

A Study on Morphometric Dimensions of Human Fetal Spleen at Different Gestational Ages

D. Srivani¹, P. Sofia², J. Jayachandra Pillai³

¹Assistant Professor, Department of Anatomy, SVIMS- Sri Padmavathi Medical college for women, Tirupathi, Andhra Pradesh, India, ²Assistant Professor, Department of Anatomy, GMC [RIMS], Kadapa, Andhra Pradesh, India, ³Professor & HOD, Department of Anatomy, S V Medical College, Tirupathi, Andhra Pradesh, India.

Abstract

Introduction: The spleen is the largest hemolymphatic organ of the human body that plays a significant role in Hematopoiesis and immune phagocytosis. Recent studies have emphasized the importance of spleen as hematopoietic organ in fetal period, role in synthesis of immunoglobulins & defense of human body against infections. A thorough knowledge of splenic morphometry and dimensions is vital in comprehending the development of spleen in fetal period. **Aim:** The aim of the study is to study detailed morphometric analysis human fetal splenic specimens of various gestational ages and compare the findings with earlier studies. **Subjects and Methods:** The present study included 40 fetal cadaveric spleen and morphometric features i.e., length, breadth, width and weight of spleen were measured. **Results:** The average weight of the fetal spleen was 1.98 gm and varied from 0.1 to 5.1 gm. The average length, breadth and width of spleen in prenatal group were 2.21 cm, 1.39 cm and 0.645 cm respectively. In the present study the average weight of the fetal spleen was 1.98 gm and varied from 0.1 to 5.1 gm. There was statistically significant increase in splenic weight till 33 weeks. **Conclusion:** Knowledge of spleen size at different gestational ages will help in early detection and diagnosis of splenic anomalies, identifying congenital malformations, early diagnosis and prompt treatment of intrauterine infections.

Keywords: Spleen, Hematopoietic, Morphometric Analysis, Fetal.

Corresponding Author: Dr. P. Sofia, Assistant Professor, Department of Anatomy, GMC [RIMS], Kadapa, Andhra Pradesh, India.

Email: sofiapeddity@gmail.com

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Introduction

The spleen is a myriad of mysteries yet to be unravelled completely. Spleen is located in the left hypochondrium, and arises from mesenchymal proliferation between two leaves of dorsal mesogastrium during 5th week of gestation.^[1] The spleen assumes its definitive morphological structure during the 3rd month and the size gradually increases during the fetal period. Sir Henry Gray in 1854 in the book "The structure and the use of spleen" reported the studies on 334 spleens of various animals determined the weight of the spleen before birth.^[2,3,4] He compared the weight of spleen with that of body weight of fetus and found it to be 1 to 1400 at 5th month, 1 to 700 at 7th and 1 to 350 at 9th fetal month.^[5,6] Jian Hong You.^[7] (2014), Schmidt et al^[8] (2008) extensively studied the morphometric parameters of fetal spleen using 2D&3D ultrasound. However there is limited research^[9-12] regarding the cadaveric analysis of morphometric parameters of spleen in fetal period which warrants the purpose of this study.

Aims & Objectives

The aim is to study morphometric parameters of human fetal

splenic specimens at various gestational ages and compare the parameters with the existing literature.

Subjects and Methods

The present study is a prospective type of study conducted in the department of Anatomy, S. V. Medical College, Tirupati Maternity Hospital, Tirupati. The ethical committee approval and consent of the relatives were obtained. Medically terminated fetuses of both sexes and relevant obstetric data were collected from Government Maternity Hospital, Tirupati which includes 40 dead aborted fetuses of both sexes ranging from 16 weeks of gestation to term. In the department of anatomy, the collected fetuses were observed for congenital anomalies and the following fetal external parameters were measured by using weighing machine, measuring scale, thread and osteometric board. 1. Fetal weight 2. Bi-parietal diameter, 3. Head circumference 4. Crown-rump length 5. Crown-heel Length 6. Chest circumference. After recording the external parameters, they were preserved in 10% formalin. After one week of preservation, the abdomen was opened by using routine dissection method and the morphological observations were

made insitu. Later spleen were removed by using routine dissection method and outer surface of fetal spleens were dried with blotting paper and then weighed by using digital weighing balance (SHIMADZU-ATY224-UNibloc). The morphometric parameters measured were fetal weight, crown rump length, splenic weight, length, breadth and width. The collected data was subjected to statistical analysis by computing the mean of each parameter with respect to the gestational age-wise groups by using SPSS 20 version.

