IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 4 Ver. VIII (Apr. 2016), PP 39-42
www.iosrjournals.org

Spleen Morphology with Clinical Significance and a Bilobed Spleen –A Legacy from the Past!

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Abstract: *Spleen is the largest organized lymphoid tissue in the human body. It is the primary haemopoeitic organ in mammalian evolution. Morphological variations of spleen are plenty which are well documented in literature. In the present study of 50 human cadaveric spleens we observed morphological variations and compared these with similar findings by other authors. We also observed an extremely rare variation of 'bilobed' spleen. Bilobed spleen is a normal finding in Platypus, an extant species of monotremes that are egg-laying mammals. The aim of the study was to study the splenic variations, to understand their clinical significance and to find out phylogenetic history of a bilobed spleen -a legacy from the past!*
Keywords*: Bilobed spleen, evolution, variations.*

I. Introduction

Spleen is the largest organized lymphoid tissue in the human1. Usually described as wedge shaped, having diaphragmatic smooth surface and visceral surface related to the surrounding abdominal organs in the left hypochondrium. Size and shape varies with age, sex and other factors. It develops as a mass of mesenchymal cells within dorsal mesogastrium2.The differentiated proliferating cells become condensed, vascularized and fuse to form fetal lobulated spleen. Postnatally it is represented as a single encapsulated lymphoid mass with the presence of a notch or notches on its superior border- a probable remnant of the earlier lobulated form3.

In the evolution , platypus (*Ornithorhynchusanatinus*), an extant species of monotremes4shows 'spleen' as the primary haemopoeitic organ5 .The spleen is bilobed and surrounded by a thick capsule of collagen, elastic fibers and few smooth muscle fibers6.Functionallyit showsprimitive spleen with a closed circulation, negligible blood storage capacity and non-sinusal7.

II. Material And Method

We studied 50 spleens removed from the embalmed cadavers in the Department of Anatomy, Bharati Vidyapeeth Deemed University Medical College, Pune, Maharashtra, India. After careful removal from the cadavers the spleens were preserved in 10% formalin solution. Each spleen was dried on a tissue paper and measurements were taken. The length ,breadth, and thickness of the spleens were measured with Digital calipers (Baker type RD 10), graduated in mms. The weight was measured by digital weighing scale (Table top model MSTT III, Ace Corporation). After noting down the measurements, all the spleens were observed for non – metrical variations in shape, presence or absence and number of notches, fissures, and accessory spleens.Followingobservations were noted - mean length, breadth, thickness of spleens were 110mms, 85 mms, and 57 mms respectively. Different shapes of spleen noted were Wedge 44, Scaphoid 01, 'V' shaped 02,Accessory spleen 01, Wedge shaped with fissure on diaphragmatic surface 01,Bilobed spleen 01,mean weight of spleens was 143.74 gms, weight of bilobed spleen was 121 gms, and accessory spleen was 108 gms. Spleens with smooth superior border were 03(Table 1).

One 'Bilobed spleen' was observed (Fig. 1, Fig.2).It had the following features -Length 75mms, Breadth 85mms, Thickness 50 mms, Weight 121gms.Diaphragmatic surface of spleen was not smooth but showed an unusual deep fissure which had divided the spleen into two lobes forming a 'Bilobed Spleen'. Length of diaphragmatic fissure was 48mms with a maximum depth of 10mm.Each lobe of spleen had its individual hilum. It showed openings of splenic vessels related to the upper lobe, two openings of scattered splenic vessels near the lower lobe. The visceral surface also showed a fissure of 30 mm length .Impressions on the visceral surface were seen. Superior border showed four notches.

III. Discussion

Until the first half of twentieth century spleen was not considered significant but later spleen's role in immunity and circulation have attracted great attention of research workers 8.Spleen begins to develop during

the 6th week as a mass of mesenchymal cells located within dorsal mesogastrium. Gene targeting experiments show that Capsule in a basic helix loop transcription factor &Homeobox genes-NKX2-5, HOX 11, Bapx 1 regulate the development of Spleen. Spleen is lobulated in fetal life but the lobules normally disappear before birth. The notches on the superior border of the adult spleen are remnants of the grooves that separated the fetal lobules2.

Notches on superior border and inferior border of spleen have attracted attention of many workers all over the world. Their findings are noted in Table 2 and are compared with the findings in the present study.

The reasons for notches and fissures of human spleen could be due to remnants of an ancestral arrangement such as lobulation or they are formed by some mechanical cause connected with growth of spleen and surrounding viscera. Spleen is larger in flesh eating(carnivora) and notching is correlated with the increased size of the organ 13 .Number of notches, whether on superior or inferior border varied between 1 to 3. More than 4 notches on the superior border were rare 11. Parsons observed less notches in Anthropoids but more in lower monkeys and Lemurs. Splenic fissures were noted on its diaphragmatic surface in only 1 or 2 spleens in a study of 100 samples by Srijit Das. Splenic fissure has also been reported by Nayaket al9.
UngorBahadyret al reported 7.8% incidence of splenic fissure on the diaphragmatic surface.

