

Sonographic Determination of Normal Spleen Size in Turkish Adults

Determinación Ecográfica del Tamaño Normal del Bazo en Adultos Turcos

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SUMMARY: The current study was undertaken to determine normal spleen dimensions and anthropometric evaluation by ultrasonography from females and males in our population. These measurements were taken using an ultrasonography. The mean values of the age, height, weight and body mass index (BMI) of subjects, spleen width (SW), spleen length (SL), spleen thickness (ST) and spleen volume calculated with ellipsoid formula; length x width x thickness x 0.524 were taken. These measurements were found to be 36.37±10.83 years, 164.22±4.72 cm, 60.26±7.11 kg, 22.30±2.09 kg/m², 7.58±1.56 cm, 9.87±1.28 cm, 3.34±0.79 cm and 136.05±61.14 cm³ in females respectively. Additionally, in males same dimensions were 40.50±12.77 years, 174.41±6.57 cm, 76.33±8.54 kg, 25.06±2.10 kg/m², 8.75±1.84 cm, 11.01±1.186 cm, 4.12±1.09 cm and 220.70±115.35 cm³ respectively. The observations presented in this report have defined anatomic parameters about spleen size that need to be taken into consideration for reference data to determine population discrepancies and helpful for radiologists and clinicians.

KEY WORDS: Spleen length; Spleen width; Spleen thickness; Spleen volume.

INTRODUCTION

The spleen is the largest lymphoid organ with a parenchymal structure in the reticuloendothelial system and it is situated in the left hypocondrium (Danila, 2010; Lamp *et al.*, 2002; Ehimwenma & Tagbo, 2011). It is covered by the ribs (Danila). The shape of the spleen is tetrahedral or wedge (Ehimwenma & Tagbo; Nayak *et al.*, 2011). Moreover, the spleen size shows variations according to people, depending on the individual's height, age and sex (Danila; Hosey *et al.*, 2006). Splenomegaly is an indicator of varieties of inflammatory, infectious, infiltrative, metabolic, neoplastic, hematopoietic diseases and the other diseases like portal hypertension, glycogen storage disorder, leukemia, lymphoma, melanoma, celiac disease (De Odorico *et al.*, 1999; Mustapha *et al.*, 2010; Asghar *et al.*, 2011a). Furthermore, splenic enlargement may be result of especially viral illnesses and is an crucial criterion in diagnosing primary myeloproliferative diseases (Picardi *et al.*, 2002; Spielmann *et al.*, 2005). However, evaluation of splenic size by palpation can cause unreliable and wrong conclusions because spleen is not palpable until it is enlarged 2 to 3 times its size (De Odorico *et al.*; Hosey *et al.*; Dhingra *et al.*, 2010). The knowledge of spleen size, shape or external features might be of importance to surgeons and radiologists

(Nayak *et al.*). Ultrasonography is commonly used to diagnose splenomegaly and to determine the spleen size and it is safe, quick and reliable method for the calculation of splenic dimensions (Mustapha *et al.*; Dhingra *et al.*).

Therefore, the purpose of this study was to establish guidelines for normal splenic sizes in our healthy adults by using sonographic method and to compare our findings to other populations' data.

MATERIAL AND METHOD

The study was carried out from the 150 adult subjects (78 males and 72 females, ages 18 to 76 years) and oral statement were obtained from these subjects. All the test procedures were approved by the ethics committee. The patients selected for the study were evaluated with ultrasonography (USG) for abdominal and/or pelvic problems unrelated to the spleen, mostly because of urinary tract infection or abdominal pain. They had no history of disease related to the liver or splen and no gastrointestinal,

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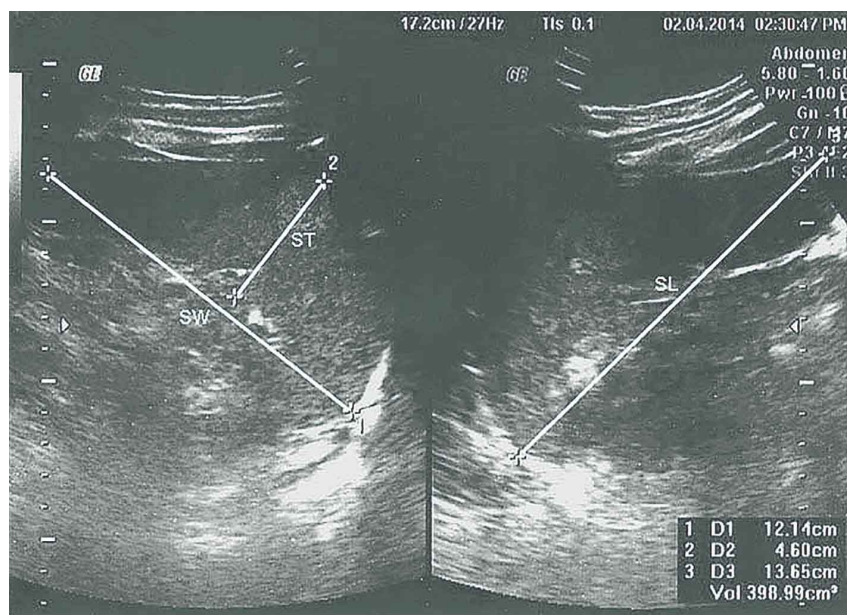


