

## ORIGINAL RESEARCH

# Morphometry of spleen during embryonic period

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### ABSTRACT

The spleen is the largest of the secondary lymphoid organ, plays a vital role in hematopoiesis and immunomodulation of the fetus. Splenic shape and size varies according to the age and weight. The aim of the study is to study variations on morphology and morphometry of human fetal spleen at different gestational ages. 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, Government Medical College, 32 Chandigarh. The fetuses were classified into 4 groups. The length of superior, intermediate and inferior borders and width of the spleen were measured and correlated with gestational age. The average length of superior border was found to be  $6.68 \pm 1.95$  mm in group I,  $10.55 \pm 3.34$  mm in Group II,  $14.76 \pm 2.90$  mm in Group III and  $17.68 \pm 3.63$  mm in Group IV respectively. The mean length of intermediate border was  $5.92 \pm 1.65$  mm in group I,  $9.41 \pm 2.72$  mm in Group II,  $12.96 \pm 2.42$  mm in Group III and  $16.39 \pm 3.95$  mm in Group IV respectively and inferior border was  $6.15 \pm 1.94$  mm in group I,  $9.78 \pm 2.86$  mm in Group II,  $13.79 \pm 3.28$  mm in Group III and  $16.48 \pm 3.92$  mm in Group IV while the mean width of spleen was  $7.78 \pm 3.59$  mm. On an average the mean length and breadth of the fetal spleen in different gestational age groups showed an increasing trend and they presented statistically significant values ( $p=0.001$ ) on comparison with increasing gestational age. These values of fetal splenic size could provide a useful diagnostic tool in the detection of congenital splenic abnormalities and can be used as an indicator of fetal growth.

**Keywords:** Spleen, Morphometry, Gestational Age, Growth, Fetuses.

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### INTRODUCTION

The spleen which is the largest of the secondary lymphoid organ, plays a vital role in the formation of cellular components of blood i.e hematopoiesis and immunomodulation of the fetus (Srivani D et al. 2019). It is an intraperitoneal organ and is situated in between the fundus of the stomach and the diaphragm and occupies hypochondrium and partly epigastric region of the abdominal cavity. 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 spleen may alter the configuration of the spleen. If the stomach is distended the spleen resembles a "segment of orange", when colon is distended it has "irregular tetrahedral" shape. (Gayer G et al. 2001 ; Dodds WJ et al. 1990; Rabushka LS et al. 1994; Elsayes KM et al. 2005). The spleen is lobulated in fetal life and these lobules usually disappear before birth but sometimes

lobulation persist in adult life. A persisting lobule may alter the shape of spleen. The presence of notches and clefts on the diaphragmatic surface and especially superior border are another congenital shape anomalies of spleen. The development of spleen begins at about 6<sup>th</sup> weeks of gestation as localized thickening of coelomic epithelium of the dorsal mesogastrium (Neil RB et al. 2005). The spleen attains its definitive morphological form in the 3<sup>rd</sup> month (Varga I et al. 2009). The size of the spleen rapidly increases between the fourth and fifth month (Gray H. 1854). The spleen weighs 13 g at birth which gets doubled in the 1<sup>st</sup> postnatal year and triples by end of 3<sup>rd</sup> year (Bannister LH et al. 2000; Standring S et al. 2008). Accessory or supernumerary spleens, or splenules, results from the failure of fusion of the primordial splenic buds in the dorsal mesogastrium during the fifth week of fetal life. Incidence of accessory spleen in the population is

10%–30% of patients in autopsy series and 16% of patients undergoing contrast enhanced abdominal CT. Although the most common location for an accessory spleen is splenic hilum (75%) and pancreatic tail, but it can occur anywhere in the abdomen including gastrosplenic or splenorenal ligaments, wall of stomach, greater omentum or the mesentery, and even in the pelvis and scrotum. **Gray et al. (1854)** in his study compared the weight of spleen with that of body weight of fetus and found it to be 1:1400 at 5th month, 1:700 at 7th month and 1:350 at 9th month. He stated that the size of the spleen increases very rapidly in the embryo from about 6th month, and attains its greatest size during adult life and concluded that its weight at birth in proportion to the entire body weight of the fetus (1:350) is almost equal to that in adult (1:340–500). **Ugboma et al. (2013)** performed a study to establish sonographically the range of splenic length in normal pregnant women. The sonographic measurements of the splenic length was performed on 150 healthy normal pregnant women correlating this with the body mass index, gestational age and parity. It was found that the mean splenic length was 10.0 cm  $\pm$  1.8 throughout pregnancy with a range of 9.7-10.3 cm. The splenic length significantly correlated positively with the body mass index ( $r = 0.006$ ,  $P < 0.01$ ) but not with parity ( $r = 0.94$ ,  $P < 0.01$ ), and gestational age ( $r = 0.31$ ,  $P < 0.01$ ).

