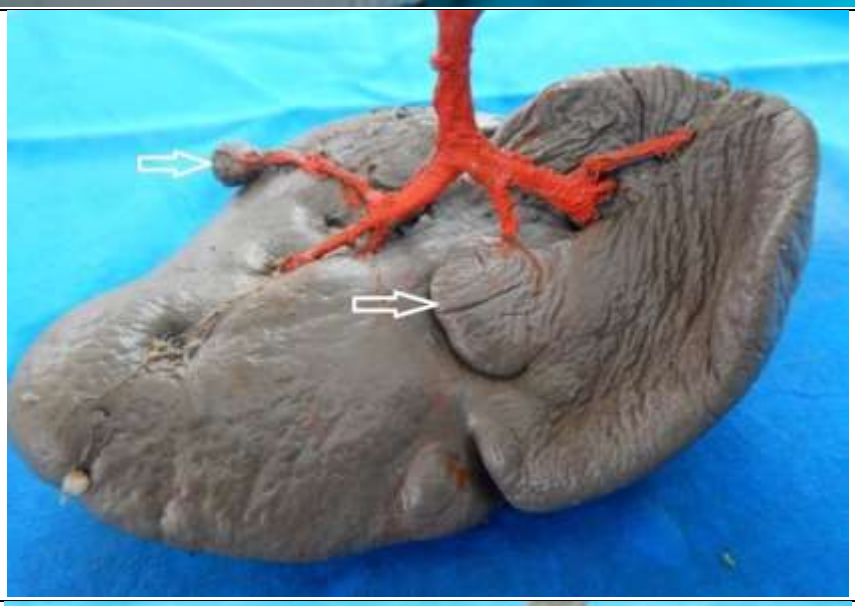
Sr. No	**Breadth(cm)**	**No. of specimens**	**Percentage**
1	3.0-3.9	3	4.62
2	4.0- 4.9	4	6.15
3	5.0-5.9	27	41.53
4	6.0- 6.9	18	27.70
5	7.0-7.9	7	10.77
6	8.0-8.9	3	4.62
7	9.0-9.9	2	3.08
8	10.0-10.9	1	1.53
Table 4-Variations in breadth of spleen			

Sr. No	**Width(cm)**	**No. of specimens**	**Percentage**
1	2.0- 2.9	2	3.08
2	3.0-3.9	8	12.30
3	4.0-4.9	30	46.16
4	5.0-5.9	18	27.70
5	6.0-69	4	6.15
6	7.0-7.9	2	3.08
7	8.0-8.9	1	1.53
Table 5-Variations in width of spleen			

	***Fig. 1- Wedge shaped spleen***
	***Fig. 2- Triangular spleen***

Fig. 3- Tetrahedral spleen

Fig. 4- Oval spleen

	***Fig. 5- Irregular spleen***
	***Fig.6- Accessory spleen with its blood supply***
	***Fig. 7- Splenic notches in both upper and lower borders.***

