

■ ORIGINAL ARTICLE

Sexual Dimorphism of Adult Human Spleen in Haryana State of North India

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ABSTRACT

INTRODUCTION: Spleen is an important lymphoid organ of human body in the upper left part of the abdomen. Spleen performs various functions as it produces immune response against blood-borne antigens and acts as the graveyard of defective and aged erythrocytes. It exhibits sexual dimorphism.

OBJECTIVE: The present study is conducted to evaluate sexual dimorphism in morphometry of spleen (spleen weight, length, width, thickness and surface area) in the Haryana region. Region wise assessment of spleen size gives a broad perspective of spleen sizes and also helps in understanding the ranges in morphometry of spleen with respect to gender. The study proves helpful in context of providing spleen size for spleen transplantation.

MATERIALS AND METHODS: After taking permission from Institute Ethics Committee, 30 males and 30 females adult human spleens in the age group of 16-70 years belonging to the Haryana region of North India were included in the study. The study was conducted in the Anatomy department along with collaboration from the Forensic department at Pt. B.D. Sharma PGIMS, Rohtak. The data thus obtained was recorded and analysed using suitable software.

RESULTS: Statistical significance in dimorphism of splenic weight, length and splenic total surface area in males and females. The results of the present study would be useful for anthropologists, and forensic medicine experts to identify a spleen.

KEYWORDS | spleen, sexual dimorphism, morphometry

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INTRODUCTION

SPLEEN, THE LARGEST UNIT OF LYMPHOID tissue in the body is a soft, purple-colored organ about the size of a fist in the left hypochondrium. It is shaped like the segment of an orange.¹ Spleen is situated in the upper and left part of abdomen between the fundus of stomach and the diaphragm. It lies in the left hypochondrium and partly in epigastrium. Its axis is oblique and is directed

downward, forwards, and laterally co inciding with the tenth rib. Two surfaces can be usually recognized, a convex diaphragmatic surface and a visceral surface. The visceral surface has concave gastric and renal impressions and a flat colic impression. The visceral surface has a depression called as hilum in the posterior part of the gastric surface, through its blood vessels, nerves and lymphatics enter or leave the organ.

The tail of pancreas is in relationship with it. The normal spleen varies greatly in size. Its average dimensions are approximately: length 5 inches, breadth 3 inches and thickness 1.5 inches. The average weight in an adult is about 140-200 gms.²

Spleen develops as a lobulated mass from the mesoderm of upper part of dorsal mesogastrium under cover of its left layer. There have been some studies depicting sexual differences between splenic parameters, but there is paucity of such study as far Haryana region of North India is concerned so it is thought pertinent to conduct this study.

MATERIALS AND METHODS

The permission from Institute Ethics committee was taken prior to commencement of study.

Material for the present study consisted of apparently healthy spleen of 60 adults (30 male and 30 female) in age group of (16-70) years, belonging to Haryana region of North India.

The specimens were obtained from the department of Forensic Medicine. The medico-legal autopsies which had been performed within twenty four hours of death were included so that the morphometry is not altered due to decomposition as Modi reported, that owing to putrefactive changes spleen becomes pulpy, greenish steel and gets reduced to a different mass in 2-3 days in summer³ and the exclusion criteria such as diseases tuberculosis, HIV, hepatitis, SLE, rheumatoid arthritis, thalassemia, polycythemia, lymphomas were noted and spleen from healthy subjects were collected. Spleen samples had not been sufficient in all the age groups and body weight of cadaver is not feasible to be measured so these two criteria were not considered for the study.

Morphometric parameters and the methods used were as follows:

1. *Weight of the spleen:* The weight of the spleen was recorded by using Electronic Weighing Balance of "SARTORIUS-AZ3102

M-PowerSeries" with sensitivity of 0.1 gm.

2. *Length of spleen:* length was noted on diaphragmatic surface by a thread from superior angle to inferior angle passing through maximum convexity. (Figure 1)
3. *Breadth of spleen:* breadth was noted on diaphragmatic surface again by the thread passing horizontally through the maximum convexity and through the mid-point of the length. (Figure 1).
Thread had been measured against the ruler and length and breadth of spleen was measured.
4. *Thickness of spleen:* Thickness was noted by passing a needle through the maximum convexity and through mid-point of length on diaphragmatic surface. Distance traversed by the needle is measured by the help of a ruler that gives the thickness of spleen. (Figure 1)
5. *Areas of various surfaces* (diaphragmatic, gastric, renal and colic) were calculated after wrapping each surface in butter paper and cutting neatly from the borders; they were outlined on the graph paper. Counting of the squares within the outline gave the surface area. (Figure 1)

Three readings of splenic weight, length, breadth, thickness, and surface area measurements were taken, and their mean values were taken as final reading. The data so obtained was subjected to statistical analysis. Student T-test was applied to study the sexual dimorphism.

