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Original Article

SCULPTING LIFE: STUDYING THE INTRICACIES OF HUMAN FETAL SPLEEN MORPHOLOGY DURING DEVELOPMENT

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ABSTRACT

Introduction: The spleen, a crucial lymphoid organ, plays a significant role in blood cell production and regulation. Emerging from mesodermal cells in the dorsal mesogastrium during the fourth embryonic week, the spleen is located in the left upper quadrant alongside the tenth rib. This study investigates morphological variations in human fetal spleens, serving as blood filters and storage sites for iron, erythrocytes, and platelets. This study aimed to assess morphological measurements of human fetal spleen development.

Materials and Methods: Sixty formalin-preserved fetuses (33 male, 27 female) of varying gestational ages were examined over a three-year period (2020-2023) at the Anatomy Department, Govt. Medical College Srinagar Garhwal, ensuring adherence to ethical guidelines. Gross characteristics such as position, shape, relations, notches & fissures, and ligaments were assessed and statistically analyzed.

Results: All fetal spleens were located in the left hypochondrium, with 50% exhibiting a wedge shape. The stomach consistently associated with the spleen, while no relationship was observed between the kidney, left colic flexure, and spleen in early fetal stages. The liver exhibited connections with the fetal spleen. Notches were most prevalent along the superior border, followed by the inferior border and lateral pole, with 27 spleens showing fissures.

Conclusions: Studying prenatal spleen development aids in understanding organ pathologies, thereby enhancing diagnostic and preventive techniques.

Keywords : Fetal Spleen, Wedge Shape, Notches, Fissures

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INTRODUCTION

We delve into the mysteries of the spleen, a magnificent organ known as the human body's largest secondary lymphoid organ. This organ develops in the upper left quadrant of the abdominal cavity, between the fundus of the stomach and the diaphragm, and takes shape around the 5th week of intrauterine life as a mesenchymal condensation inside the dorsal mesogastrium [1,2].

At birth, the spleen weighs around 13g and has distinct surfaces and boundaries that contribute to its individuality. Its uneven visceral surface is defined by impressions from gastric, renal, pancreatic, and colic organs [2].

Surprisingly, studies on adult spleens show a 25% to 50% difference in spleen diameters between living and deceased individuals. This disparity is caused by variables such as blood drainage, decreased portal pressure, muscular contraction, and autolytic alterations [1].

The present work embraces this fascinating differential. This understanding leads us into a compelling investigation of the morphological development of the fetal spleen, revealing mysteries that bridge the gap between life and afterlife in the field of spleen related morphometrical and morphological research based on the various stages of gestational age.

MATERIAL AND METHODS

This study evaluated 60 fetuses (33 male, 27 female) with gestational ages ranging from 13 to 40 weeks; the study took place between the years 2020 and 2023. The specimens were obtained at the obstetric and gynecology department of the base teaching hospital Srinagar Garhwal, Uttarakhand. Fixed medically terminated fetuses were kept in 10% formalin. Prior to beginning the study, written agreements had to be obtained from the families, as well as approval from the institutional Ethical Board. Fetuses with obvious abnormalities or diseases were excluded from the research.

Sample Stratification: From the 13th to the 40th week of gestation. These 60 fetuses (33 male, 27 female) were divided into 3 groups: - Group I - 13-20 weeks (n=22), Group II - 21-30 weeks (n=18), and Group III - 31-40 weeks (n=20).

Gestational ages were calculated using a variety of criteria, including crown-rump length (CRL), biparietal diameter, head circumference, and foot length. Fig-1(A,B) Based on gestational age, the fetuses were divided into 3 groups: group 1 (13-20 gw), group 2 (21-30 gw), and group 3 (31-40 gw), respectively. Dimensional measurements were taken using an electronic weighing scale, digital vernier caliper, measuring tape, a plastic ruler, and saker tape. (gw-gestational weeks)

(A) **(B)**

Fig. 1. (A) Weight (wt) measurement of 28th GW fetus
(B) Head circumference (HC) of 32 GW fetus

