ORIGINAL ARTICLE

A STUDY OF REGIONAL ANATOMY OF SPLEEN

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ABSTRACT: INTRODUCTION: The spleen is very important organ with versatile functions for physicians, surgeons, hematologists. It has wide anatomical variations in its size, shape, weight, volume, blood supply, relations with neighboring organs and in relation to age of the individual. In fact it is a wonder organ with very important functions but not mandatory for sustenance of life. **AIM OF THE STUDY:** To study anatomical variations of spleen such that they may also be useful for clinicians. **MATERIAL AND METHODS:** 50 cadaver spleens, 8 fetal spleens and 200 individuals with ultra-sonograms of spleen (Not diseased) are searched for variations. **OBSERVATIONS:** Wide variations were observed with adult spleens. **SUMMARY & CONCLUSIONS:** Up to 40 years of age there is increase in all parameters and decreased from 40 to 70 years of age studied.

KEYWORDS: Embalmed Cadaver – Hypochondrium - Diaphragm Hilum - Splenic Artery - Pancreas Ultra Sono Graphy - Splenectomy.

INTRODUCTION: The spleen is an enigmatic organ with a peculiar anatomy and physiology. Though our understanding of this organ has improved vastly over the years, the spleen continues to produce problems for the Surgeon, Physicians, Haematologist and the patient. The history of spleen is full of fables and myths, but it is also full of realities. It has been with in the past 50 years that the most significant advances in the knowledge of the spleen and splenic surgery have been made.(1)

Spleen is largest lymphoid organ in the body. It lies deep in the left hypochondrium wedged obliquely between diaphragm, stomach and left kidney. It develops from both coelomic epithelium and dorsal mesogastrium as separate masses each with its own blood supply and migrates to left hypochondrium.(2) Hence its position varies in normal people also. It may present as spleniculi, retroperitoneal masses through diagnostic challenges. Palpable notches of spleen are considered as hallmark of splenomegaly for physicians. They are always not felt. Notches are due to lobulated form of spleen in early foetal life. Size of the spleen is very varying normally. It varies is volume from 45 cm3 to 332 cm3. Weight varies from 80-300 grams.(3) An idea of size of spleen is important, to label as normal and abnormal. Spleen is palpable when it enlarges three times its size.

It plays important role in immunity and filtering of antibodies, senescent RBCs, foreign bodies. It serves as reservoir of platelets and marginated polymorphs. It is highly vascular. Each spleen has its own peculiar pattern of branching of splenic artery before entering hilum and variations in tributaries of splenic vein. Injury to spleen also may pose a threat to life because of heavy bleeding. Tip of the tail of pancreas may reach hilum of spleen. It is cut during splenectomy if care is not taken. A thorough knowledge of normal and variational anatomy of its site, size, shape, weight, volume and blood vessels, relation with left kidney are very essential.(4)

Ultrasound examination is highly sensitive, specific, safe, noninvasive, quick, mobile and less costly to access the spleen enlargement even much before clinically palpable.[5]

Keeping the above facts in mind an attempt is made to study the gross anatomy of spleen on both cadaveric specimens of adults, fetuses and by ultrasound examination.

AIM OF THE STUDY: Aim of the study is to evaluate gross anatomy of spleen both by cadaveric dissection and by ultra sound examination in life. The findings are to be correlated with each other, so that they will be better utilized in clinical practices.

MATERIALS AND METHODS: The present study is being done at Department of Anatomy, Osmania Medical College, and Hyderabad.

MATERIALS: The materials for the present study comprises of, 50 adult human spleens of the embalmed cadavers from dissection hall of our department and eight spleens of the dead fetuses collected from Government Maternity Hospital, Sultan Bazaar, Hyderabad. Ultrasound examination of abdomen for spleen is done in the department of Radiology and Imageology, Osmania general hospital, Hyderabad.