P value was calculated and analyzed⁴ as:

>0.05 – Statistically Insignificant

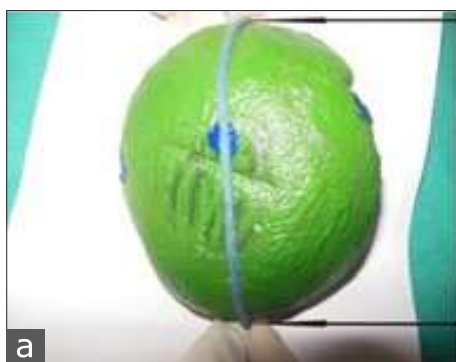
<0.05 – Statistically Significant

<0.01 – Statistically Highly significant

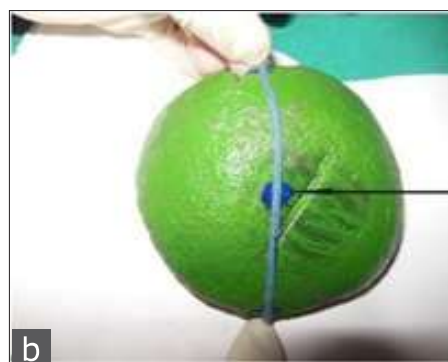
RESULTS

1. Weight of spleen in male and female.

In males, the splenic weight varied from 90 gm to 148 gm. The mean weight was 131.60 ± 12.90gm. In females, the splenic weight varied from 70gm to 94gm. The mean weight was



a Method to show measurement of splenic length



b Method to show measurement of splenic breadth



c Method of measuring thickness of spleen .



d Method showing measurement of surface area.

87.86 ± 5.69 gm. When splenic weight of male was compared with that of females; it showed p value as <0.01 . The difference was found to be highly significant statistically. (Table 1)

2. Sexual dimorphism in dimensions (length, breadth and thickness) of spleen.

I Length of spleen

In males, the length of spleen varied from 9.5 cm to 17 cm. (mean length 11.45 ± 1.43 cm). In females, the length of spleen varied from 8 cm to 13 cm. (mean length 9.91 ± 1.18 cm). The difference was found to be extremely statistically significant (p value = .000166). (Table 1).

II Breadth of spleen

In males, breadth of spleen varied from 5 to 8 cm. (mean breadth was 6.26 ± 0.73 cm). In females, breadth of spleen varied from 4 to 8 cm. In females; mean breadth of spleen was 6.01 ± 0.914 cm. The difference was not statistically significant. (Table 1).

III Thickness of spleen

In males, thickness varied from 1.5 to 2 cm.

(mean thickness was 1.92 ± 0.09 cm). In females, thickness varied from 1.5 to 2 cm. (mean splenic thickness was 1.92 ± 0.15 cm). The difference was not statistically significant as p value was 0.91. (Table 1).

3. Sexual dimorphism in total surface area of spleen.

In males, surface area varied from 213 cm sq to 308 cm sq. (mean surface area of spleen was 256.23 ± 23.46 cm sq). In females, surface area varied from 123 to 202 cm sq. (mean surface area was 158.96 ± 25.41 cm sq). When comparison between the two was done; P value was <0.01 . The difference was found to be highly significant. (Table 1).

DISCUSSION

The present study was conducted to see sexual dimorphism of spleen in North Indian population (specifically of Haryana). Such study was not done in the past to the best of my knowledge. The comparison of the observations of morphometric parameters of the spleen in

Serial No.:	Morphometric parameter	Male (n=30)	Female (n=30)	P Value
1	Splenic weight (gm)	131.6 ± 12.8	87.86 ± 5.7	P <0.01 (Significant)
2	Splenic length (cm)	11.45 ± 1.44	9.91 ± 1.18	P <0.01 (Significant)
3	Splenic breadth (cm)	6.26 ± 0.74	6.01 ± 0.90	p> 0.01 (Non-significant)
4	Splenic thickness (cm)	1.92 ± 0.09	1.92 ± 0.25	p> 0.01
5	Splenic total surface area (sq cm)	256.23 ± 23.47	158.96 ± 25.82	P <0.01 (Significant)

Table 1: Measurements of spleen morphometry.

LENGTH	PRESENT STUDY (Cadaveric)	ASGHAR (by CT Images) ¹⁵	MITTAL (Sonographic) ¹³	MACHALEK (Cadaveric Study) ¹¹
Male	11.45 ± 1.43	10.91 ± 1.67	9.40 ± 0.91	12.3
Female	9.916 ± 1.18	10.34 ± 1.58	9.34 ± 0.95	11.2
Sex Difference	Significant	Not significant	Not significant	Significant

Table 2: Comparison of splenic length with other studies

Average Splenic width (cms)	Present study	Arora et al ¹⁴	Asghar et al ^{15,16}	Spielmann et al ¹²	Mittal & Choudhry ¹³	Machalek et al ¹¹
	6.13+/-0.82		6.26+/-1.66			
Males	6.26 +/-0.73	–	6.74 +/- 1.62	5.0 +/-0.8	3.45+/-0.59	7.5
Females	6.01 +/- 0.91	–	5.61 +/- 1.58	4.2 +/-0.7	3.45+/-0.59	7.4
Sexual difference	Not significant	More in Males	Not Significant	–	–	–

Table 3: Comparison of splenic width with other studies.

