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A study on morphological variations of spleen in fetal and adult specimens and it's clinical significance

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ABSTRACT

Introduction: The spleen is the largest organ of lymphatic system in the human body with distinct circulatory and immunomodulatory functions. Therefore, comprehensive knowledge of splenic anatomical variations and dimensions are essential for early diagnosis, appropriate management and prevention of various infectious diseases and prevention of complications during splenectomy for surgeons.
Aim: The aim of the study is to find morphology of spleen in fetus specimens, morphology of spleen in adults and the incidence of variations in the morphology of spleen in both fetal and adult specimens.
Material and Methods: The present study included 40 fetal and 40 adult cadaveric spleen. The morphological features like shape, poles, borders, surfaces and the impressions of spleen were observed.
Results: In the Fetal group, most common shape observed was wedge or segment of an orange in 52.5%, tetrahedral in 35%, triangular in 7.5%. In the present study in adult specimens, 52.5% of spleen were tetrahedral, 35% were wedge or segment of an orange, 20% were triangular and 2.5% were oval in shape. Of total 80% of the spleen showed notches.
Conclusion: Exclusive knowledge of morphological variations, antenatal detection of splenic anomalies a re beneficial to elucidate developmental defects, early diagnosis and prompt treatment of intrauterine infections. The awareness of them morphological variations of spleen is of fundamental importance to the clinicians, radiologists, Hematologists and surgeons while performing surgical procedures on spleen.

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1. Introduction

The spleen is an enigmatic organ with a peculiar anatomical and physiological features. The history of the spleen is full of mysteries, but extensive research of structure and function of spleen in recent years, provided insights regarding the importance of spleen in human body.[1] Ayurveda, based on the humor doctrine, describes the spleen as "the root of the ducts which transport the blood".[2] Both Aristotle and Erasistratus thought that the spleen represented a left sided equivalent of the liver.[3] Hewson in 1780s, suggested that colourless corpuscles of spleen had a role in haemopoiesis.[4]

The spleen is the largest hemolymphatic organ in the human body which is closely associated with the circulating system, situated in the upper end left part of abdomen between the fundus of stomach and the diaphragm.[5] It lies mainly in the left hypochondriac and epigastric regions. It has diaphragmatic and visceral surfaces, superior and anterior borders. Diaphragmatic surface is smooth and convex, directed upwards, backwards and to the left.[6] Visceral surface presents gastric, renal colic and pancreatic impressions. Accessory spleens are present near the hilum of main spleen, within gastro splenic ligament, greater omentum and rarely left spermatic cord . Normally spleen is dark purple in colour. The shape of spleen is influenced largely by the stomach and left colonic flexure. When

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the stomach is distended the spleen resembles a "segment of orange", when colon is distended it has "irregular tetrahedral" shape [7–9] Liu divided the spleen into two primary lobes (superior and inferior), one accessory lobe, and three to five segments. [10]

The spleen in healthy adult humans is usually 12cm long, 7cm broad and 3–4cm wide. It's average weight is about 150 gm ranging between 80 gm to 300 gm, depending on the amount of blood in it. [5]

In the fetus, the spleen acts as a haemopoietic centre until late in the fetal period and lymphocyte-monocyte production continues throughout life. The spleen plays an important role in the immunomodulation [11] clearance of circulating apoptotic cells, differentiation and activation of T and B cells and production of antibodies in the white pulp.

The awareness of the variational anatomy of the spleen is essential to the surgeon during splenectomy as bleeding often results in significant perioperative mortality. Despite its clinical significance, spleen is very often prone to negligence. Splenomegaly and splenic anomalies are often accompani ed by complex congenital malformations, transplacental infection, immunological disorders, congestive heart failure, Thrombocytopenia and haemolytic anaemia.

Therefore, detailed knowledge of splenic variational anatomy is essential for early diagnosis, prevention and management of various infections and complications during splenectomy for surgeons. Effective Fetal detection and diagnosis of splenic abnormalities are beneficial to explain developmental defects.

2. Aim of the study

The aim of the study is to find morphology of spleen in fetus specimens, morphology of spleen in adults and the incidence of variations in the morphology of spleen in both fetal and adult specimens.