A. Spleens (Cadaver and Foetuses):

Instruments used to extract and study spleens from cadavers:

1. Scalpel.
2. Toothed Forceps and non-toothed forceps.
3. Scissors.
4. Divider.
5. Metal scale graduated in millimetres.
6. Ordinary scale.
7. Weighing machine.
8. Graduated Jar.
9. Vernier Calipers.

Method of extraction: After proper fixation Cadaver was taken out from tank and kept on dissection table in supine position. Sex of each Cadaver was noted. An incision was made from xiphisternum to symphysis pubis in the mid line, encircling umbilicus. The skin was reflected laterally. The abdominal muscles were cut transversely at the level of umbilicus and the flaps were reflected laterally. The peritoneum was opened. The visceral relations were noted, with the spleen in situ. The origin and course of splenic artery and splenic vein were observed. The right hand was passed into the left hypochondrium, the diaphragmatic surface of spleen, and ligaments of spleen were appreciated. After studying the spleen in situ it was removed from the abdomen by detaching, phrenicocolic, splenorenal and gastrosplenic ligaments and carefully separated from the stomach and pancreas. The spleen was thoroughly washed with water.

The shape, borders, surfaces, extremities and notches were noted. The weight was recorded and length and breadth were measured at its maximum dimensions with metal scale and thickness was measured at its maximum dimension with Vernier Calipers. All the

measurements were tabulated. The volume of spleen was determined by water displacement method by immersing the spleen in graduated Jar of 2 liters.

The maximum length and breadth of gastric, renal, colic and pancreatic (if present) impressions were recorded.

The splenic artery was traced from its origin; its branching pattern was noted. Splenic veins tributaries were noted.

The spleen was preserved in a plastic jar with 10% formalin.

B. Ultrasonographic Study of Spleen

Equipment used:

1. Aloka Ultrasound Machine.
2. 3.5 MHz Convex Probe.
3. Ultrasound Jelly.

Technique: Ultrasound examination was carried out by a qualified radiologist in the hospital and readings were recorded. For ultrasound evaluation of the spleen the patients were examined in left side up position (Right lateral decubitus position). This is the preferred position for better visualization. After applying the jelly in the left upper quadrant, the 3.5 MHz convex probe was angled obliquely between the ribs. In this position spleen will be seen superior to the left kidney. Normally nothing is seen between spleen and left hemi-diaphragm. The location, echo-pattern, relation, length, breadth of spleen and diameter of splenic vein were studied. The study was done on 200 patients aged between 10 to 75 years. All the measurements were tabulated.

OBSERVATIONS: The present study was undertaken on 50 adult cadaver (41 male & 9 female) spleen specimens. All information is tabulated.

A. Table 1. Different parameters of adult spleen.
B. Table 2. Different parameters of fetal spleen.
C. Table 3. Ultrasound measurements of spleen.

Similar study was performed by Rodrigues Junior et al.[6] on cadavers only.

Shape	No. of speci-mens	Branches of splenic artery before entering hilum	No. of Speci-mens	Tributaries of splenic vein	No. of speci –mens	Tail of pancreas	No. of speci -mens	Average volume LxBxW	Average weight	Volume (water displacement method)
Wedge shaped	39	3 branches	22	05	02	Not extending upto hilum	32	266.72	129.08	123.78
Tetrahedral	09	2branches	27	05	14	Extending upto hilum	18			
Triangular	01	4 branches	01	04	02					
Kidney shaped	01	3 branches	20							
		2 branches	11							
		01	01							

Table 1: DIFFERENT PARAMETERS OF ADULT SPLEEN

Anterior extremity	No. of specimens	Posterior extremity	No. of specimens	Superior border notches	No. of specimens	inferior border notches	No. of specimens	Intermediate border notches	No. of specimens	Impression of ribs	No. of specimens	Visceral impressions
Broad	34	Rounded	36	01	22	Absent	38	Absent	11	1 rib	02	Gastric-50 Colic-50 Renal-50 Pancr-18
Pointed	16	Pointed	14	02	14	One	09	Length 2-6 cms	39	2 rib	02	
				03	04	03	03			3 rib	05	
										absent	41	

