

## MORPHOLOGICAL AND MORPHOMETRIC STUDY OF HUMAN FOETAL SPLEEN

Shaik Hussain Saheb \*<sup>1</sup>, Subhadra Devi Velichety <sup>2</sup>, Haseena S <sup>3</sup>.

\*<sup>1</sup> Assistant Professor of Anatomy, JJM Medical College, Davangere, India.

<sup>2</sup> Professor and HOD, Department of Anatomy and Controller of Examinations, SVIMS University, Tirupati, India.

<sup>3</sup> Ph.D. Scholar, Department of Physiology, Shri BM Patil Medical College, Bijapur, India.

### ABSTRACT

**Background:** Spleen is a part of circulatory system, it is generally described with the lymphatic organs because of very large population of lymphocytes present in it. In surgical and medical history spleen has been described as a mysterious organ. Clear understanding and appreciation of its function emerged only later half of the 20<sup>th</sup> century, because of erythropoietic nature of foetal spleen the present study was conducted.

**Aims and Objects:** To study variations on morphology and morphometry of human foetal spleen at different gestational ages.

**Materials and Methods:** Foetal spleens were collected from SV Medical college, Tirupati and JJM Medical College, Davangere, India. Total 108 spleens were collected from foetal cadavers. The measurements length, width, thickness and weight of foetal spleen and ratio between foetal weight and spleen weight were measured.

**Results:** The average length, width and thickness of foetal spleen of gestational age between 12 to 24 weeks were 1.7cm, 1.08 and 0.8cm respectively, gestational age between 25 to 36 weeks were 2.53cm, 1.64 and 1.0cm respectively and gestational age greater than 36 weeks were 2.67cm, 1.67 and 1.0cm respectively. The average foetal weight and spleen weight of gestational age between 12 to 24 weeks were 800gm and 2.84gm respectively and ratio between two was 0.35%, gestational age between 25 to 36 weeks were 1321.42gm and 4.52gm respectively ratio between two was 0.34% and gestational age greater than 36 weeks were 2100gm and 7.07gm respectively ratio between two was 0.33%.

**Conclusion:** The measurements of foetal spleen are very helpful in medicine and surgical practice because of its clinical importance. The human foetal spleen is a secondary site of red blood cell.

**KEYWORDS:** Spleen; Erythropoiesis; Accessory Spleen; Splenic artery.

**Address for Correspondence:** Shaik Hussain Saheb, Assistant Professor of Anatomy, JJM Medical College, Davangere, India. Mobile --+91-9242056660. **E-Mail:** anatomyshs@gmail.com

### Access this Article online

#### Quick Response code



**Web site:** International Journal of Anatomy and Research  
ISSN 2321-4287  
[www.ijmhr.org/ijar.htm](http://www.ijmhr.org/ijar.htm)

Received: 02 Feb 2014

Peer Review: 02 Feb 2014 Published (O):30 March 2014

Accepted: 21 Feb 2014 Published (P):30 March 2014

### INTRODUCTION

Through spleen is a part of circulatory system it is generally described with the lymphatic organs because of very large population of lymphocytes present in it [1]. In surgical and medical history spleen has been described as mysterious organ. Clear understanding and appreciation of its function emerged only in the later half of 20<sup>th</sup> century [2]. Lymphatic system is defence against illness. The cells which deals with invasion by

harmful agents originated, developed, matured and stored in lymphatic organs. For these reasons the lymphatic system is intimately related both structurally and functionally to the blood vascular system. Certain specialized organs devoted to processing and modifying lymph and lymphoid cells are present in all normal mammals. The largest and best example for lymphatic organ is spleen. Spleen is flaccid bag that serves as a storage site of blood and

processing station for scavenging of aged erythrocytes. Spleen is one of the dispensable organs, because mammal get along quite nicely without a spleen [1]. The spleen has the third – highest specific blood perfusion rate in human body typically  $48\text{mm}^3/\text{sec-gm.}(450\text{m}^3/\text{min})$ [3].