Splenic thickness	Present study	Arora et al ¹⁴
Average	1.89+/-0.16	–
Male	1.86+/-0.17	–
Female	1.92+/-0.15	–
Sexual difference	Not significant	More in Males

Table 4: Comparison of splenic thickness with other studies.

Total surface area of spleen	Present study	Asghar et al ^{15,16}
Males	256.23+/-23.46	290.35+/-14.78
Females	158.96+/-25.41	205.56+/-77.65
Sexual difference	Highly Significant	Significant

Table 5: Comparison of splenic total surface area with other studies

our study with those of other workers is shown in the table: 1-5 as per available literature.

In our study, average weight in males was 131.6 ± 12.90 gm and in females average weight was 87.86 ± 5.69 gm. The difference was found to be highly statistically significant. In the study done by Krumbhaar and Lipincott, they had found that male spleens were heavier than the female spleens.⁵ Jain *et al.* calculated mean average weight in males as 149 gm and 146.4 gm in females.⁶ Sprogoe-Jakobsen *et al.* reported that

in males; average weight was found to be 130.3 gm while in females average weight was 124.2 gm.⁷ Their study concluded that spleen weight is not correlated to sex apart from the fact that females are smaller than males. Grandmison *et al.* reported that in males; average weight was reported as 156 ± 87 gm, while in females average weight was 140 ± 78 gm.⁸ Kim *et al.* studied the average weight in males as 115.29 ± 42.93 gm; and in females average weight was 99.51 ± 43 gm.⁹ There was no statistically

significant difference in the spleen weight of males and females. In 2006, Kohli and Aggarwal compared the spleen weights at various places e.g. Delhi, U.P., Bombay, and Nagpur and gave the average weight of spleen in males as 130-160 gm and in females as 120-150 gm.¹⁰ The average length of spleen in males was 11.45 ± 1.43 cm and in females it was 9.91 ± 1.18 cm. The difference was found to be extremely significant. (p value = 0.00016). In a study done⁴ on the cadavers by Machalek *et al.*¹¹ (sample size =35); average in males was found to be 12.3 cm and average in females was 11.2 cm. In study by Spielman *et al.*¹² average in males was found to be 11.40 ± 1.7 cm and average in females was found to be 10.30 ± 1.1 cm. Mittal *et al.*¹³ did sonographic study on 100 male and 100 female subjects and came out with average of 9.40 ± 0.91 cm in males and 9.34 ± 0.95 cm. Asghar *et al.*^{15,16} did study on CT images and found the average to be 10.67 ± 1.62 cm and in males average was found to be 10.91 ± 1.67 cm and in females it was 10.34 ± 1.58 cm. The difference in our study and in other studies was not much. Sexual dimorphism was positive in our study and length is more in males as was concluded by the sonographic study of Arora *et al.*¹⁴ Sexual dimorphism was not reported by Machalek *et al.*¹¹ and by Asghar *et al.*^{15,16} (As shown in Table 2)

Machalek *et al.*¹¹ (cadaveric study; n= 35 each) concluded that average width was 7.5 cm in males and 7.4 in females. Mittal *et al.*¹³ (sonographic study; n =100 each) concluded that 3.45 ± 0.59 cm was average width in males and in females. Study by Asghar *et al.*^{15,16} concluded that average width was 6.26 ± 1.66 cm.

Average width in males was 6.74 ± 1.62 cm and in females was 5.61 ± 1.58 cm. In our study, average width was 6.13 ± 0.82 cm. In males, it was 6.26 ± 0.73 cm. In females, average width was 6.01 ± 0.914 cm. Sexual dimorphism was not seen in our study as well as those in the studies by Machalek *et al.*¹¹ and Asghar *et al.*^{15,16} (As shown in Table 3)

Splenic thickness was calculated, and average came out to be 1.89 ± 0.16 cm. In males; average thickness was 1.86 ± 0.17 cm and in females; average thickness was found to be 1.92 ± 0.15 cm. Thickness was found to be greater in females in our study though the difference was not statistically significant but in the study done by Arora *et al.*¹⁴ thickness was more in males. (As shown in Table 4).

Average total surface area in our study 207.59 ± 24.43 sq cm. In males, it was 256.23 ± 23.46 sq cm and in females it was 158.96 ± 25.41 sq cm (p value < 0.01). The difference was highly statistically significant. The average surface area calculated by Asghar *et al.* was 254.01 ± 127.56 sq cm. In males, it was 290.35 ± 14.78 sq cm. and in females it was 205.56 ± 77.65 sq cm (p value was > 0.5)^{15,16} (As shown in Table 5).

CONCLUSION

The broad objective of the study was to assess the morphometry and sexual dimorphism of spleen in Haryana region of North India.

Thirty spleens of each male and female human cadavers (of Haryana region) were taken and studied for morphometry and sexual dimorphism. The results showed sexual dimorphism in splenic weight, length and total surface area. **IJFMP**

Conflict of Interest:

The author has made no acknowledgment in this article.

Conflict of Interest:

The author declares that there is no commercial or financial links that could be construed as conflict of interests.

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