DIFFERENT PARAMETERS OF ADULT SPLEEN (TABLE 1: CONTD…)

Shape	No. of specimens	Branches of splenic artery before entering hilum	No of specimens	Tributaries of splenic vein	No. of specimens	Tail of pancreas	No. of specimens	Average volume	Average weight	Volume in water displacement
Wedge shaped	06	3 branches	02	05	03	Not extending upto hilum	08	1-5cms	.85gm-4.95gms	123.78
Tetrahedral	02	2 branches	06	03	03					
				02	02					

Table 2: DIFFERENT PARAMETERS OF FOETAL SPLEEN

Anterior extremity	No. of specimens	Posterior extremity	No. of specimens	Superior border notches	No. of specimens	inferior border notches	No. of specimens	Intermediate border notches	No. of specimens	Impression of ribs	No. of specimens	Visceral impressions
pointed	04	Rounded	08	01	04	01	03	Absent	03	Absent	08	Nil
Broad	04			02	3	Absent	05	Length veries 0.5-2.5	05			
				03	01							

DIFFERENT PARAMETERS OF FOETAL SPLEEN (TABLE 2: CONTD…)

Age in years	Sex	Mean length in cms	Mean breadth in cms	Mean diameter of splenic vein in mms
10-15	M	8.9	4.4	4.3
	F	8.8	4.98	5.2
16-20	M	9.92	6.02	6.17
	F	8.98	4.46	5.6
21-30	M	9.8	5.1	5.6
	F	10.05	5.1	6
31-40	M	10.02	5.31	5.46

	F	10.22	4.96	6.23
41-50	M	9.7	4.9	5.8
	F	9.3	4.5	4.9
51-60	M	9.6	4.8	5.3
	F	8.6	4.16	5.1
61-70	M	9.4	4.7	4.0
	F	7.9	4.3	5.3