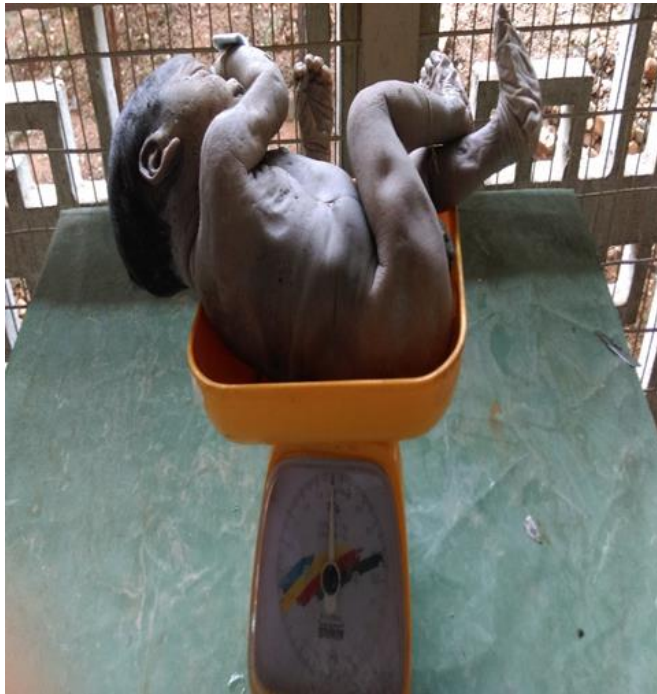


Figure 1: showing measurement of the Fetal weight with digital weighing balance (SHIMADZU-ATY224-UNibloc)



Figure 2: showing measurement of splenic length with digital Vernier calipers

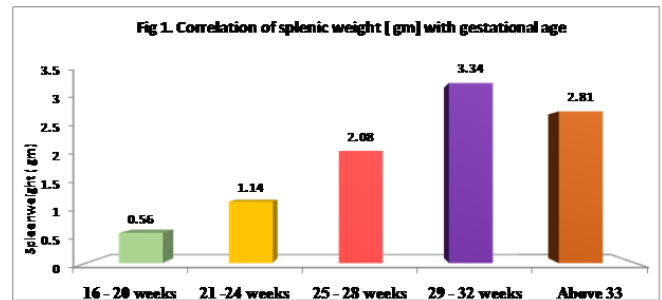
Results

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 largest group was fetuses with gestational age 16-20 weeks with 10 specimens. The gender-wise distribution was 57.5% and 42.5 % for male and female groups respectively.

Table 1: Gestational age/ Gender wise distribution of prenatal group

Group	Gestational age (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)

The splenic weight is maximal in 29-32 weeks group with mean 3.33 ± 1.01 gm and a slight decrease thereafter till Term. The statistical analysis suggests that there is significant increase in fetal weight in relation to gestational age with maximal weight 3.38 ± 1.01 gm in 29-32 weeks group. The maximal splenic weight is 5.1 gm in a fetus of 30 weeks gestational age. The weight of the spleen ranged from 0.1 gm to 5.1 gm. The average weight of the fetal spleen is 1.98 ± 1.22 gm.

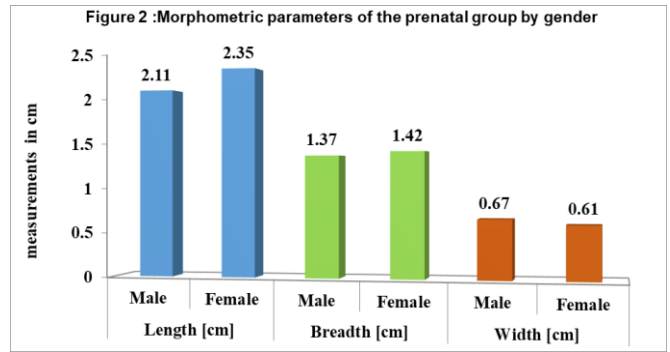


Graph 1: Correlation of gestational age for splenic length, breadth and width of prenatal group