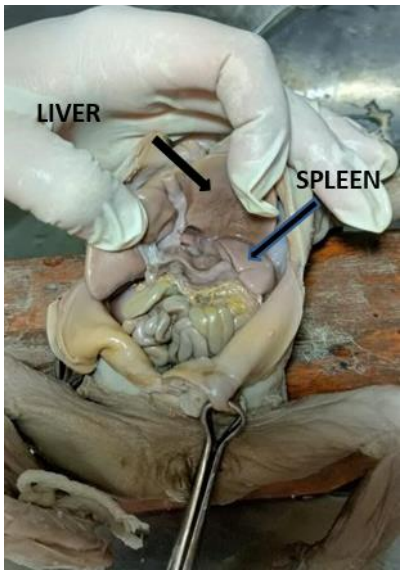

Fig. 2. Dissection of 32 GW fetus

(A) **(B)**

Fig. 3. (A) Length measurement of 32 GW fetal spleen
(B) Splenic notch on the superior border

Intra-abdominal tissues and the spleen were seen during abdominal dissection. The spleen's position in relation to the long axis, as indicated by the subcostal, vertical, and coronal planes, was studied. The relationships between the liver, stomach, colon, pancreas, kidney, adrenal gland, and diaphragm were investigated. The visibility of kidney and adrenal gland outlines was aided by the openness of the peritoneum at the posterior abdominal wall; otherwise, these organs were investigated by dissection. (Fig. 2)

The spleen's three primary ligaments—gastrosplenic, splenorenal, and phrenicocolic—were studied. The weights of the spleens were measured using an electronic weighing scale. Each spleen underwent a preparation step before weight and volume measurements were taken. (Table 2, 3)

The assessment of 60 dead human fetuses showed consistent features in spleen location and relationships with surrounding organs. Except at the hilum, [8,11] in all cases, stomach and spleen contact was made, with the spleen on the left and posterior to the stomach. In 95.5% of instances, the left colic flexure made contact with the spleen, mostly during the first trimester. Contact with the left kidney increased with gestational age. The spleen was continuously in touch with the left suprarenal gland, diaphragm, and tail of the pancreas.

The fetal spleens analyzed had a variety of forms, with the majority (65%) being wedge-shaped. In varying proportions, the stomach, left colic flexure, and pancreas were consistently connected to the fetal spleen. [Table-1] The study also looked at spleen notches and fissures, discovering the most amounts of notches on the superior border and fissures in 26 fetal spleens [3,4].

All parameters were defined using descriptive statistics. Using a one-way ANOVA test between and within groups, each morphological and metric was connected with separated gestational age groups. To detect sexual dimorphism, an independent sample test (T-test) was performed. This detailed observation gives vital insights into the fetal spleen's constant structural characteristics and alterations across gestational ages.

RESULTS

Shape of the fetal spleen	Numbers (n=60)	Percentage (100%)
Wedge shaped	30	**50%**
Irregular shaped	10	**16.666%**
Tetrahedral shaped	12	**20%**
Triangular shaped	5	**8.333%**
Oval shaped	3	**5%**