Table 3: ULTRASOUND MEASUREMENT OF SPLEEN

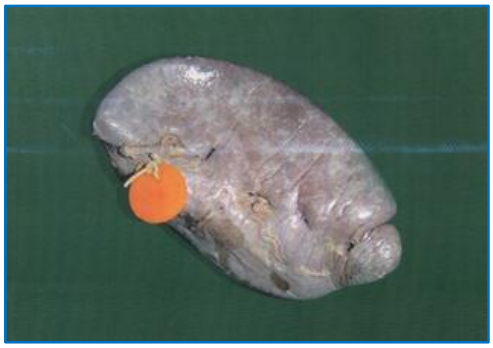

Fig. 1: Wedge Shaped Spleen

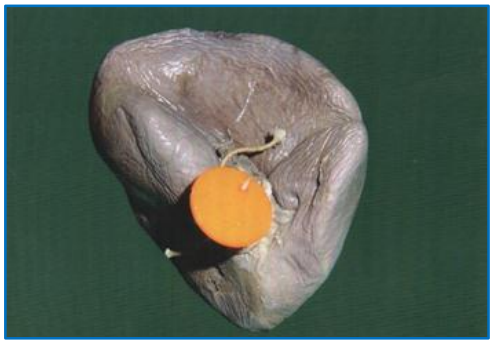

Fig. 2: Tetrahedral Spleen

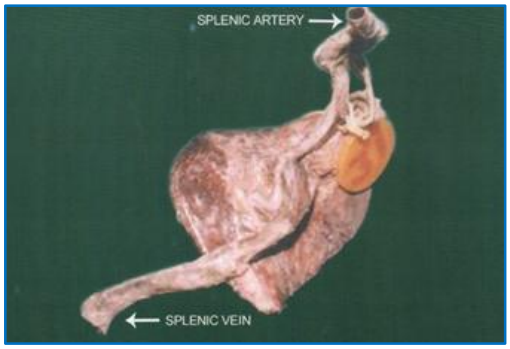

Fig. 3: Triangular Spleen

Fig. 4: Kidney Shaped Spleen

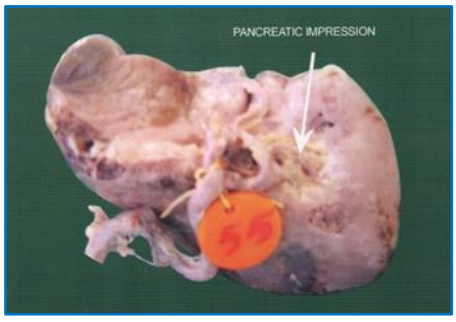

Fig. 5: Spleen Showing Pancreatic Impression

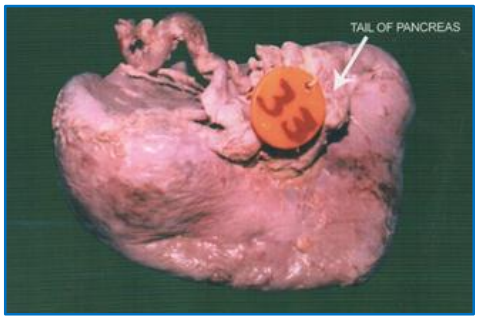

Fig. 6: Tail of Pancreas Extending Up to Hilum of the Spleen

Fig. 7: Diaphragmatic Surface of the Spleen

Fig. 8: Impression of Rib on the Diaphragmatic Surface of the Spleen

Fig. 9: Spleen with No Notch on the Superior Border

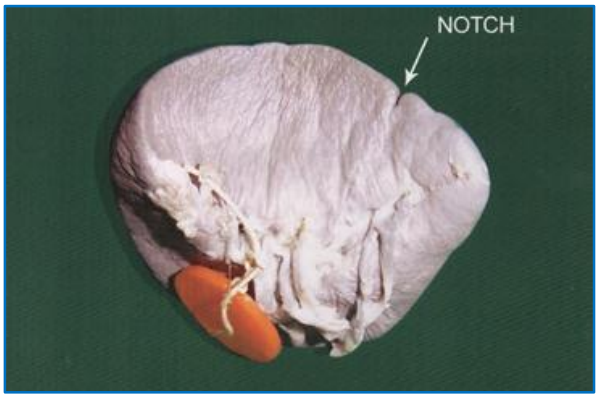

Fig. 10: Spleen with Single Notch on the Superior Border

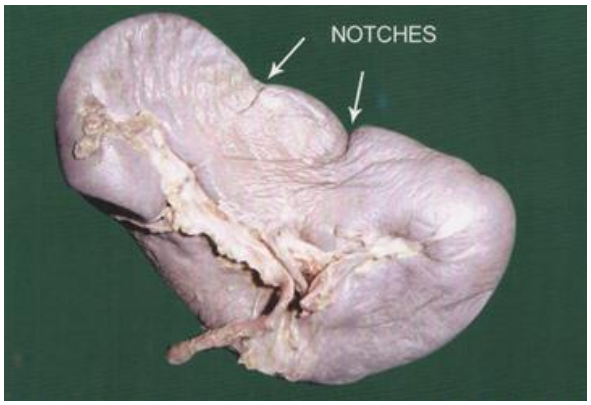

Fig. 11: Spleen with Two Notch on the Superior Border

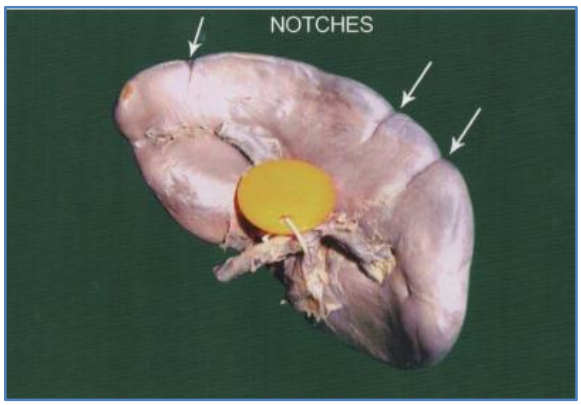

Fig. 12: Spleen with Three Notch on the Superior Border

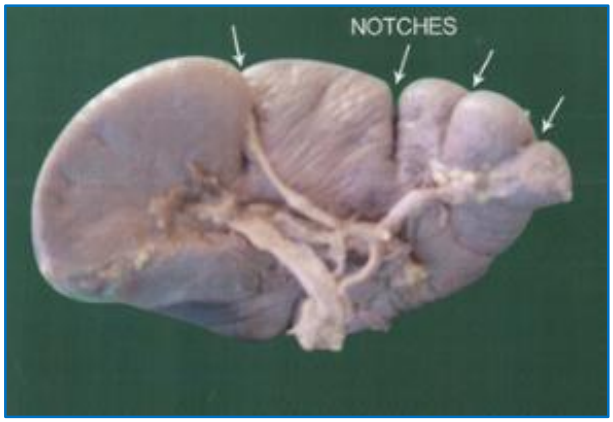

Fig. 13: Spleen with Four Notch on the Superior Border

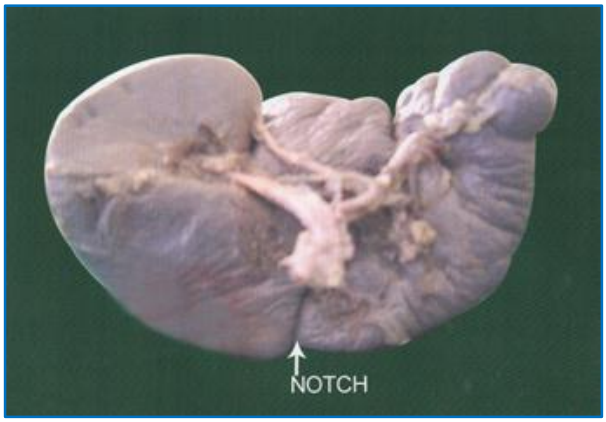

Fig. 14: Spleen with Single Notch on the Inferior Border

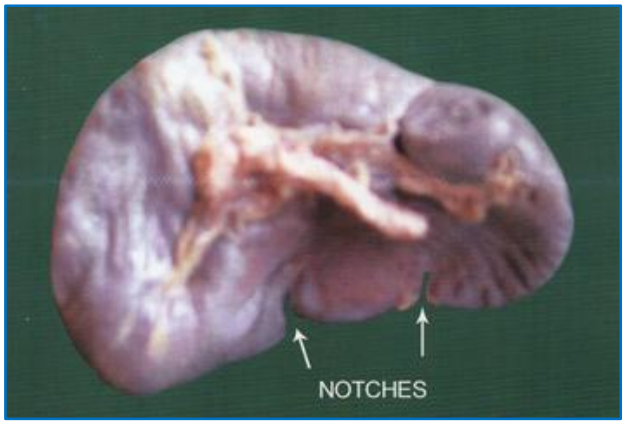

Fig. 15: Spleen with Single Notch on the Inferior Border

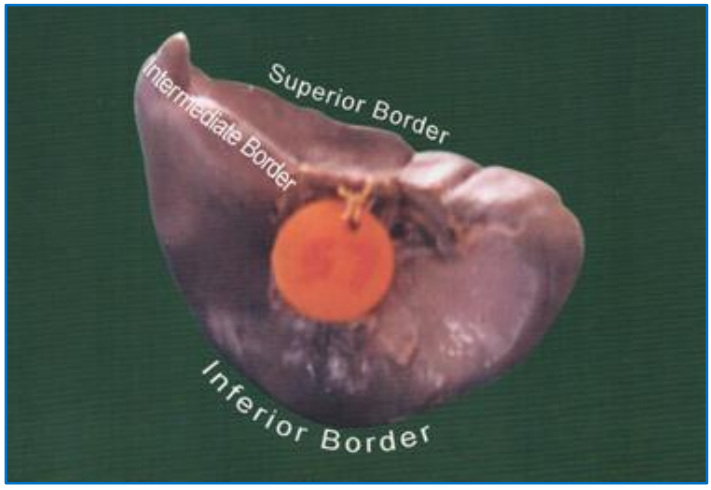