3. Materials and Methods

The present study is a prospective type of study conducted in the department of Anatomy, S.V. Medical College, Tirupati with cooperation of Government Maternity Hospital, Tirupati and Narayan a Medical College, Nellore. 40 dead fetuses of both sexes from 16 weeks of gestation to term and 40 adult spleen specimens of both sexes ranging from 10 to 70 yrs were collected and the specimens were preserved in 10% formalin. The collected data of both fetal and adult age groups were subjected to statistical analysis by computing the mean of each parameter with respect to the age – wise groups by using SPSS 20 version.

4. Results

In the present study the specimens were broadly categorized into Fetal and adult groups. The parameters studied are - 1. Colour 2. Shape 3. Poles 4. Borders 5. Surfaces 6. Presences of notches 7. Impressions. The Crown-rump length of all the fetuses were initially measured and fetal gestational age was calculated and the fetal specimens were categorized into 5 groups i.e., 16-20 weeks, 21-24 weeks, 25-28 weeks, 29-32 weeks and 33 weeks to Term. The following morphological parameters of Fetal and adult spleen were observed for location, distribution of splenic artery at hilum, relations of spleen and any presence of accessory spleen.

4.1. Analysis of the data of fetal group

The number of fetuses in 21-24 weeks group (5 specimens) were less when compared to the other groups. The largest group was fetuses with gestational age 16-20 weeks with 10 specimens and the gender-wise distribution is 57.5% and 42.5 % for male and female groups respectively.

In the present study in all the fetuses, 100% spleen was dark purple in color and was located in the left hypochondriac region with the normal ligamentous position without any variation.

4.2. Surface

All had smooth surfaces with impressions both on diaphragmatic and visceral surfaces.

4.3. Shape

In the present study out of 40 spleen of Fetal group studied, 21 spleen (52.5%) were wedge or segment of an orange, 14(35%) were tetrahedral, 3(7.5%) were triangular, one spleen showed twisted segment of an orange shape and one oval in shape respectively (2.5%).

In 100% spleen two poles, two borders and two surfaces were observed. The anterior pole was broad and posterior pole was rounded in tetrahedral spleen. The segment of an orange shaped spleen showed rounded shape at both poles and the triangular spleen had rounded anterior and broad posterior pole.

4.4. Notches of the spleen

The number of spleen showing the notches on the superior border and inferior border was found to be 22(55%) and 8 (20%) respectively. Although, in most of the specimens there were one or two notches but the number of notches varied from zero to six. However, no notches were observed in 16 spleen (40%).

4.5. Splenic artery distribution at hilum in fetal group

In the present study, the observation of splenic artery distribution at hilum predominantly showed two types of distribution a) Distributive in 31 specimens (77.5%) b) Magistral in 9 specimens (22.5%).

Table 1: Distribution of the sample with gestational age and gender

Group	Gestationalage (weeks)	Male (%)	Female (%)	Total (%)
A	16-20 Weeks	6 (26)	4 (23.5)	10(25)
B	21-24 Weeks	3(13)	2(11.7)	5(12.5)
C	25-28 Weeks	3(13)	6(35.7)	9(22.5)
D	29-32 Weeks	6 (26)	2(11.7)	8(20)
E	33 – Term	5 (22)	3(17.6)	8(20)
	Total	23 (100 %)	17(100 %)	40 (100)

Table 2: Observations of shape of the spleen in fetal group

		Shape				Total	Chi square value	p- value
		Oval	Segment of an orange	Tetrahedral	Triangular			
Sex	**Male**	1	10	17	2	30	2.159	.540
		3.3%	33.3%	56.7%	6.7%	100.0%		
	Female	0	4	4	2	10		
		0.0%	40.0%	40.0%	20.0%	100.0%		
Total		1	14	21	4	40		
		2.5%	35.0%	52.5%	10.0%	100.0%		

Table 3: Gender-wise distribution of number of notches at the Inferior border of spleen

		Notches Inferior border			Total	Chi-square Value	p-value
		0	1	2			
Sex	Male	18	5	0	23	1.929	.381
		78.3%	21.7%	0.0%	100%		
	Female	14	2	1	17		
		82.4%	11.8%	5.9%	100%		
Total		32	7	1	40		
		80.0%	17.5%	2.5%	100%		

