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Morphometric Analysis of Fetal Spleen Development in Different Gestational Ages: A Cross-Sectional Study

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KEYWORDS

Fetal spleen, Morphometric analysis, Gestational age, Organ development, Anatomical dissection, Prenatal biometry

ABSTRACT:

Background:

The fetal spleen plays a crucial role in haematopoiesis and immune system development during gestation. Morphometric evaluation of the spleen across different gestational ages provides essential baseline data for both clinical and anatomical reference.

Aim:

To assess the morphometric parameters of the fetal spleen in relation to gestational age using direct anatomical dissection and measurement.

Materials and Methods:

This descriptive, cross-sectional study was conducted on 39 human fetuses ranging from 13 to 40 weeks of gestation, obtained from spontaneous abortions and preterm deliveries. Fetuses were fixed in 10%formaline & grouped into four different groups according to gestational age. Dissection was performed according to standard anatomical protocols. Spleen weight, outer and inner length, width, and thickness were measured using a digital scale, caliper, and measuring tools. All parameters were taken in triplicate to ensure accuracy.

Results:

There was a statistically significant increase ($p < 0.0001$) in all morphometric parameters of the spleen with advancing gestational age. Mean spleen weight increased from 0.29 ± 0.19 g in Group A (13–20 weeks) to 3.09 ± 0.56 g in Group D (≥31 weeks). A strong positive correlation was observed between gestational age and all spleen dimensions like length, width & thickness.

Conclusion:

Fetal spleen growth follows a predictable and significant pattern with increasing gestational age. These normative morphometric values provide a critical anatomical reference for fetal development assessments and may assist in prenatal diagnostics, anatomical research, and forensic evaluations.

INTRODUCTION

The human spleen it is organ of the lymphatic and immune systems which plays a important role in hematopoiesis, immune surveillance, and removal of senescent erythrocytes. During fetal life, the spleen serves as a significant hematopoietic organ until the bone marrow takes over [1]. Development of the spleen begins fifth week of gestation both Morphological also histological, with distinct changes observed throughout the second and third trimesters [2].

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Prenatal evaluation of splenic growth provides essential information about fetal development and overall health status. Intrauterine growth retardation, congenital infections, hematological disorders, and immunodeficiencies can be suspected based on abnormal splenic dimensions [3,4]. Therefore, normative morphometric data on the fetal spleen across gestational ages is crucial for fetal anatomical assessment, especially in the second and third trimesters [5].

Several researchers have emphasized the importance of fetal organ biometry for both anatomical teaching and clinical applications in prenatal diagnostics [6]. However, the available literature on the morphometry of the fetal spleen, particularly in the Indian population, remains limited. Most existing studies are confined to sonographic evaluations, which may be limited by operator dependency and resolution constraints, especially in mid-gestation [7].

Direct anatomical measurement of spleen parameters from fetal specimens allows for a more accurate understanding of organ growth patterns. Parameters such as spleen length, width, thickness, and weight are useful indicators of normal splenic development [8]. Establishing baseline morphometric values through anatomical dissection contributes to improving sonographic interpretations and can serve as a reference for gestational age estimation in forensic and anthropological contexts [9,10].

This study aims to document the morphometric changes in the fetal spleen across different gestational ages using dissected fetal specimens, thereby contributing normative data to the anatomical and clinical repository. Such data will be instrumental in enhancing diagnostic accuracy in prenatal evaluations and advancing the understanding of fetal organ development.

MATERIAL AND METHODS

Study Design

This was a descriptive, cross-sectional observational study conducted in the Department of Anatomy MGM Medical College Chhatrapati Sambhajinagar, following institutional ethical clearance and informed written consent from the parents.

Sample Collection

A total of 39 human fetuses of both sexes, ranging from 13 weeks of gestation to full term, were obtained from the Department of Obstetrics and Gynaecology after spontaneous abortions or preterm deliveries. Relevant obstetric history was documented, and permission was obtained from the Head of the Department.

Inclusion Criteria

- Spontaneous abortion and preterm fetuses

Exclusion Criteria

- Fetuses with visible congenital anomalies were excluded from the study.