Fig. 16: Borders of the Spleen

Fig. 17: Extremities & Impressions of the Spleen

Fig. 18: Fetal Spleens

Fig. 19: Ultrasonographic Picture of Normal Spleen

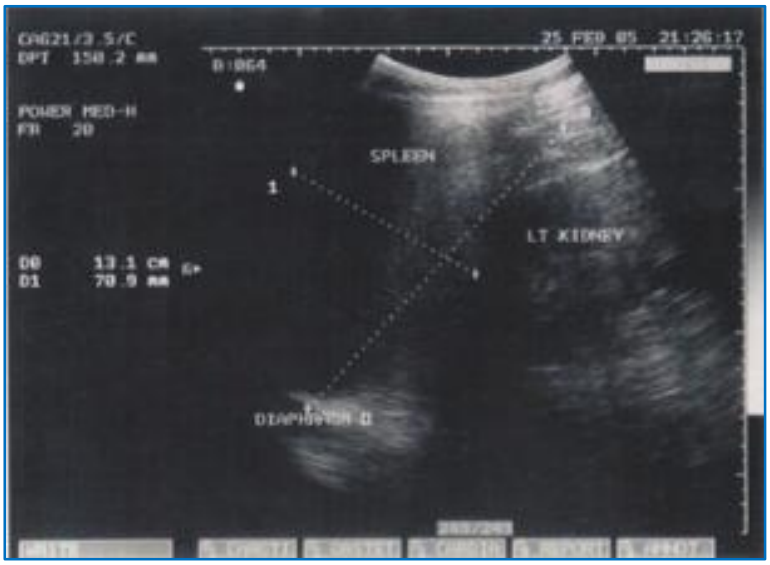

Fig. 20: Ultrasonographic Picture Showing Splenomegaly

SUMMARY AND CONCLUSION:

i. The location of spleen was in left hypochondrium in all the specimens.
The spleen was wedge shaped in 39 specimens (78%), tetrahedral in 9 specimen (18%), triangular in 1 specimen (2%) and kidney shaped in 1 specimen (2%).

ii. The average weight of an adult spleen was 129 grams, (SD = 66.88)

iii. The mean volume determined by water displacement method was 123.78 cm3 (SD = 66.48) and it is less when compared to western standards.

iv. The mean length of an adult spleen was 9.5 cm, breadth was 7.1 cm and thickness was 3.7 cm. The length of spleen is small compared to western standards.

v. The visceral surface was irregular and marked by impressions of gastric, renal, colic and pancreatic when present. The tail of pancreas was in contact with hilum of spleen in 36% of the specimens. Pancreatic impression was absent in fetal specimen.

vi. The diaphragmatic surface was smooth, impression of ribs were not conspicuous and seen only in eight specimens. Impression of ribs were absent in fetal specimens.

vii. The splenic artery was tortuous and originated, from celiac trunk, in all the cases. In fetal specimens splenic artery was not tortuous. The splenic artery divided into two branches in 54%, three branches in 44% and 4 branches in 2% of the cases, before entry into the hilum.

viii. The splenic vein was formed by 2 to 6 major tributaries. The splenic vein was formed by two tributaries in 22% from 3 tributaries in 40%. 4 tributaries in 4%, 5 tributaries in 28% and 6 tributaries in 4% of the specimens. In 2% only single vein was emerging out from the hilum.

ix. Broad anterior extremity was a common observation. Notches on the superior border were commonly seen, but 24% of specimens presented notches on the inferior border. Notches were lacking in 14% of the specimen.

x. Intermediate border was present in 78% of adult specimens and in 5 fetal specimens, out of eight.

xi. By ultrosonography it was observed that the mean length of spleen increased up to 40 years of age, followed by slight decrease in length from 41-70 years. Much difference was not observed between male and female individuals. The breadth of spleen and diameter of splenic vein did not show any correlation with age after puberty.

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