The spleen has colourful history. The English name 'spleen' is unclear. The word spleen is derived from the Greek word "Splanchnon" which menace, "Viscous" or "Spaw" which menace "to draw". English dictionary meaning of word "spleen" is 'ill temper'. Ancient people believed that the function of spleen is to draw spoiled blood. They attribute this to 'dark purple red' colour spleen. In ancient Greece the spleen was thought to be the source of black bile and it is related to melancholy. The ancient authors wrote that spleen is the "seat of laughter" and the locus of "conflicting emotions"[4].

In athletes the spleen was thought to be a source of discomfort sometimes felt as "A stitch in the site" and that if it were removed or ablated would be able to run faster. Ancient Greece athletes may have had their spleen ablated to improve their performance. This hypothesis was studied by John F by conducting studies on splenectomised mice and control mice to evaluate their ability to run a race where the splenectomised mice were reported to be faster [5]. Vasalius performed splenectomy in mice and some other animals and determined that the spleen is not essential to life and did not observe any changes following removal of spleen[6]. Rosh M H identified the spleen as the site of red cell destruction in autoimmune haemolytic anaemia [7].

The spleen is a haemo lymph organ and belongs to the reticulo endothelial system. It is haemolymph because of the following reasons. Spleen filters blood by taking out worn out erythrocytes or any microbial antigens from the circulation, whereas lymph node filters lymph. In foetal life spleen manufactures erythrocytes and after birth it manufactures lymphocytes. Each splenic lymphatic follicle is traversed eccentrically by an arteriole and is surrounded by red pulp. Spleen is the major respiratory of mononuclear phagocyte macrophage cells in the red pulp and of lymphoid cell in the white pulp.

Spleen is the major respiratory of mononuclear phagocyte macrophage cells in the red pulp and of lymphoid cell in the white pulp. Spleen has diaphragmatic and visceral surfaces, superior and anterior borders and inferior and posterior extremities [8]. Diaphragmatic surface is smooth and convex, directed upwards, backwards and to the left. Visceral surface presents gastric, renal colic and pancreatic impressions. Superior border separating the gastric impression from the diaphragmatic surface is thin, convex and presents one or two notches close to the lateral end. Inferior border separates the renal impression from diaphragmatic surface and extends obliquely coinciding with the lower border of the left 11 rib. Anterior basal angle is the junction of the superior border and lateral end and it represents the most forward projecting part of spleen. Posterior basal angle is the junction of the inferior border and lateral end of spleen. Posterior extremity or medial end is blunt and rounded, directed upwards backwards and medially towards vertebral column. Anterior extremity or lateral end is broad and represented by a border, which extends between superior and inferior borders. It is directed downwards, forwards and to the left [9].

Spleen is situated in the upper end left part of abdomen between the fundus of stomach and the diaphragm. It lies mainly in the left hypochondria and partly in epigastric regions [10]. Accessory spleens may form near the hilum of main spleen, with in gastro splenic ligament, greater omentum and rarely left spermatic cord [11]. Spleen has dark purple colour [3]. The shape of spleen is influenced largely by the stomach and left colic flexure. When the stomach is distended the spleen resembles a "segment of orange", while distension of the colon causes it to become an "irregular tetrahedral" form. According to Harald Ellis the spleen has cupped hand shape [12]. According to Sir Alfred Cuschier spleen varies in shape and three morphological types are desired [13]. According to studies of Prassopolous and Ranganathan spleen shapes are crescentic, rhomboid and triangular [14, 15]. Size of spleen varies with age, with the individual and in the same individual under different conditions. In the adult it is usually about 12cm

long, 7 to 8 cm broad and 3 to 4 cm wide [16]. According to Malawatkar [17] the sizes are 1.4x3.5x7 cm. According to Hareldellis the odd numbers 1,3,5,7,9,11 summarize some splenic statistic. Spleen measures 1x3x5 inches, weight 7 oz and lies deep to the left 9<sup>th</sup> to 11<sup>th</sup> ribs, same study mentioned that spleen is about size of cupped hand [12]. According to Sir Alfred Cushier the normal dimensions of the spleen are 13x9x3 cm [13]. There is limited research about the sizes of foetal spleen and infant spleen at 6<sup>th</sup> week the length of spleen is 10mm [18,19].