Table 1. Morphological features of fetal spleen

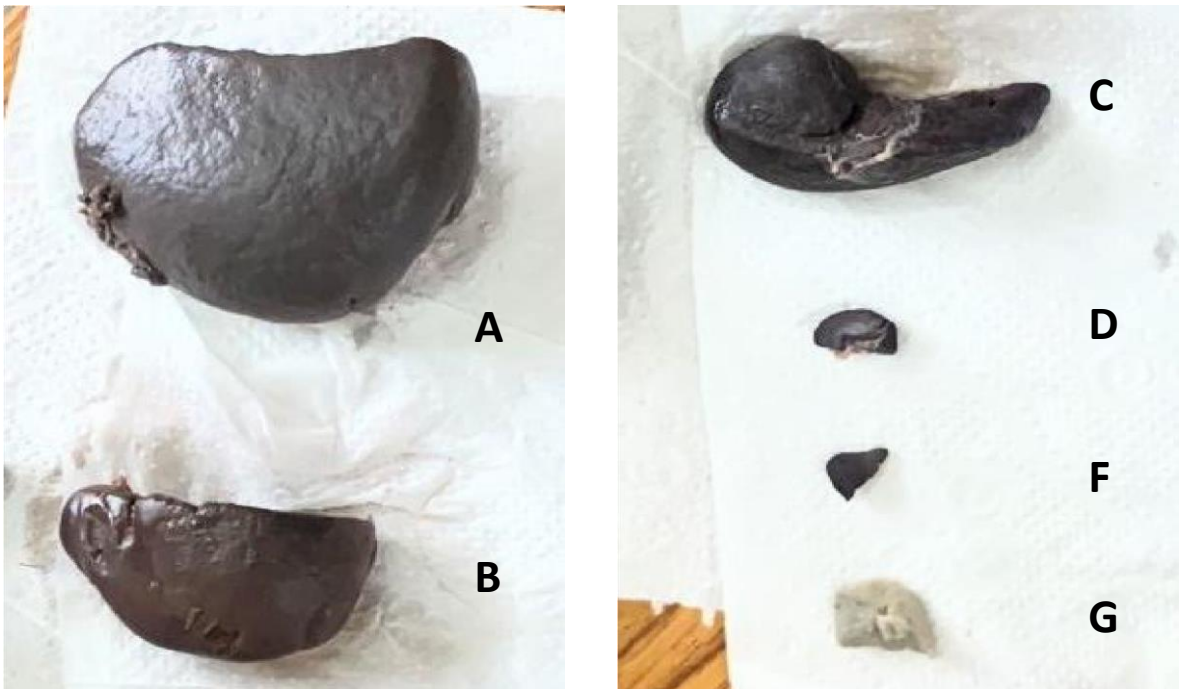

Fig. 4. Shapes of fetal spleen (A) Tetrahedral; (B) Wedge shaped; (C) Irregular shaped; (D) Oval shaped; (E) Triangular shaped; (G) Wedge shaped

GESTATIONAL WEEKS OF HUMAN FETUSES	MEAN±SD OF FETUS WEIGHT	MEAN±SD OF FETUS CHL	MEAN±SD OF FETUS CRL	MEAN±SD OF FETUS FL
GROUP1(13-20)	153.10±117.46	18.52±6.85	13.55±4.41	2.22±0.62
GROUP2(21-30)	854.34±339.79	36.58±4.22	25±4.07	5.49±1.05
GROUP3(31-40)	1940.32±339.72	46.77±1.64	31.14±0.88	6.90±0.70

Table 2. Mean weight, length, (CHL, CRL AND FL) of the human fetuses in different gestational age groups *(CHL-Crown Heel Length, CRL-Crown Rump Length, FL-Foot Length)

DISCUSSION

The present research focuses on the morphological development of the spleen throughout gestational weeks, with efforts to collect a larger sample from hospital resources. We were able to obtain 60 human fetuses, including gestational weeks 13 to 40, within the current limitations.

The average length, width, thickness, and weight of the fetal spleen across different gestational age groups demonstrated a steady rising trend with increasing gestational age. Further analysis revealed statistically significant changes in the mean fetal spleen length, width, and thickness across all gestational age ranges ($p < 0.001$).

GASTATIONAL AGE GROUPS	GROUP 1 (13-20WEEKS) (n=22)	GROUP 2 (21-30WEEKS) (n=18)	GROUP 3 (31-40WEEKS) (n=20)
MEAN WEIGHT OF FETAL SPLEEN(g) (mean ±SD)	1.78 ± 7.41	2.42 ± 2.03	4.66 ± 2.99
MEAN LEANGTH OF FETAL SPLEEN(cm) (mean ±SD)	1.05 ± 0.47	2.23 ± 0.79	2.93 ± 0.86
MEAN BREADTH OF FETAL SPLEEN(cm) (mean ±SD)	0.63 ± 0.28	1.51 ± 0.56	2.12 ± 0.51

Table 3. Mean weight, length, breadth, and thickness of the fetal spleen in different gestational age groups

Furthermore, a positive linear association was found between gestational age and spleen dimensions, emphasizing the complex interaction between fetal development and spleen morphology. This alignment with established observations from previous studies, such as Ungor et al. (2007), who carried out their study on 141 dead human fetuses aged between 9 and 40 weeks with no marked pathology and anomaly. The location of the spleen with neighboring structures, the existence of accessory spleens, notches on the border, fissures on the surfaces, major ligaments, and the shape of the spleen and its hilum were established.