Table 2: Summary of ANOVA and Duncan's Multiple Range Test (DMRT) by G. age

Fetal	G. age	N	Mean	Std. Deviation	F-value	p-value	Min	Max
Length [cm]	16 - 20 weeks	10	1.320	0.2974	23.646**	0.000	0.9	1.7
	21 - 24 weeks	5	1.940	0.2510			1.7	2.3
	25 - 28 weeks	9	2.456	0.3321			1.8	2.8
	29 - 32 weeks	8	2.713	0.4764			2.1	3.4

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	33 - Term	8	2.738	0.4340			2.3	3.7
	Total	40	2.215	0.6777			0.9	3.7
Breadth [cm]	16 - 20 weeks	10	0.810	0.2331	22.017**	0.000	0.4	1.2
	21 - 24 weeks	5	1.240	0.1949			1.1	1.5
	25 - 28 weeks	9	1.500	0.3500			.8	1.9
	29 - 32 weeks	8	1.813	0.2696			1.5	2.1
	33 - Term	8	1.662	0.1188			1.5	1.8
	Total	40	1.390	0.4482			0.4	2.1
	Width [cm]	16 - 20 weeks	10	0.410			0.1912	2.593*
21 - 24 weeks		5	0.640	0.1140	0.5	0.8		
25 - 28 weeks		9	0.744	0.3245	0.1	1.1		
29 - 32 weeks		8	0.688	0.3357	0.1	0.9		
33 - Term		8	0.788	0.3271	0.1	0.12		
Total		40	0.645	0.3029	0.1	0.12		



Graph 1: Correlation of gestational age for splenic length, breadth and width of prenatal group

The mean splenic length, breadth and width followed the same pattern as splenic weight in relation to gender without any statistically significant difference in male and female groups (P values 0.2, 0.7 and 0.55 respectively). The Karl Pearson coefficient of correlation analysis showed a positive correlation between the fetal weight and the morphometric parameters like splenic weight, length, breadth and width with maximal positive correlation between the fetal weight and the splenic length (Pearson coefficient 0.814) and least positive correlation between fetal weight and splenic width. In the present study the correlation of weight of spleen with that of body weight of fetus found to be 1 to 707 at 16–20 wks, 1 to 763 at 21 -24 wks, 1 to 620 at 25 - 28 wks, 1 to 543 at 29-32 wks and 1 to 769 at 33 wks to Term

Table 3: Ratio between fetal weight and splenic weight in different groups

Gestational age (wks.)	Average fetal Weight (gm)	Average splenic Weight (gm)	Ratio between fetal and spleen weight (%)
16 - 20 weeks	396	0.560	0.14
21 -24 weeks	870	1.140	0.13
25 - 28 weeks	1290	2.078	0.16
29 - 32 weeks	1809.5	3.338	0.18
33 - Term	2162.5	2.812	0.12

Discussion

In the present study the average weight of the prenatal spleen was 1.98 gm. The splenic weight ranged from 0.1 gm to 5.1 gm which gradually increased with gestational age significantly till 32 weeks. The findings of morphometric parameters in the present study were in accordance with the observations of 2D & 3D ultrasound guided measurements in fetuses by Jian-Hong You et al^[7] (2014), Toshiyuki Hata et al^[13] (2007), Schmidt et al (1985)^[8].

The findings regarding the weight of the spleen in relation to gestational age were in agreement with the observations of Gruenwald P & Minh HN (1960)^[6] and John G Archie et al^[14] (2006) in prenatal autopsies and with the descriptions of Sir Henry Gray (1854)^[2] and Potter (1961)^[15] till 32 weeks of gestation and not in agreement afterwards.

The weight of the spleen at term was reported as 13 gm (210 grains) by Sir Henry Gray (1854) and 11 gm by potter (1961) which was not observed in the present study which were more than the average observed in the present study.

The analysis shows morphometric parameters splenic weight, length and breadth steadily increased with gestational age and the difference is highly significant (P<0.05, High F value). The maximal splenic length is in 33 weeks to Term group with mean 2.7 cm ±0.47 cm with gradual and significant increase with gestational age. The average splenic length is 2.21 ±0.67 cm and varied from 0.9 to 3.7 cm.