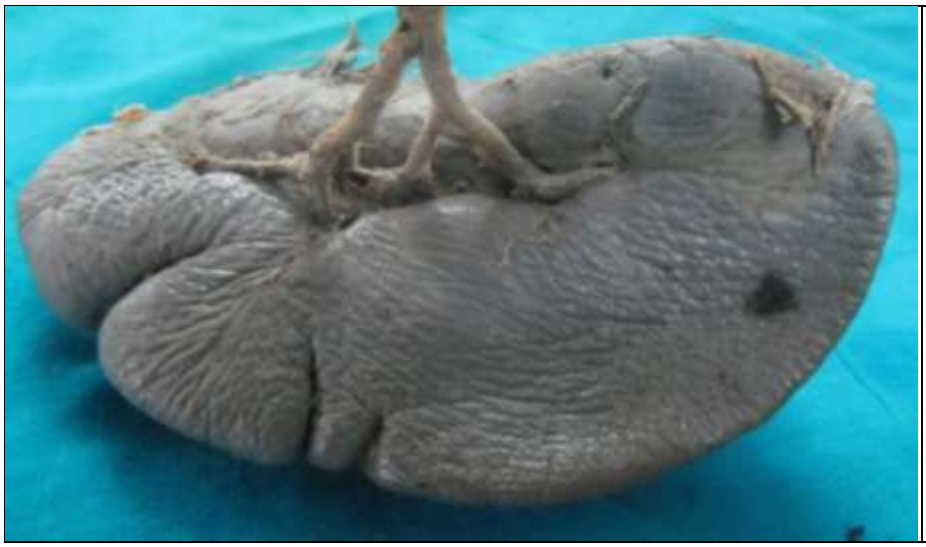


Fig 8- Three splenic notches in upper superior borders of spleen

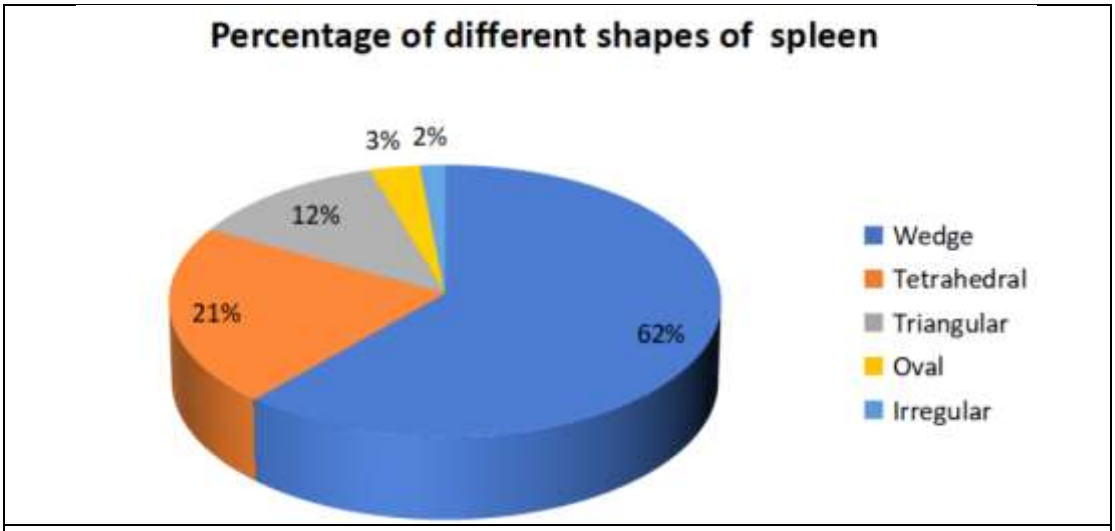


Fig. 9- Percentage of different shapes of spleen