Materials Used

- 10% Formalin for fixation
- Scientific digital weighing scale
- Measuring scale and thread
- Digital sliding calliper
- Standard surgical dissection instruments

Specimen Handling and Grouping

Fetuses were immediately fixed in 10% neutral buffered formalin. Based on gestational age calculated from obstetric records, crown-rump length (CRL), and biparietal diameter (BPD), fetuses were categorized into four groups:

Group	Gestational Age (Weeks)	Number of Fetuses
A	16–20 weeks	10
B	21–25 weeks	10
C	26–30 weeks	10
D	≥31 weeks	9

Parameters Studied

For each fetus, the following parameters were recorded:

- Crown-Rump Length (CRL)
- Biparietal Diameter (BPD)
- Weight of fetus
- Right and Left Foot Length
- Abdominal Circumference (AC)
- Thoracic Circumference (TC)

Spleen Dissection and Morphometric Analysis

Dissection of the spleen was carried out as per Cunningham's Manual of Practical Anatomy, 15th Edition. The spleen was removed carefully, and the following were measured:

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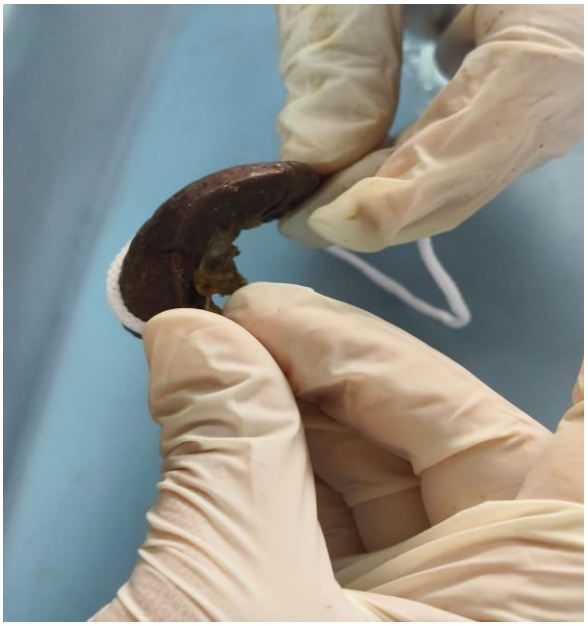
- Weight using a digital scale
- Length and Width using a measuring scale
- Thickness using a digital calliper

All morphometric measurements were taken thrice, and the average was recorded to minimize interobserver error. The spleens were further processed for histological examination using Haematoxylin and Eosin staining and examined under a light microscope.

Fig; 1

Fig; 2 Width of fetal spleen



Fig; 3 Length of fetal spleen

RESULTS AND OBSERVATIONS;

Table 1. Group-wise Distribution of Fetuses Based on Gestational Age

Group	Gestational Age (Weeks)	Number of Fetuses
A	13–20	10
B	21–25	10
C	26–30	10
D	31 (onwards)	9
Total		39

GA: Gestational Age, **n**: number of samples in each week, MIN-minimum , MAX-maximum, STD.DEV-standard deviation Data expressed as *Mean* ± *SD*.

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Table; 2 Group A (13–20 weeks) Fetal Spleen Morphometry

MAX	17.51	15.88	10.72	6.97	0.63
MIN	7.58	7.23	3.17	2.22	0.043
AVRAGE	12.972	11.796	7.966	5.589	0.2923
STD.DEV	2.672335308	2.354816341	2.192954375	1.412699937	0.186146925

Table; 3 Group B (21–25 weeks) Fetal Spleen Morphometry

MIN	17.32	16.01	11.39	8.77	0.73
MAX	21.64	20.55	17.01	12.34	1.39
AVRAGE	19.72090909	19.46727273	13.09727273	11.08	1.041818182
STD.DEV	1.704356835	1.413278694	2.077224644	1.289853135	0.223758302