The weight of spleen varies with age, with the individual and in the same individual and in the same individual under different conditions. Henry Gray in his book on the structure and uses of spleen reported a table of experiments to determine the weight of spleen before birth. Henry Gray compared the weight of spleen with that of body weight of foetus and found it to be 1 to 4000 at 5<sup>th</sup> month, 1 to 700 at 7<sup>th</sup> and 1 to 350 at 9<sup>th</sup> foetal month. Henry gray concluded that the spleen attains its greatest size during adult life. He stated that size of the spleen increases very rapidly in the embryo from about 6<sup>th</sup> month and at birth its weight in proportion to entire body is almost equal to that in the adult. According to same study at birth it is 1 to 350, while in adult life it varies from 1 to 340 or 500. In old age the organ proportion to the entire body weighed is 1 to 700[20]. Normal weight of spleen in adults is about 150g or 70 oz and normal range is 80 to 300 gm [21].

Potter compared splenic weight to that of the body weight, according to his study weight of spleen at birth is 11gm [22]. According to Bannister at birth spleen weighs 13gm and it doubles in the first postnatal year and triples by the end of the third year [8]. Spleen length was highly correlated with age, height, weight and BSA, but there is no statistical significant differences between the sexes [23]. According to Audrey et al the length of spleen ranges between 14 -16.3cm in normal adults. There is limited research about breadth and width [24]. Normally the breadth is 3 inches and width is 5 inches [25].

According to Ayers study spleen is supplied by the sympathetic from coeliac plexus. The fibres

pass along with splenic artery and its branches, to enter the hilum and run with the segmental arteries and their branches. These fibres appear to be mainly noradrenergic vasomotor, concerned with the regulation of blood flow through the spleen. The spleen performs the functions of both immune and hematopoietic systems[26]. The present study undertaken for morphometric data and morphological features of human foetal spleen.

## MATERIALS AND METHODS

A total of 108 spleen were collected from aborted embryos and fetuses of both sexes and different gestational in the department of Anatomy, SV Medical College, Tirupati and JJM Medical College, Davangere, India. The specimens were categorized into the different age groups ie. 0-12 weeks, 12-24 weeks, 25-36 weeks and above 36 weeks and distributions of spleens in different groups were tabled (Table 1).

Gestational age (weeks)	No. of Spleens
0-12	12
12-24	30
24-36	42
>36	24
Total	108

**Table 1:** Distribution of number of spleens in different groups.

## RESULTS

The average length, width and thickness of foetal spleen of gestational age between 12 to 24 weeks were 1.7cm, 1.08 and 0.8cm respectively, gestational age between 25 to 36 weeks were 2.53cm, 1.64 and 1.0cm respectively and gestational age greater than 36 weeks were 2.67cm, 1.67 and 1.0cm respectively (Table 2). The average foetal weight and spleen weight of gestational age between 12 to 24 weeks were 800gm and 2.84gm respectively and ratio between two was 0.35%, gestational age between 25 to 36 weeks were 1321.42gm and 4.52gm respectively ratio between two was 0.34% and gestational age greater than 36 weeks were 2100gm and 7.07gm respectively ratio between two was 0.33%.

## DISCUSSION

In the embryos of 6-8weeks and 8-10 weeks gestational age spleen was identified at the lumbar level of serial sections of abdominal region.