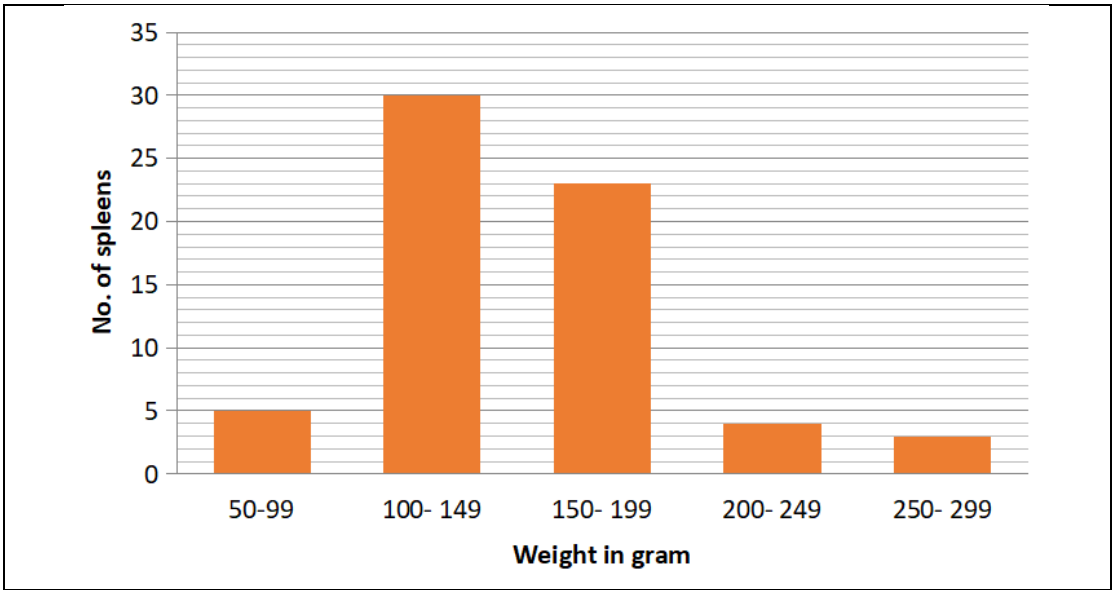


Fig. 10- Weight of spleens in gram

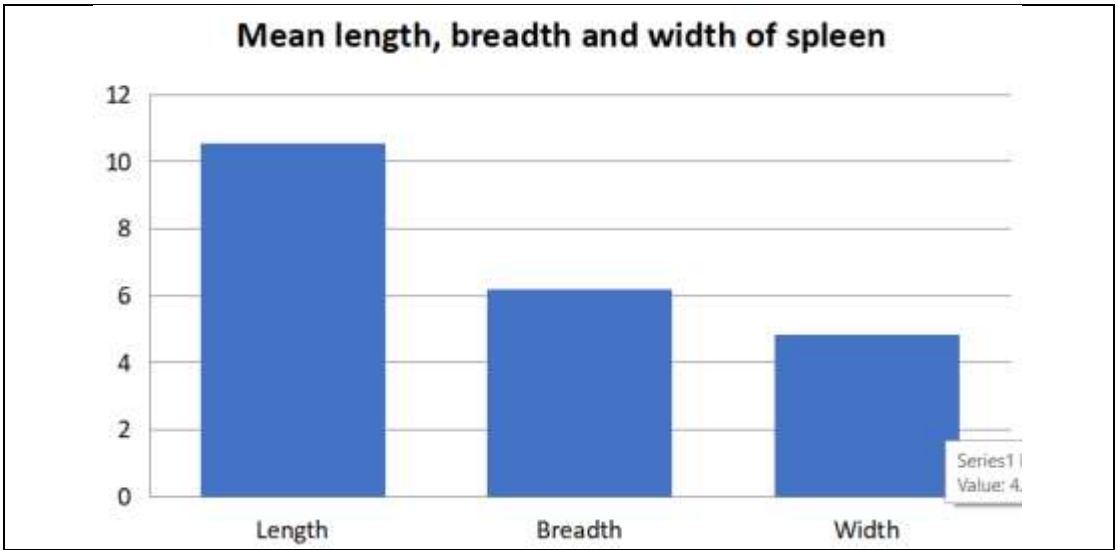


Fig. 11- Mean length, breadth and width of spleens(in cm).