The spleen phylogeny is highly complex because spleen has mesenchymal origin and insertion is in hematic circulation and not in lymphatic7.Mammals have different types of spleen. Phylogeny of Spleen was proposed from a 'primitive type' with closed circulation (characteristic of monotremes, insectivores and tree shrews), to 'archetypal type' with open circulation (peculiar to mice, gerbils, bats and marsupials), further into 'blood-storing'spleens (ungulates and carnivores) and 'defensive' spleens (Old World monkeys and the majority of rodents) 7. Monotremata, Insectivora, Scandentia and Cetacea show a 'primitive splenic type' distinguished by a closed circulation7. Tanaka Y states that the intermediate zone (IZ) of spleens of primitive mammals (shrew, mole, platypus) may be representative of primitive mammalian spleens that have closed circulation14.
Xenathra group of placental mammals which are represented by ant eaters, sloths,armadilos, shows haemopoesis in accordance with their phylogenetic basal position and have open circulation7.

Carnivora have relatively more splenic weight, a capsule and trabeculae rich in smooth muscle cells indicating contractibility. Therefore Carnivore spleen can store and release blood. Though platypus is a carnivore, the amount of erythrocytes that can be accumulated in the spleen of Monotremata (platypus), is negligible15. Different ecological demands led to different morphologies of the spleen but also that the same demand led to tissue specialization that was species specific15.

With the appearance of blood-forming bone marrow, splenic erythropoiesis was no longer essential7. This resulted in, the spleen becoming more involved in immunological processes and developed a specialized white pulp.7In mammalian spleens, the white pulp reached the highest degree of specialization among all vertebrates.15

'Defensive type', was characterized by the predominance of white pulp in comparison to red pulp7. High specialization of the immune function of the spleen (defensive type) is a common character of all mammals (including monotremes and marsupials).The development of the blood-storing properties could be due the ecological pressures on evolutionary process14.

The complexity of splenic phylogeny may lie in the mesenchymal origin of this organ, the presence of other lymphoid organs and its peculiar insertion in the hematic (rather than lymphatic) circulation7.

IV. Conclusion

In mammals ,the spleen could have evolved from a 'primitive type' with a closed circulation and bilobed spleen in platypus (monotreme) to 'archetypal' with open circulation in mice, bats, marsupials and further evolved in man to 'defensive' and 'sinusal' type. Therefore, knowledge of the differences between the 'splenic types' is not only useful in the field of comparative physiology, but it may also provide some helpful indications in the study of mammalian evolution15.

The splenic notches are rare but significant, hence anatomical variation should be considered in the differential diagnosis of scintigraphic defects16. Bilobed spleen may cause confusion in ultrasound and scanning examinations. The radiologists must be aware of various splenic variations to interpret the findings, and to avoid the confusion for labeling them as an abnormality17.

The surgeons must be aware of the presence of scattered blood vessels during any procedures on spleen. The clinicians must be aware of increased number of notches on the superior border during palpation of spleen. The notches may be misinterpreted as splenic laceration in patients with abdominal trauma 17.
Bilobed spleen is rare but significant, and therefore must be remembered to interpret the diagnosis correctly.

In our study a very rare bilobed spleen was found. Bilobed spleen is normal occurrence in platypus, an extant egg laying monotreme .A review of the phylogeny of the spleen was taken and a bilobed spleen in human can be considered as an isolated legacy from the past. This 'Legacy' could definitely interest the anthropologists and further support the concept of 'ontogeny recapitulates phylogeny'!

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Table 1

Sr. No	Parameters	Description	No of spleens	Mean value
1	Length	75mms to147mms	50	110mms
2	Breadth	60mms to 110mms	50	85mms
3	Thickness	30mms to 85mms	50	57mms
4	Shape	Wedge	44	
		Scaphoid	01	
		V shaped	02	
		Accessory spleen-	01	
		Wedge shaped with fissure on diaphragmatic surface	01	
		Bilobed spleen	01	
5	Weight	54 gms to 583 gms	50	143.74 gms
		Accessory spleen	01	108 gms
		Bilobed spleen	01	121gms
6	Notches	Smooth superior border	03	
7	Additional features	Bilobed spleen	01	
		Wedge shaped with fissure on diaphragmatic surface	01	
		Accessory spleen	01	

Table 2

Notches on superior border			
Sr. No.	Name	Country	Incidence
1	Nayaketal9	South India	50%
2	Skandalakisetal9	America	78.65 %
3	Ungor etal9	Turkey	95%
4	Rayhanetal10	Dhaka	88.75
5	Das et al11	Malaysia	98%
6	Present study	India	96%
Notches on Inferior border			
Sr. No.	Name	Country	Incidence
1	Das et al	Malaysia	2
2	Muktyaz Hussein, et al12	North India	12.5%
3	Our study	India	10

Figure 1: Bilobed spleen as seen from diaphragmatic surface

Figure 2: Bilobed spleen as seen from visceral surface