**Table 2:** Average length, width and thickness of spleen specimens.

Gestational age (weeks)	Average length (Cm)	Average width (Cm)	Average thickness (Cm)
12-24	1.7	1.08	0.8
25-36	2.52	1.64	1
>36	2.67	1.64	1

In the rest of the foetuses of more than 12 weeks gestational age the spleen was observed in its normal location in the left hypochondric region of abdomen. These findings on location are in agreement with the findings reported by several authors in the literature [2,7]. Surfaces of all the collected spleens were smooth in appearance. Diaphragmatic surface presented impressions of 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> ribs in almost all the spleens. All the spleens were dark purple in colour. These findings on colour are in agreement with the Robert and Adman et al [3,4].

The data on various morphometric characters viz. length, width, thickness and weight of spleens were measured in present study (Table 2). Length of spleen in our study varied from 1.5 cm at 12 weeks to 3.2cm at 38 weeks gestation. Breadth of spleen ranged from 0.6cm at 12 weeks to 1.3cm at 38weeks. Average length, width and thickness of spleen at different gestational ages were gradually increased. There is limited literature available on sizes of foetal spleen and infant spleen. According to Jepta and Jlskoot studies the length of spleen at 6<sup>th</sup> week of gestation is 10mm [18,19].

The weight of spleen varied from 1.3 grams at 12 weeks to 9 grams at 38 weeks gestational age. There is gradual increase in weight in the weight of spleen in the three gestational age groups of more than 12weeks studied. Henry Gray compared the weight of spleen with that of body weight of foetus and found it to be 1 to 4000 at 5<sup>th</sup> month, 1 to 700 at 7<sup>th</sup> and 1 to 350 at 9<sup>th</sup> foetal month. In the present study during the similar gestational ages it was 2700 at 5<sup>th</sup> month, 1 in 2787 at 7<sup>th</sup> month and 1 in 313 at full term. It is in agreement with that reported by Henry Gray at full term but not before that. Henry Gray stated that size of the spleen increases very rapidly in the embryo from about 6<sup>th</sup> month. Observation in the present study are in agreement to this statement [20].

The ratio between foetal weight and spleen

weight in the present study is 500 to 999: 2.7; 1000 to 1999: 4.4 2000-2999:7.8. In a similar group Potter reported it as 1.7, 4.2 and 8.0 for the similar range of foetal weight. Excepting for the smaller weight group of 500 to 999 in the other groups our results are close to those reported by Potter [22]. There is gradual increase in the organ weight at different groups with the increase in foetal weight, but the ratio between foetal and splenic weight is more or less equal in the three categories studied (Table 3).

**Table 3:** Ratio between foetal weight and spleen weight in different groups.

Gestational age (weeks)	Average foetal weight (Gms)	Average Spleen weight (Gms)	Ratio between weight of Foetus and Spleen (%)
12-24	800	2.84	0.35
25-36	1321.42	4.52	0.34
>36	2100	7.07	0.33

## CONCLUSION

The knowledge of human foetal spleen is very helpful to paediatric medicine and surgery practice because of its multifunction in children as erythropoietic and lymphatic organ.

**Conflicts of Interests: None**

## REFERENCES

- [1]. Thomas Caceci. Lymphatic System: Spleen & Other Organs. <http://www.vetmed.vt.edu/education/curriculum/vm8054/Labs/Lab13/Lab13.htm>.
- [2]. Douglas L Fraker. Surgery – Scientific principles and practice 3<sup>rd</sup> edition. Philadelphia, Pa; London : Lippincott Williams & Wilkins 2001;1236-59pp.
- [3]. Robert A Focitias Jr. Nano medicine, volume III A; Biocompatibility, Cadern Biosciences, George Town. ISBN-10: 1570596808. Edition: 1. June 1999.
- [4]. Adman F E Park, Rodnick Mckimij. Schwartz's Principles of Surgery McGraw -Hill. 2005;292p.
- [5]. John F Upledger. Cell talk. Talking to your cell published by North Atlantic Books. ISBN-1556434618. 1984;125p.
- [6]. Vasalius. A catalog of the H.Winnet Orr Historical collection . American college of surgeons; Chicago 1960. Library of congress catalogue. Card number 60-11348.
- [7]. Ross M H. Histology – A text book and Atlas 3<sup>rd</sup> edition. Lippincott Williams & Wilkins. 1999;349-53p.
- [8]. Bannister. Gray's Anatomy 38<sup>th</sup> edition. Churchill Living tone. 1995;1437-45pp.
- [9]. Romanes GJ. Cunningham's text book of Anatomy 12<sup>th</sup> edition. Oxford Medical publications. 1918:633-39 p.