Table 4: Splenic artery distribution in fetal group

		Splenic artery		Total	Chi-square value	p-value
		DT	MT			
Age	16 - 20 weeks	8	2	10	4.46	0.347
		80.0%	20.0%	100.0%		
	21 -24 weeks	5	0	5		
		100.0%	0.0%	100.0%		
	25 - 28 weeks	5	4	9		
		55.6%	44.4%	100.0%		
	29 - 32 weeks	6	2	8		
		75.0%	25.0%	100.0%		
	33-Term	7	1	8		
		87.5%	12.5%	100.0%		
Total		31	9	40		
		77.5%	22.5%	100.0%		

4.6. Accessory spleen

Among the 40 fetal specimens, one accessory spleen was found at the hilar region, in form of roundish nodule, approximately of the size of a peanut and it was supplied by one of the branches from the splenic artery.

4.7. Adult Group

The percentage distribution of the adult samples with respect to the age in years and gender were calculated and the gender-wise distribution was 75% and 25% for male and female groups respectively. The adult spleen were categorized in 6 groups as 0–19 Years, 20 – 29 Years, 30–39 Years, 40–49 Years, 50–59 Years and 60 – 69 Years and the largest group was samples with age 30-39 years with 11 specimens closely followed by 40-49 years group with 9 specimens.

4.8. Observations of morphological parameters of the adult group

In all adult groups they were in the left hypochondriac region with normal ligamentous position without any variations and dark purple in colour. Wandering or ectopic spleen is a rare entity in which the spleen is located outside of its normal location All had smooth surface with normal impressions on both diaphragmatic and visceral surfaces.

4.9. Shape

In the present study out of 40 spleen of adult group studied, 21 spleen (52.5%) were Tetrahedral, 14 spleen (35%) were wedge or segment of an orange, 4 (10%) spleen were triangular and one spleen was oval in shape (2.5%). In all the spleen two poles, two borders and two surfaces were observed. The anterior pole was broad and posterior pole was rounded in tetrahedral spleen. The segment of an orange spleen showed rounded shape at both poles and the triangular spleen had rounded anterior and broad posterior pole.

Superior border is thin and convex with notches varied from zero to six, but in most of the specimens [55%] there were one or two notches and inferior border is blunt and rounded with notches varied from one to two.

The number of spleen showing the notches on the superior border and inferior border was found to be 29 (77.5%) and 20 (50%), respectively. However, no notches were observed 8 spleen (20%). The observation of splenic artery distribution at hilum predominantly showed two types of distribution a) Distributive in 30 specimens (75%) b) Magistral in 10 specimens (25%)

Fig. 1: Showing all spleen

Fig. 2: Splenic notches on superior border

5. Discussion

5.1. Morphological features of fetal group

A total of 40 spleen of the fetal group were observed for morphological parameters. The location, relations, colour and surface appearance of the Fetal spleen were in agreement with the studies reported in literature and standard textbooks[5,6] The morphology of the spleen depends upon the circulatory system at the birth. Since the cause of the death of the fetus is not known, the results can vary and have different morphologies.

5.2. Situation

The spleen was present in the normal anatomical location at left upper quadrant of the abdomen as reported in the standard literature.[14]

5.3. Surface

All the spleen in the present study had smooth surface with impressions both on diaphragmatic and visceral surfaces

Table 5: Age-wise and gender-wise distribution of adult group

Group	Age (Years)	Male (%)	Female (%)	Total (%)
A	0 – 19 Years	2 (6.6)	1 (10)	3 (7.5)
B	20 – 29 Years	4 (13.3)	2 (20)	6 (15)
C	30 – 39 Years	8 (26.6)	3 (30)	11 (27.5)
D	40 – 49 Years	9 (30)	-	9 (22.5)
E	50 – 59 Years	3 (10)	3 (30)	6 (15)
F	60 – 69 Years	4 (13.3)	1 (10)	5 (12.5)
	Total	30 (100)	10 (100)	40 (100)

Table 6: Observations of variation of shape of the spleen with gender in adult group