The aim of the study is to observe the variations in the morphometry of spleen in human fetuses at different gestational ages.

#### MATERIAL 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, Government Medical College, 32 Chandigarh sent for

routine autopsy. An approval from the research and University Ethics committee was taken prior to the commencement of the study. Congenitally malformed and Macerated fetuses were excluded from the study.

The fetal weight, crown-rump length (CRL), crown-heel length (CHL), foot length (FL), handlength (HL), Chest and abdominal circumference were taken before exposure of spleen. The spleen has been studied in total 100 fetuses of varying gestational ages. And the specimens have 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

**Exposure of Spleen:** The spleen has been studied after the dissection of fetuses according to Cunningham's text book of Anatomy 12th edition (**Romanes GJ. 1981**). The following steps were followed for the dissection:

- A straight anterior midline vertical incision was made from symphysis menti till pubic symphysis.
- Two transverse incisions were made one extending from right to left shoulder joint and another extending from the right to left anterior superior iliac spine.
- Skin was retracted laterally.
- The spleen was exposed by reflecting the diaphragm upwards.
- The position, relations of the diaphragmatic and visceral surface and vascular pattern of spleen was noted insitu.
- Thereafter, the spleen was removed from its position by dissecting the gastrosplenic and splenorenal ligaments for further study.



**Incision for the exposure of fetal spleen**

**MORPHOLOGICAL MEASUREMENTS**

- The gross morphological measurements of spleen were taken using a digital vernier caliper.
- Electronic weighing balance was used to measure the weight of the spleen.

Following morphometric parameters were recorded.

1. Length of the spleen (distance between the two



**Length of the spleen**

planes passing from the most prominent points on anterior and posterior ends of spleen). Length of superior, intermediate and inferior border was taken.

2. Breadth of the spleen (distance between the two planes passing from the most prominent points on superior and inferior borders of the spleen).



**Breadth of the spleen**

**STATISTICAL EVALUATION**

Statistical analysis was done with statistical package for social sciences (SPSS Inc; Chicago, IL, version 20.0 for windows). All the quantitative variables were measures of central location (mean, median) and measures of dispersion (standard error and standard deviation) and data were presented in the form of figures and tables. Correlation of morphometric dimensions with fetal weight and gestational age were calculated using Pearson's coefficient.

**OBSERVATIONS AND RESULTS**

- The average length of superior border was found to be 6.68±1.95 mm in group I, 10.55±3.34 mm in Group II, 14.76±2.90 in Group III and 17.68±3.63mm in Group IV respectively. The mean