Table; 4 Group C (26–30 weeks) Fetal Spleen Morphometry

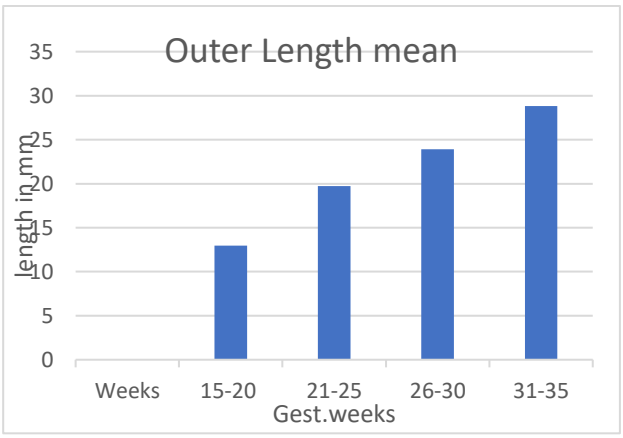
MIN	21.03	20.43	15.22	10.02	1.13
MAX	24.91	22.66	17.22	11.77	1.98
AVRAGE	23.69666667	21.48083333	16.4875	11.125	1.704166667
STD.DEV	1.102318768	0.778642694	0.570349795	0.536789841	0.309630604

Table; 5 **Group D (≥31 weeks) Fetal Spleen Morphometry**

MIN	27.38	25.04	19.99	12.15	2.33
MAX	29.71	27.98	20.68	14.78	3.86
AVRAGE	28.81454545	26.97363636	20.33090909	13.57454545	3.09090909
STD.DEV	0.88897569	0.918531437	0.19937402	1.093531486	0.56064695

Range mean charts

	Outer Length
Weeks	Mean
15-20	12.97
21-25	19.72
26-30	23.91
31-35	28.81



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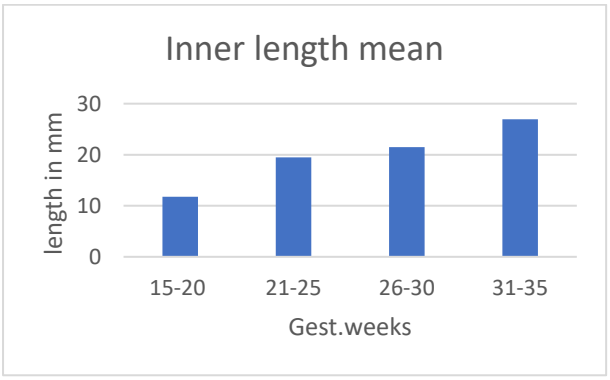
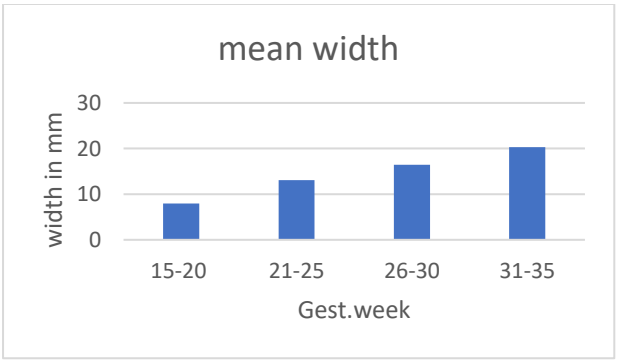
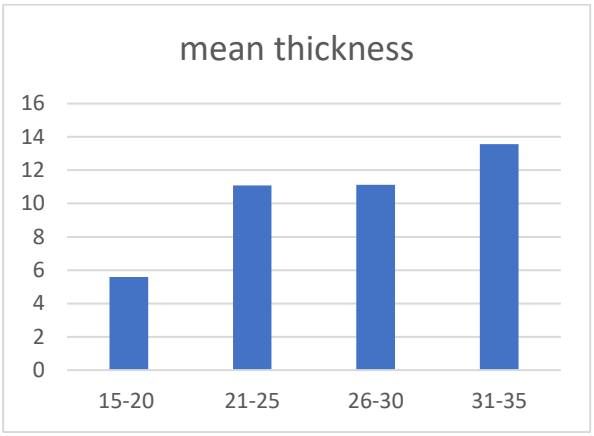
Inner length	
Weeks	mean
15-20	11.79
21-25	19.46
26-30	21.48
31-35	26.97