The analysis by gestational age for splenic breadth showed a gradual and significant increase with gestational age up to 33 weeks reaching maximum in 29-32 week group (mean breadth 1.81 ± 0.269 cm) and a slight decrease there afterwards. The average splenic breadth is 1.39± 0.44 cm. The analysis of splenic width with gestational age showed statistically insignificant association with gestational age. The average splenic width is 0.645± 0.302 cm and the maximal width is in 33 weeks to Term. The splenic width varied from 0.1 to 1.2 cm.

Table 4: Gestational age with splenic weight

G. age	Present study Mean Splenic weight	Sir Henry Gray[2](1854)	Gruenwald P & Minh HN[6](1960)	John G Archie et al[14] (2006)
16- 20 weeks	0.560 gm	0.32 gm	-	0.23gm
21 -24 weeks	1.140	1.16 gm	1.7gm	0.71gm
25 - 28 weeks	2.078	1.94 gm	2.6gm	1.63gm
29 - 32 weeks	3.338	3.88 gm	4.1gm	3.5gm
33 wks – Term	2.812	4.5 gm	6.7gm	-

Table 5: Gestational age with splenic length

G. age	Present study Splenic length (cm)	Jian-Hong You et al ^[7] (2014)	Schmidt et al ^[8] (1985)	Shaik Hussain et al ^[16] (2013)	Toshiyuki Hata et al ^[13,17] (2007)
16- 20 weeks	1.32 cm	1.79 cm	1.7 cm	1.7 cm	1.5 cm
21 -24 weeks	1.94 cm	2.15 cm	2.08 cm	-	-
25 - 28 weeks	2.45 cm	2.68 cm	2.8 cm	2.5 cm	-
29 - 32 weeks	2.71 cm	2.91 cm	3.3 cm	-	-
33 wks - Term	2.73 cm	3.26 cm	5.1 cm	2.67 cm	4 cm

In the present study splenic length steadily increased with gestational age and the difference was highly significant (P<0.05) and average was 2.21cm. These findings were in agreement with the study on aborted fetuses by Shaik Hussain et al^[16] (2013).The fetal splenic length at 5th month was 1.32 cm and term was 2.73 cm, which was in agreement with the findings of Toshiyuki Hata et al^[13,17] (2007).

The present study showed a gradual and significant increase (P value < 0.05) of splenic breadth with gestational age up to 33 weeks reaching maximum in 29-32 week group and a slight decrease thereafter and average was 1.39 cm which was in agreement with the descriptions of Shaik Hussain et al^[16] (2013), Jian-Hong You et al^[7](2014), Toshiyuki Hata et al^[13,17] (2007), Schmidt et al^[8] (1985)

In the present study the average splenic width was 0.645 cm and correlation of splenic width with gestational age showed statistically insignificant and the maximal width is in 33 weeks to Term group .These findings were in agreement with the observations of Jian-Hong You et al (2014)^[7] till 28 weeks and not in agreement afterwards.

Splenic volume calculated from the regression formula 1.83 x length x breadth x width by Ellen M. Yetter et al^[10].

Table 6: Gestational age with splenic volume

G.age	Present study	Schmidt et al ^[8] (1965)	Latini et al ^[9] (2004)	Toshiyuki Hata et al ^[13,17] (2007)
16- 20 weeks	1.83 cc	-	-	-
21 -24 weeks	2.43 cc	2.2	3	-
25 - 28 weeks	2.86 cc	3.4	-	2.2 cc
29 - 32 weeks	4.81 cc	5.7	8	6.2 cc
33 wks -term	8.77 cc	10.1	15	9.3 cc

The present study showed a gradual and significant increase of splenic volume with gestational age upto till term which correlated with the findings of Schmidt et al^[8] (1965) and Toshiyuki Hata et al^[13,17] (2007) but differed with the findings of Latini et al.^[9]

However, the slight differences in the morphometric parameters with respect to previous studies may be attributed to the genetic factors, geographical conditions, maternal feeding habits, fetal care and the socioeconomic status of the population where these studies were done.

Conclusion

The parameters observed by our study regarding morphometric dimensions at various gestational ages of fetal spleen provide useful information to sonologist to assess the stages of growth with measurement of the spleen in utero. Antenatal detection of splenomegaly is helpful in identifying hemolytic anemia, congestive heart failure, various metabolic disorders and even leukemias in fetus. Prenatal detection of splenic abnormalities is a valuable tool in diagnosing developmental anomalies in utero, early diagnosis of intrauterine infections and can be used as a surrogate marker of fetal development.

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