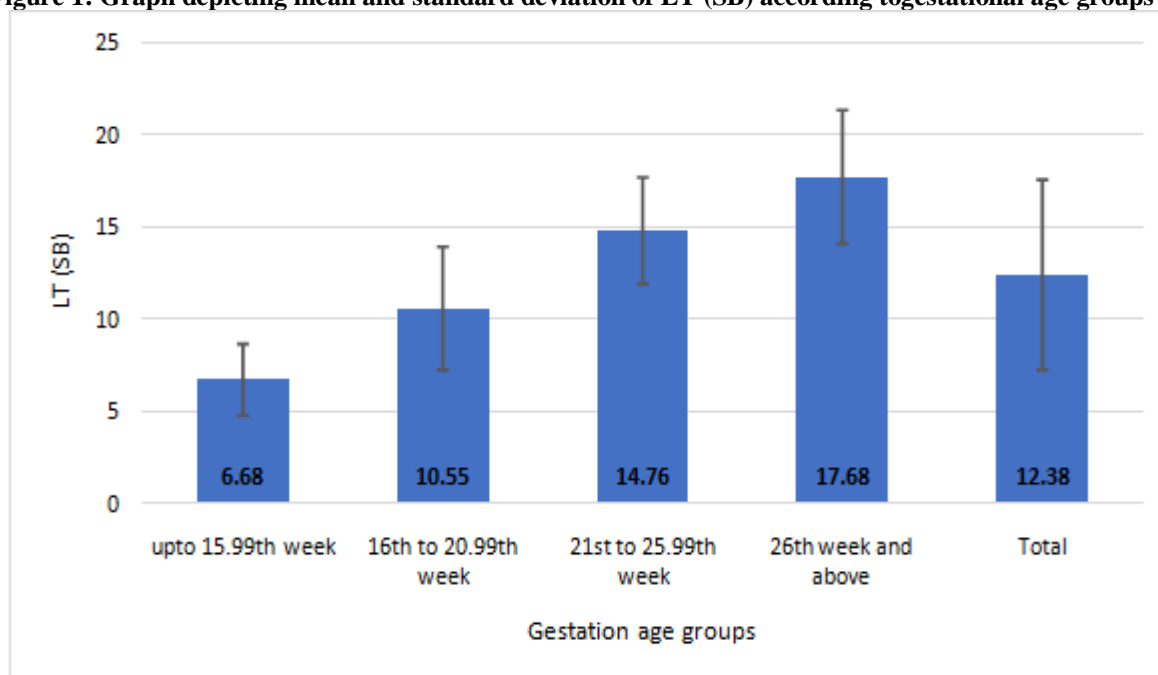
length of intermediate border was 5.92±1.65 mm in group I, 9.41±2.72 mm in Group II, 12.96±2.42 in Group III and 16.39± 3.95 mm in Group IV respectively And inferior border was 6.15±1.94 mm in group I, 9.78±2.86 mm in Group II, 13.79±3.28 in Group III and 16.48± 3.92mm in Group IV

- While the mean Breadth of spleen was 4.10±1.40mm in group I, 6.11±2.21 mm in Group II, 9.96±2.55 in Group III and 11.02 ± 2.59 mm in Group IV .On an average the mean length and breadth of the fetal spleen in different gestational age groups showed an increasing trend and they presented statistically significant values (p=0.001) on comparison with increasing gestational age.

**Table 1: Descriptive statistics and Kruskal Wallis test of LT (SB) according to the gestation age groups.**

Dependent Variable	Gestation Age Groups	N	Mean	SD	SEM	Minimum	Maximum	Kruskal Wallis test	
								H	p
LT (SB)mm	11-16 week	26	6.68	1.95	.38	2.70	10.10	68.66	0.000*
	16 - 21week	25	10.55	3.34	.68	4.40	18.80		
	21-26week	25	14.76	2.90	.58	9.20	23.20		
	26 <sup>th</sup> week and above	25	17.68	3.63	.73	11.20	25.50		
	Total	100	12.38	5.16	.52	2.70	25.50		