		Shape Oval	Seg. o f an orange	Tetrahedral	Triangular	Twistedse g. of an orange	Total	Chi-square value	p - value
Sex	Male	0	12	10	1	0	23		
		0.0%	52.2%	43.5%	4.3%	0.0%	100.0%		
	Female	1	9	4	2	1	17	4.535	.338
		5.9%	52.9%	23.5%	11.8%	5.9%	100.0%		
Total		1	21	14	3	1	40		
		2.5%	52.5%	35.0%	7.5%	2.5%	100.0%		

Table 7: Comparison of shapes in adult group with various studies

Shape	Present study	Charware et al [12]	Hollinshead WH [6]	Rao et al [13]	Michels [14]
Tetrahedral	52.5 %	21.62%	14 %	10%	42%
Segment of an orange	35 %	61.26%	44 %	20%	44%
Triangular	10 %	12.61%	42 %	16%	14%
Oval	2.5%	3.6%	-	4%	-
Irregular	-	0.9%	-	-	-

Table 8: Comparison of notches in adult group with various studies

Notches	Present study	Rayhan KA [15]	Chaware et al [12]	Michels NA [14]	Rao et al [13]
Superior border	77.5%	88.5%	74.76%	85%	64%
Inferior border	20%	27.14%	24.32%	20%	20%
Notches Absent	37.5%	-	-	-	16%

5.4. Shape of the spleen

In the present study the spleen specimens were dark purple in colour and the most common shape observed was segment of an orange or wedge in 52.5%, followed by tetrahedral in 35%, triangular in 7.5%, twisted segment of an orange in 2.5% and oval in 2.5% respectively. The observation of shape of spleen showed statistically insignificant association in relation to gestational age and gender in the fetal group.

5.5. Splenic artery distribution at hilum in fetal group:

In the present study, the observation of splenic artery distribution at hilum predominantly showed two types a) Distributive in 31 specimens (77.5%) b) Magistral in 9 specimens (22.5 %). This was in agreement with the observations of Michels NA [14] (1948) and Libor Machaleka et al. [16]

5.6. Adult Group

5.6.1. Morphological features of adult data

A total of 40 spleen of the adult group were observed for morphological the location, relations, colour, surface appearance of the adult spleen and the findings were in agreement with the studies reported in literature and standard textbooks. [5,6]

5.6.2. Surface & Shape of the spleen

The variations in the Surface & Shape of the spleen in the present data correlated with the observations of Michels NA. [14] The proportion of wedge, tetrahedral, triangular and oval shaped spleen was not in accordance with the findings of previous studies by Chaware, Rao et al. [12,13] The specimens were dark purple in colour and no accessory

spleen were observed at hilum in the present study.

5.6.3. Notches of the spleen

In the present study the number of spleen showing the notches on the superior border and inferior border was found to be 29 (77.5 %) and 8 (20%) respectively. The observations regarding the number of notches in spleen correlated with the observations of Rayhan KA,[15] Rao et al,[13] Michels NA[14] and Voboril[7] showed in Table 8.

5.7. Distribution of splenic artery at hilum in adult group

In the present study, the splenic artery distribution at hilum predominantly showed two types of distribution-Distributive in 75 % and Magistral in 25 % correlating with the studies of Michels NA[14] and Libor Machalek.[16]

The variation in splenic artery distribution at the hilum showed a significant statistical association with gender (P value 0.003) with a predilection to distributed type in 86.7 % of male specimens and magistral type in 60% of female specimens an observation which was not mentioned in literature.

6. Conclusion

The fetal and adult data regarding the various parameters collected and analyzed in the present study emphasized the significance of insight into the morphological variations of spleen in diagnosing various Fetal and adult diseases. The study regarding fetal spleen provide useful information to sonologist to report the stages of growth with measurement of the spleen in utero. Exclusive knowledge of morphological variations, antenatal detection and diagnosis of splenic abnormalities are beneficial to elucidate developmental defects, early diagnosis and prompt treatment of intrauterine infections. The awareness of the morphological variations of spleen is of fundamental importance to the clinicians, radiologists, Hematologists, surgeons and paediatric surgeon while performing surgical procedures on spleen.

7. Source of funding

None.

8. Conflict of interest

None

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