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ORIGINAL RESEARCH

A morphological study on the variations of shape and relations of the fetal spleen at different gestational ages

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Abstract
Background: Spleen is the largest secondary lymphoid organ which plays an important role in immunomodulation of fetus. Very few studies are available governing the embryological development of human fetal spleen.
Objectives: To determine the location, shape of spleen and its hilum and its relation with the neighbouring structures.
Methods: The study was conducted on 100 human fetal spleens, aged between 11 - 30 weeksof gestation. The location of spleen and its relation with the neighbouring structures, the shape of spleen and its hilum were studied.
Results: The spleen was observed in the left hypochondriac region of abdomen. Tetrahedral shaped spleen was seen in the majority of the fetuses (62%) whereas the wedged shape spleen was found only in 7 fetuses (7%). Two other shapes were also noticed i.e segment of an orange in 16% of cases and wedge shaped in 15% of cases. Out of 100 fetal spleens, longitudinal hilum was most commonly found in 69 cases and V shaped hilum was seen in only 4 cases. In 39 out of 100 cases, liver was found in no relation with the developing spleen. Renal impression was present in 45 cases.
Conclusion: The morphological parameters of the spleen at different gestational ages can be used in determining various pathologies of the spleen and may also contribute to future studies.

Introduction
Among the lymphoid organs, spleen is the largest one with rich blood supply. It serves to filter the blood, shows immune responses to antigens and in fetal life acts as a haematopoieticorgan to produce erythrocytes and granulocytes **(Eroschenko V et al 2013).** It consist of an encapsulated mass of lymphoid and vascular tissue situated in the upper left quadrant of the abdominal cavity between the fundus of the stomach and the diaphragm **(Standring S 2008)** The spleen appears at about 5th week of intrauterine life as a mesenchymal condensation between the two layers of the dorsal mesogastrium **(Moore K.L. et al 2008, Sadler T.W 2012, Schoenwolf B.C 2009).**The spleen assumes its definitive morphological form in the 3rd month **(Varga I et al. 2009).** Between the fourth and fifth month the size of the spleen rapidly increases **(Gray H. 1854).** At birth the weight of spleen is 13 g. It doubles its weight in the 1st postnatal year and triples by end of 3rd year **(Bannister LH et al. 2000, Standring**
S. 2008). Splenic size changes according to the age and weight. Configuration of the spleen is also variable according to the indentations of the organs including stomach, colon, pancreas, and kidney which are in close relation to the spleen. **(Gayer G et al. 2001 ; Dodds WJ et al. 1990; Rabushka LS et al. 1994; Elsayes KM et al. 2005).** In the literature, there is limited research about the morphological parameters of fetal spleen at different gestational ages.

Aims and objectives
The aim of the study was desired to investigate and observe the variations in the morphology of spleen in human fetuses at different gestational ages. The results have been statistically analyzed and correlated with other parameters and the variables are documented in the lightof the existing literature.

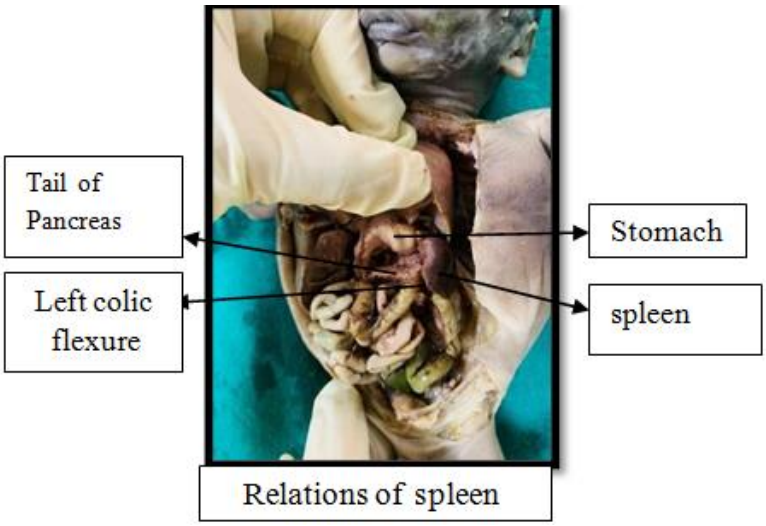
Materials and methods

The present study was carried out on 100 aborted preserved human fetuses of four different gestational age groups ranging from 11-30 weeks in the department of Anatomy, GovernmentMedical College, 32 Chandigarh sent for routine autopsy. An approval from the research and Ethics committee of Government Medical college, 32 Chandigarh was taken prior to the commencement of the study. Congenitally malformed and macerated foetuses were excluded from the study. The spleen specimens has been categorized into following groups:

Group I - 11th to 15th gestational weeks. Group II - 16th to 20th gestational weeks. Group III - 21st to 25th gestational weeks. Group IV - 26th weeks onwards

The spleen was exposed after the dissection of fetuses according to Cunningham's text bookof Anatomy 12th edition **(Romanes GJ. 1981).** The position, shape and relations of the diaphragmatic and visceral surface was noted insitu. Thereafter, the spleen was removed from its position by dissecting the gastrosplenic and splenorenal ligaments for studying the shapeof its hilum.