**Figure 1: Graph depicting mean and standard deviation of LT (SB) according to gestational age groups**



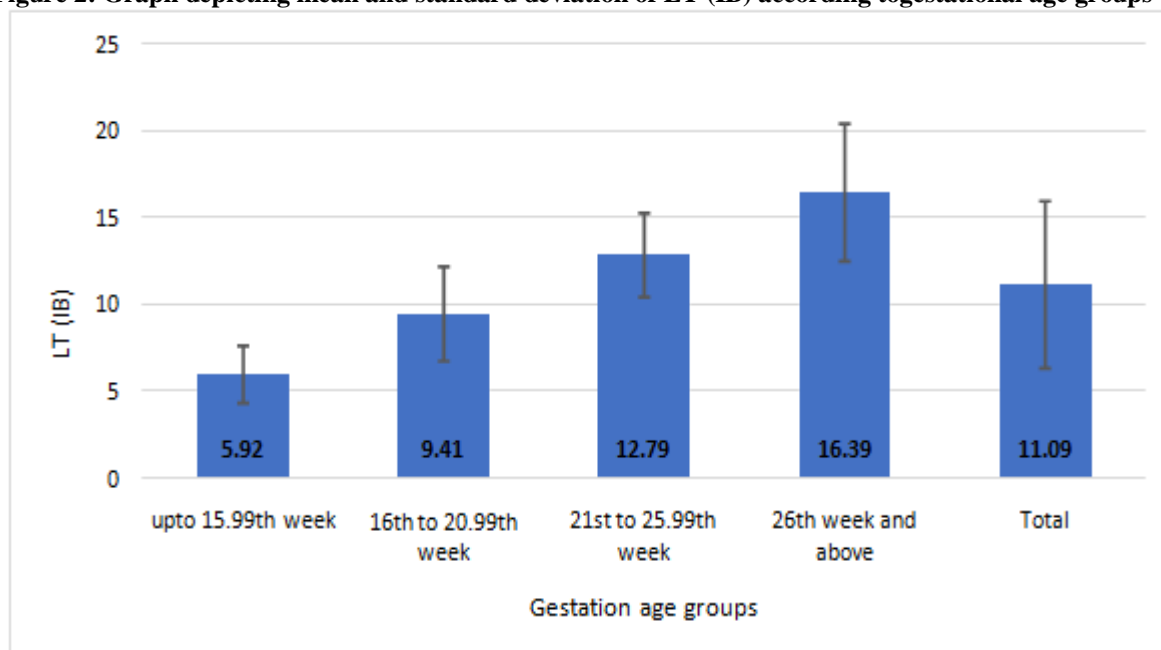
- LT (SB)- Length of Superior Border

**Table 2: Descriptive statistics and Kruskal Wallis test of LT (IB) according to the gestational age groups.**

Dependent Variable	Gestation Age Groups	N	Mean	SD	SEM	Minimum	Maximum	Kruskal Wallis test	
								H	p
LT (IB)mm	11-16 week	26	5.92	1.65	.32	2.80	8.70	70.99	0.000*
	16 - 21week	24	9.41	2.72	.56	3.70	16.60		
	21-26week	25	12.79	2.42	.48	8.80	18.90		
	26 <sup>th</sup> week and above	25	16.39	3.95	.79	10.10	23.40		
	Total	100	11.09	4.81	.48	2.80	23.40		

\* Statistically significant  $p < 0.001$

**Figure 2: Graph depicting mean and standard deviation of LT (IB) according to gestational age groups**



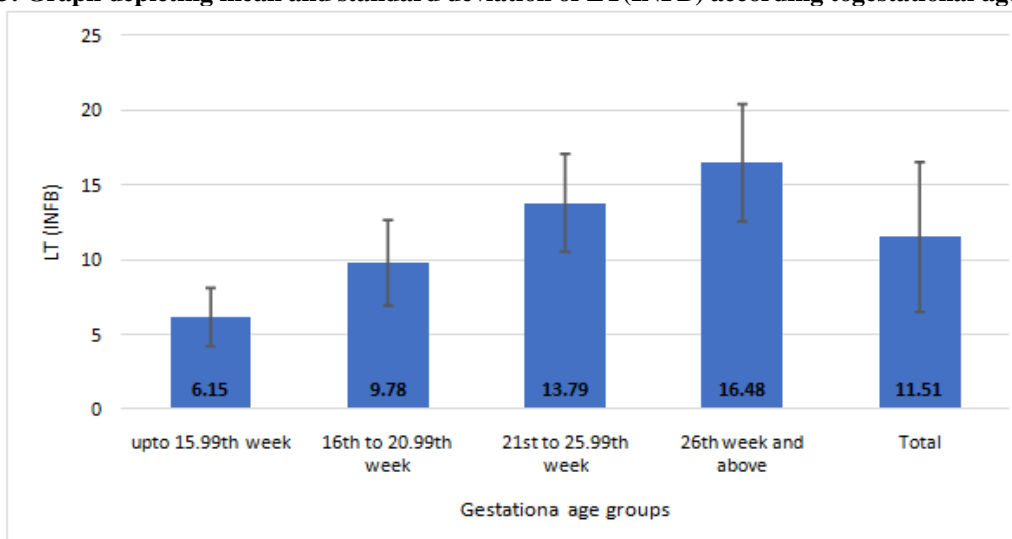
\*LT (IB) - Length of Intermediate Border