The length, width, thickness, weight, volume, and the hilum dimensions of the spleen were measured. The dimensions, weight, and volume of the spleen increased with gestational age, and positive significant correlations were determined ($p < 0.001$). There was no difference between sexes in all parameters ($p > 0.05$). One or more accessory spleens have been found in 14% of cases.

Saheb et al. (2014) studied a total of 108 spleens collected from formalin-preserved fetuses. The measurements included length, width, thickness, and weight of the fetal spleen, and the ratio between fetal weight and spleen weight was measured after dividing the fetuses into 3 groups: 12-24 weeks, 25-36 weeks, and > 36 weeks. The average length, width, and thickness of the fetal spleen increased with gestational age, and the indices of splenic weight ranged between 0.33-0.35 percent. This reinforces the stability of the spleen location in the abdominal region.

Notably, during the embryonic stages of 6-10 weeks, the spleen was identified at the lumber level, later adopting its normal left hypochondriac position after 12 weeks, aligning with existing literature.

Examining morphometric aspects, measurements of length, width, thickness, and weight were conducted. Notably, the size of the spleen gradually increased from 1.5 cm at 13 weeks to 3.5 cm at 37 weeks gestation. The weight of the spleen exhibited a similar upward trend, ranging from 1.3 grams at 12 weeks to 9 grams at 38 weeks. These findings provide valuable insights into the developmental progression of the fetal spleen.

Regarding notches on the spleen borders, the superior border showed the highest incidence ratio (93.5%), followed by the inferior border (18%) and the lateral end or anterior extremity (7%). Notches were more numerous and deeper on the superior border, consistent with previous studies. The weight increase of the spleen was correlated with gestational age, aligning with the observations made by Henry Gray. Fissures were present in 32% of cases, primarily affecting the diaphragmatic surface, suggesting potential developmental defects or mechanical pressure influences. Interestingly, the relationship between the spleen and neighboring organs demonstrated variations from adult cases. The gastric impression and its consistent concave nature aligned with adults, while distinct rib impressions on the diaphragmatic surface were absent.

Adult spleen along with its anatomical variations has been studied extensively by several authors in human cadavers such as Das et al. (2008), Nayak et al. (2011), Rayhan et al. (2011), Chaware et al. (2012), Setty et al. (2013), Hussein et al. (2013), Chaudhari et al. (2014), Usha Kumari et al. (2014), Patil et al. (2014), Alex et al. (2015), Siva Chidambaram and Sridhar (2015), and Shankarrao and Rajendra (2016). They observed and counted notches on the borders of the spleen. The notches were mostly found on the superior border of the spleen in all the studies. Fissures on the diaphragmatic surface were also observed in some spleens. They also observed various shapes of the spleen such as wedge, tetrahedral and triangular, oval, scaphoid, V-shaped, liver-shaped. In the above studies, the wedge shape of the spleen was the most common.

In assessing relationships with surrounding structures, the left colic flexure, left adrenal gland, and pancreatic tail exhibited dynamic interactions during different trimesters. Notably, left kidney contact increased with gestational age. The study also delved into the presence of ligaments, with gastrosplenic and lienorenal ligaments consistently present and phrenicocolic ligament absent in a significant percentage, especially in the early fetal period. These detailed findings contribute to a comprehensive understanding of the morphological and relational aspects of the fetal spleen throughout various stages of development.

CONCLUSION

Studying the development of the spleen is essential given its dual role as a hematological and lymphopoietic organ during fetal life. Identification and palpation of notches on the superior border play an important role in diagnosing splenomegaly, providing a helpful foundation for clinicians in clinical practice. Furthermore, investigating the interactions between the spleen and other organs adds to our understanding of their development throughout fetal life. The lack of literature on the morphological evolution of the spleen emphasizes the significance of this research. It not only lays the groundwork for additional study, but it also has potential uses in pediatric medicine and surgery. This work adds to our understanding of spleen morphology, providing useful insights for both medical research and practical applications.

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