Position of spleen insitu



Relations of spleen

Table 1: Distribution of fetuses according to their gestational age

Gestational age	Groups	Number of Cases
12^{+} - 16 weeks	A	25
16^{+} - 21 weeks	B	25
21^{+}- 26 weeks	C	25
26 week onwards	D	25

Results

All the spleens were found in its normal location in the left hypochondric region of abdomen and was intraperitoneal without any variation.

Table 2: Shape of the fetal spleen in all the gestational age groups

Gestationage group	Shape				Total Count(%)	P
	Tetrahedral	Triangular	Wedge	Segment of orange		
12^{+} - 16 weeks (A)	17(68%)	2(7.7%)	2(7.7%)	4(15.4%)	25(100.0%)	0.014
16^{+} - 21 weeks (B)	15(60%)	3(12.5%)	0(0.0%)	7(29.2%)	25(100.0%)	
21^{+}- 26 weeks (C)	21(84.0%)	3(12.0%)	1(4.0%)	0(0.0%)	25(100.0%)	
26 week onwards (D)	9 (36.0%)	7(28.0%)	4(16.0%)	5(20.0%)	25(100.0%)	
Total	62(62.0%)	15(15.0%)	7(7.0%)	16(16.0%)	100(100.0%)	

Concerning the shape of fetal spleen, 4 different shapes of spleen have been observed.Tetrahedral shaped spleen was seen in the majority of the fetuses (62%) whereas the wedged shape spleen was found only in 7 fetuses (7%). Two other shapes were also noticed i.e segment of an orange in 16% of cases and wedge shaped in 15% of cases. Splenic shape and size varies according to the age and weight. The organs which are in close relation to the spleen including stomach, colon, pancreas, and kidney may alter the configuration of the spleen. No association was found in the different shapes of the fetal spleen with that of the gestational age.

Table 3: Distribution of sample according to the Hilum in different gestation age groups

Gestation age group	HILUM				Total	p
	V-shape	Longitudinal	Irregular	Triangular		
12^{+} - 16 weeks (A)	2(8%)	17(68%)	3(12%)	3(12%)	25(100.0%)	0.363
16^{+} - 21 weeks (B)	0(0.0%)	20(80%)	4(16%)	1(4%)	25(100.0%)	
21^{+}- 26 weeks (C)	1(4.0%)	15 (60.0%)	7(28.0%)	2(8.0%)	25(100.0%)	
26 week onwards (D)	0(0.0%)	18(72.0%)	6(24.0%)	1(4.0%)	25(100.0%)	
Total	4(4.0%)	69(69.0%)	20(20.0%)	7(7.0%)	100(100.0%)	

Out of 25 spleens in group A longitudinal shaped hilum was observed in maximum number of cases that is 17 which is followed by triangular (3), irregular (3) and V-shaped hilum (2).In group B, 80% had longitudinal shaped hilum, while 16% had irregular shaped hilum and 4% cases had triangular hilum. In group C, it was found that longitudinal shaped hilum was seen in 15 cases followed by irregular in 7, triangular in 2 and V shape in just 1 case.

Similarly in group D, longitudinal hilum was noticed in maximum number of cases (18) followed by irregular shaped hilum in 6 cases and triangular in minimum number of cases(1). Although longitudinal shaped hilum was found in maximum number of cases but variation in shape of hilum with changing age groups was found to be insignificant (p=0.363).