- [10].Rosenberg HK, Markowitz RI, Kolberg, Park C, Hubbard A, Bellah RD. Normal splenic size in infants and children: Sonographic measurements. American Journal of Roentgenol.1991;157(1):119-21.
- [11].Albarzanji AJ, Penny SR, Lemery J. Pathology of spleen. Journal of Clinical Pathology. 1976;29:657-79.
- [12].Herald Ellis. Clinical Anatomy. Blackwell publications. 2002;110-13p.
- [13].Sir Alfred Cushieri, Robert JC, Steel. Essentials of Surgical Practice, Butterworth-Heinemann Limited, 4<sup>th</sup> edition. 2000;454-75p.
- [14].Prassopoulos P, Daskalogiannaki M, Raissaki A, Hatjidakis, Gourtsoyiannis. Determination of normal splenic volume on computed tomography in relation to age, gender and habitus. European Radiology.1997;7:246-48.
- [15].Ranganathan T.S. A text book of Human Anatomy. S. Chand Group. ISBN:8121903955. 2006;281-82p.
- [16].Hamilton W J. Text book of Anatomy. London etc.: Macmillan, 1976. 2<sup>nd</sup> edition. 1976;501-03.
- [17].Malwatkar SG. Integrated text book of Anatomy. Oxford university press. ISBN 0195648722. 1999;100-10.
- [18].JepthaR. Hostetler, G.Adolph Ackerman, Lymphopoiesis and lymph node histogenesis in the embryonic and neonatal rabbit, American Journal of Anatomy, 1969;124(1);57-75.
- [19].Jiskoot PMC. Unusual splenic sinusoidal in an overload in sickle cell. Journal of clinical pathology. 2004;57:539-40.
- [20]. Henry Gary. On the structure and uses of the spleen. JW Parker and Sons. 1860:36p
- [21]. Chummy S Sinatamby. Lats's Anatomy – Regional and applied anatomy. Churchill Living stone. 1994;279-81p.
- [22]. Potter EL. Pathology of foetal neonatal anatomy. 1961:415-20.
- [23]. Al-Iman O, Suleiman A, Khuleifat S. Ultra sound assessment of normal splenic Length and spleen to kidney ratio in children. East Mediterr Health Journal. 2000;(2):514-6.
- [24].Audrey L, Spielmann, David M, DeLong, Mark A, Kliever. Sonographic Evaluation of Spleen size in tall healthy athletes Splenic. American Journal of Pathology. 2001;159:501-12.
- [25].Swischuk L E, Williams JB, John SD. Torsion of wandering spleen. The whorled appearance of the spleen pedicle on CT. Paediatric Radiology. 1993;23:476-7.
- [26]. Ayers A B, Davies BN, Washington PG. Responses of the isolated perfused human spleen to sympathetic nerve stimulation, catecholamine and poly peptides. British Journal of Pharmacology. 2001;44:17-30.

#### How to cite this article:

Shaik Hussain Saheb, Subhadra Devi Velichety, Haseena S. MORPHOLOGICAL AND MORPHOMETRIC STUDY OF HUMAN FOETAL SPLEEN. Int J Anat Res 2014;2(1):234-38.