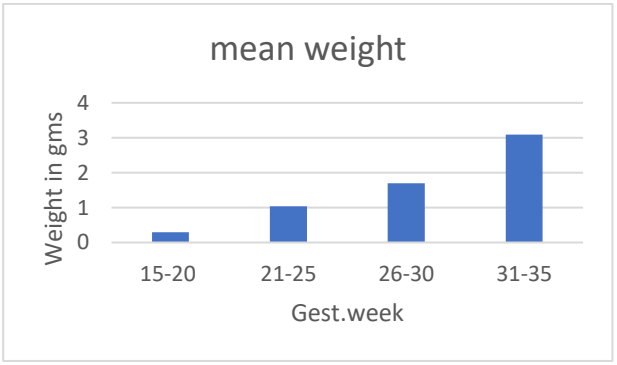
Weeks	mean width
15-20	7.96
21-25	13.09
26-30	16.48
31-35	20.33



Weeks	mean thickness
15-20	5.58
21-25	11.08
26-30	11.12
31-35	13.57



Weeks	Mean weight
15-20	0.29
21-25	1.04
26-30	1.7
31-35	3.09



Mean value of different dimensions like length, width, thickness & weight for each week is determined (Table 2,3,4,5). All the parametric values they are increasing as increase in gestational age.

DISCUSSION

In present cross-sectional study there is evaluation of different morphometric changes in the human fetal spleen from different gestational age from 13 weeks to full-term gestation. Our findings demonstrated a consistent and statistically significant increase in all spleen parameters — outer length, inner length, width, thickness, and weight — with advancing gestational age. This growth trend suggests a steady and predictable developmental pattern of the spleen in utero, reinforcing the importance of splenic biometry in fetal assessment.

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The spleen, although primarily lymphoid in function postnatally, plays a vital hematopoietic role during fetal life, especially between 12 and 24 weeks of gestation [11]. Our data supports this, with marked increases in spleen size observed particularly in the second trimester (Group B), aligning with peak fetal splenic hematopoietic activity [12].

The mean outer length of the spleen in Group A (13–20 weeks) was 12.97 mm, which progressively increased to 28.87 mm in Group D (≥31 weeks). Similarly, the spleen weight increased from 0.29 ± 0.19 g in early gestation to 3.09 ± 0.56 g in late gestation. These values are consistent with findings reported by Ghosh et al. and Puvithra et al., who documented linear and significant correlations between fetal spleen size and gestational age [13,14].

Interestingly, the most rapid increase in spleen thickness and width occurred between 21–30 weeks, a period when immune organ development accelerates [15]. This aligns with the histological maturation observed in studies by Siddiqui et al., where follicular structures begin to appear and differentiate in mid-gestation [16].

Our findings also complement imaging-based studies, such as those by Nishimura et al. and Levine et al., which highlight the feasibility of using spleen dimensions in ultrasonography as a reliable parameter for gestational age estimation and screening for fetal growth abnormalities [17,18]. However, direct anatomical measurement, as used in this study, provides more accurate and reproducible data, free from interobserver variability associated with sonographic techniques.

Additionally, studies like that of Bortoluzzi et al. emphasized that splenic weight and dimensions correlate well with other biometric indicators such as crown-rump length and biparietal diameter, which were also included in our data collection process [19]. Therefore, the spleen can serve as a valuable ancillary organ for assessing fetal maturity, especially in medico-legal or forensic cases.

While our results align with most published data, minor variations in measurements may be attributed to population-specific factors, fixation artifacts, or sample size limitations. This highlights the need for region-specific fetal anatomical databases to support both clinical and academic applications [20].

CONCLUSION

This study demonstrates a significant, consistent increase in fetal spleen size with advancing gestational age. The morphometric data provide important reference values for fetal development and can aid in prenatal assessment, growth monitoring, and forensic evaluation.

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