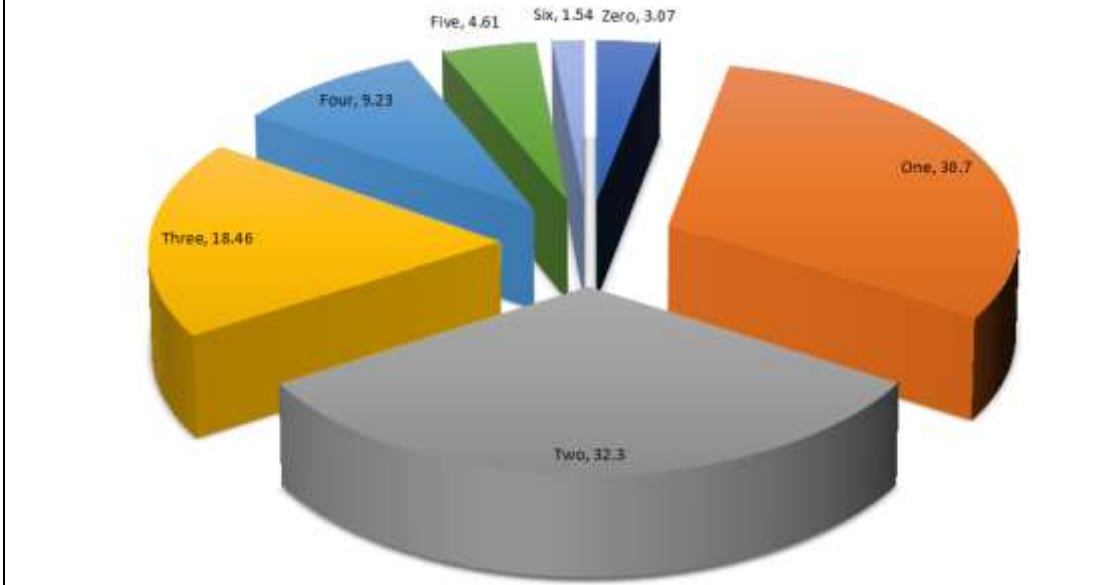


Fig. 12- Number of notches found in the spleen

DISCUSSION

The structure and functions of the spleen are still unknown, making it a mystery organ that has only recently come to light. The morphology of the spleen showed numerous variations, as noted by Michels[2] and Gray's anatomy[3], as well as in this work.

The spleen was seen in five distinct morphologies in the current investigation. The wedge form (61.54%), tetrahedral (21.53%) and triangular (12.31%) shapes were the most prevalent among them. This was in variance with other research findings which showed that 44% of specimens had a wedge shape, 42% had a tetrahedral shape, and 14% had a triangular shape[2,3]. There were more oval (3.08%) and irregularly shaped (1.50%) spleens discovered, in contrast to the results of earlier research but similar findings of Chaware at al[11]. Similar findings regarding the spleen's size were found in the current study as well as earlier research. The spleen measured an average of 10.55 cm in length in this study, ranging from 7.4 to 14.3 cm. The breadth varied from 3.3 to

9.9 cm, with an average of 6.18 cm and the width ranged from 2.0 to 8 cm, with an average of 4.08 cm. The spleen's length, breadth, and width had mean values of 10.55 cm, 6.18 cm, and 4.85 cm in our study, compared to 11 cm, 7 cm, and 3 cm in Michels' study[2]. These values have been listed as 12 cm, 7 cm, and 3 to 4 cm, respectively, in the textbook of Gray's Anatomy[3].

The weight varied between 80 and 300 gm in our investigation as well as was seen in the previous research[4]. The spleen ranges in weight from 80 to 300 grams, with an average mature weight of 150 grams[3,4]. The average weight of the spleens in our investigation was 148.3% grams. The discrepancies could be caused by variations in North East India's genetic makeup, body composition, geographic location, eating habits, and socioeconomic standing compared to other parts of India and the world.

The mesoderm gives rise to the spleen. Different lobules are produced throughout development and later fuse with one another. The adult spleen's notched superior border is indicative of lobulation[12]. This lobulated look in the spleen might occasionally persist. This explains why the spleen has several notches, which are visible mainly on superior border but inferior border also contains the notches. In our 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 usually one to three splenic notches were observed. The current study's findings were consistent with those of previous investigations[6,13].

Small masses of splenic tissue may separate from the main mass during spleen development and evolve into accessory spleens[14]. In 6 (9.23%) specimens in the current investigation, accessory spleen was noticed. However, according to certain researchers[12,15,16] the occurrence of the accessory spleen in specimens might range from 10% to 35%. The accessory spleen was discovered near the spleen's hilum as well as in the larger omentum, gastrosplenic ligament, splenic arteries, pancreas and scrotum (rarely). However, the current investigation solely examined the hilar region, lienorenal ligaments, gastrosplenic ligaments and parasplenic areas; this could be the cause of the low number of accessory spleens we observed. Understanding whether an accessory spleen may exist is crucial, because if it remains after splenectomy, it could lead to the persistence of symptoms (such as splenic anemia) that imply no splenic removal[4].

CONCLUSIONS

A fundamental understanding of the anatomical variations of the spleen is necessary for radiologists to perform diagnostic procedures, clinicians to conduct routine clinical examinations of the abdomen, surgeons to perform spleen-related surgical procedures and anatomists to perform routine classroom dissections. Because some diseases like thalassemia and malaria are so prevalent in the North-Eastern region of India, the morphological differences of the spleen are extremely important.

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