Table 4: Distribution of sample according to the impression of liver in differentgestation age groups

Gestationage group	Liver			Total(Count(%))	p
	Absent(Count(%))	Partially Overlapping (Count(%)	Overlapping (Count(%)		
12^{+} - 16 weeks (A)	6(23.1%)	10 (42.3%)	9(34.6%)	25(100.0%)	0.38
16^{+} - 21 weeks (B)	13(52.0%)	6(24.0%)	6(24.0%)	25(100%)	
21^{+}- 26 weeks (C)	11(44.0%)	7(28.0%)	7 (28.0%)	25(100.0%)	
26 week onwards (D)	10(40.0%)	11(44.0%)	4(16.0%)	25(100.0%)	
Total	39(39.0%)	35(35.0%)	26(26.0%)	100(100.0%)	

In 39 cases, the liver did not have any contact with spleen while it was in contact inremaining 61 cases. The percentage of non-contact cases (52%) was highest in group B (16- 20 weeks of gestation). In 35% of the cases liver was partially overlapping spleen that is only left lobe of liver is covering the spleen. The percentage of spleens with partially overlapping liver was maximum in group D (above 26 weeks of gestation). In 26 cases out of 100 the left lobe of liver was completely overlapping spleen reaching till midaxillary line. The maximum number belongs to group A that is initial period of development. In 100% cases, the tail of the pancreas was in

contact with the visceral face of the.
In all cases, stomach and spleen have been established to be in contact with each other and spleen was located on the left and posterior according to the stomach. When we looked for the relation of the large intestine, it has been established that in 96% cases, left colic flexure was in contact with the spleen and not in contact in the rest 4% cases. These four cases belongs to Group A ranging from 12-16 weeks (at the early periods of fetal development).

Table 5: Distribution of sample according to the suprarenal in different gestation agegroups

Gestation age group	Suprarenal		Total(Count(%))
	Absent(Count(%))	Present(Count(%))	
12^{+} - 16 weeks (A)	0(0.0%)	25(100.0%)	25(100.0%)
16^{+} - 21 weeks (B)	3(12%)	22(88%)	25(100.0%)
21^{+}- 26 weeks (C)	5(20.0%)	20(80.0%)	25(100.0%)
26 week onwards (D)	2(8.0%)	23(92.0%)	25(100.0%)
Total	10(10.0%)	90(90.0%)	100(100.0%)

For the relation of left kidney with the spleen, there was contact in 45% cases while there was no contact in 55% cases. With the increase of gestational age, percentage value of contactwas also increased. In all cases, left kidney was located posterior, inferior and medial to the spleen. The left suprarenal gland was in contact with the spleen in 90% of the cases and was located posterior, inferior and medial to the spleen. In 43% of the spleens, both renal as well as suprarenal impressions were found which fall in the category of group B and C ranging from 16-26 weeks of gestation. In all cases, the diaphragm was in contact with the spleen located superior and lateral to the spleen.

Discussion

Review of the literature suggests that there are very few studies regarding position, shape and visceral relations of fetal spleen. According to Ungor et al. 2007 and studies done by Saheb et al. 2014 and Ramanujan et al. 2016, all the spleens were located in left hypochondrium of abdomen. In our study also, all the spleens were located in left hypochondrium and were intraperitoneal. In the present study, the relation of spleen with neighboring viscera was different as compared to adult spleen except its relation with the stomach and diaphragm which followed adult pattern. The relation of spleen with large intestine varied with gestational age. Left colic flexure was in contact with spleen in 96 % cases which belong to group A of our study. Similar to our finding in a study done by Ungor at el. 2007 large intestine was in relation with spleen in late second and third trimester and it was not incontact in first and early second trimester cases.
Regarding the relation of spleen with tail of pancreas, **Skandalakis et al** and **Soyluoglu et al** reported that pancreatic tail was in contact with spleen in all the cases they studied, thoughthe position of tail varied with age of foetus. In another study, pancreatic tail was in contact with spleen in 93.6% of cases **(Ungor et al. 2007).** While in our study tail of pancreas was in contact with spleen in 100% of cases.
Srivani et al. (2019) conducted a study out of 40 spleen, 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%) but in our study spleen was tetrahedral in maximum number of cases (62%) and wedge shaped in 7 cases, in 15 cases it was triangular and in 16% cases it was segment of an orange shape.
To the best of our knowledge, there is only one study regarding the shape of fetal splenic hilum by Ungor et al who reported longitudinal hilum in 69.5% cases, triangular in 20.6% cases, 2.8% had irregular shape and 2.8 % having V shaped hilum. In our study we also found 69% cases having longitudinal hilum, 7% cases it was triangular, in 4% cases it was V shaped and in 20% cases it was irregular in shape. We did not find T or bow shaped hilum in our study as was reported by Ungor et al in 4.2 percent cases.

Conclusion

The morphological study of fetal spleen provide necessary details to sonologist to access the stages of growth of the spleen in utero. Awareness of morphological variations, antenatal detection and diagnosis of splenic anomalies are helpful to elucidate developmental defects, early diagnosis and elicit treatment of intrauterine infections. The present study is of great importance to the clinicians, radiologists, Hematologists, surgeons and paediatric surgeon while performing surgical procedures on spleen.

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