**Table 3: Descriptive statistics and Kruskal Wallis test of LT(INFB) according to the gestation age groups.**

Dependent Variable	Gestation Age Groups	N	Mean	SD	SEM	Minimum	Maximum	Kruskal Wallis test	
								H	p
LT(INF Bmm)	11-16 week	26	6.15	1.94	.38	2.4	9.2	69.24	0.000*
	16 - 21week	24	9.78	2.86	.58	4.1	18.3		
	21-26week	25	13.79	3.28	.66	8.7	20.4		
	26 <sup>th</sup> week and above	25	16.48	3.92	.78	11.2	26.0		
	Total	100	11.51	5.00	.50	2.4	26.0		

\* Statistically significant  $p < 0.001$

**Figure 3: Graph depicting mean and standard deviation of LT(INFB) according to gestational age groups**



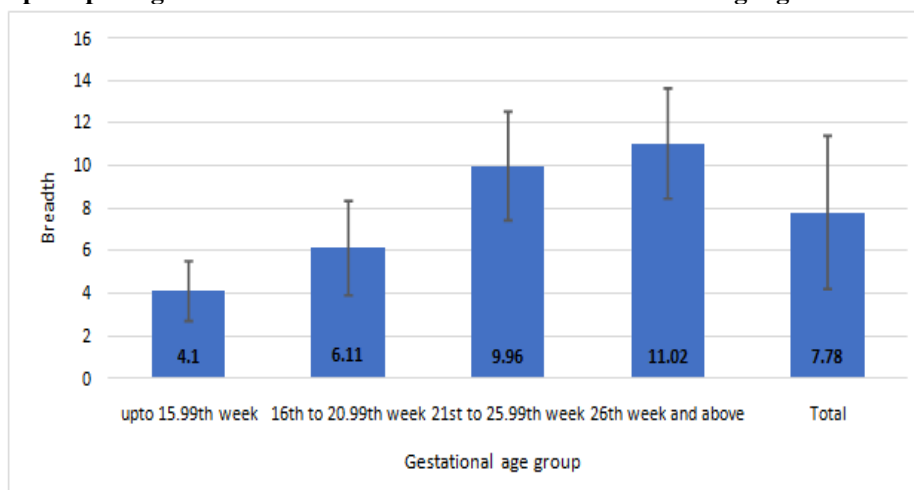
\*LT (INF) - Length of Inferior Border

**Table 4: Descriptive statistics and Kruskal Wallis test of BREADTH according to the gestation age groups.**

Dependent Variable	Gestation Age Groups	N	Mean	SD	SEM	Minimum	Maximum	Kruskal Wallis test	
								H	p
BREADTH (mm)	11-16 week	26	4.10	1.40	.28	1.6	8.1	66.42	0.000*
	16 - 21week	24	6.11	2.21	.45	2.3	12.1		
	21-26week	25	9.96	2.55	.51	5.8	15.1		
	26 <sup>th</sup> week and above	25	11.02	2.59	.52	5.5	16.6		
	Total	100	7.78	3.59	.36	1.6	16.6		

\* Statistically significant  $p < 0.001$

**Figure 4: Graph depicting mean and standard deviation of breadth according to gestational age groups**



## CONCLUSION

Morphometry of spleen at different gestational ages is somewhat similar and support the previous literature. There is a steep rise in Length of superior border, Intermediate and Inferior border and Width occurs during Group I,II,III i.e. from 11<sup>th</sup> to 25<sup>th</sup> week of gestational age. All the parameters were found statically significant (p-value < 0.001). The measurements of fetal splenic size could be a useful diagnostic tool in the detection of congenital splenic abnormalities in utero such as splenomegaly, hypoplastic spleen and various congenital anomalies and also an indicator of fetal growth. Knowledge about prenatal ontogenesis of the spleen will help to understand the mechanisms of pathology in the organ and create methods of diagnosis and prevention and also helpful to paediatric clinicians because of its several erythropoietic and lymphopoietic functions in children.

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