Fig. 1. Splenic length, thickness and width measurement methods used in this study. SW= Splenic width, ST= Splenic thickness, SL= Splenic length.

hematologic, oncologic or traumatic conditions. Anthropometric data, including sex, age, height and weight was recorded from each subject and body mass index was calculated according to the formula $BMI = \text{weight}/\text{height}^2$. All examinations were performed by radiologist and anatomist in abdominal ultrasonography using a commercially available high-resolution real time US scanner (GE Voluser,730 USA) with a 3.5 MHz sector transducer. Moreover, images were obtained with the subject lying in the supine or slightly right lateral decubitus position and through an oblique intercostal approach following suspended deep inspiration. Splenic length, thickness, width and volume were obtained as follows: splenic length was defined as the maximum distance between the dome of the spleen and tip of the spleen on a longitudinal section in the sagittal plane) (SL), splenic width was defined as the maximum distance between the medial and lateral borders of the spleen (it was measured in a plane perpendicular to the length) (SW); splenic thickness was defined as the distance between the inner and outer surface (it was measured

at the level of the splenic hilum on a transverse section) (ST) and splenic volume was calculated with the following standard elipsoid formula as; $0.524 \times \text{width} \times \text{length} \times \text{thickness}$. Splenic length, thickness and width measurement methods were shown in Figure 1.

The data were divided into two groups: female and male. The SPSS 13.0 program was used for statistical analysis of the measurement results. From these measurements, Means, standard deviations (SD), and minimum and maximum values were calculated.

RESULTS

The minimum-maximum, Mean and standard deviations values of the measurements from female and male spleen are shown in Table I.

Table I. Characteristics of spleen from 150 subjects (78 males and 72 females ages 18–76 years).

Parameters	Females (n= 78)		Males (n= 72)	
	Mean ± SD	Min – Max	Mean ± SD	Min – Max
Age (years)	36.37±10.83	19–63	40.50±12.77	18–76
Height (cm)	164.22±4.72	155–178	174.41± 6.57	162–188
Weight (kg)	60.26±7.11	45–75	76.33±8.54	62–103
Body Mass Index (BMI) (kg/m ²)	22.30±2.09	16.40–26.60	25.06±2.10	20.50–35.60
Splenic Width (cm) (SW)	7.58±1.56	4.70–13.40	8.75±1.84	4.20–13
Splenic Length (cm) (SL)	9.87±1.28	6.90–12.70	11.01±1.186	8.40–14.00
Splenic Thickness (cm) (ST)	3.34±0.79	1.70–5.40	4.12±1.09	1.90–7.10
Splenic Volume**	136.05±61.14	30.11–302.62	220.70±115.35	56.70–599.91

DISCUSSION

The spleen which filters the unwanted elements from blood by phagocytosis, is located in the abdomen, below the diaphragm and connected to the stomach. Moreover it is an important lymphoid organ and plays an crucial role in the immune responses (Mebius & Kraal, 2005; Chaware *et al.*, 2012). Splenic size can be used as an indicator of disease activity in a variety of disorders of the reticuloendothelial system and many disorders alter splenic size including infective, infestation, infiltrative, immunologic and malignant conditions. However, the physical examination is unreliable to evaluate the splenic enlargement (Ehimwenma & Tagbo; Lamp *et al.*; Spielmann *et al.*). Moreover, it has been reported that the presence of the colon, stomach and lung near the spleen makes the examination difficult. But, the intercostal approach permits a good examination (Danila). Ultrasonography (USG) is usually used for the diagnosis of the splenomegaly. Additionally, US measurement of splenic size is standard application and it provides a objective way of noninvasive examination of the spleen. It is especially useful because of lack of radiation exposure (Ehimwenma & Tagbo; Lamp *et al.*; Hosey *et al.*; Mustapha *et al.*; Megremis *et al.*, 2004; Mittal & Chowdhary, 2010). Thus, it is safe, quick and accurate method for measurement of splenic dimensions (Picardi *et al.*; Dhingra *et al.*, 2010; Megremis *et al.*; Mittal & Chowdhary). Moreover, the spleen size is exposed to many variations at different periods of life, in different individuals, and in the same individual under different conditions. It can vary from individual, depending on the individual's height, age and sex (Danila; Hosey *et al.*).

The information of anamalous size, shape or external features of the spleen could be of important for surgeons and radiologists (Nayak *et al.*). Moreover, splenomegaly is a crucial clinical sign. Because it might be the only manifestation of a serious underlying disease such as lymphoma and other hematologic diseases (De Odorico *et al.*; Loftus *et al.*, 1999). Furthermore, it was reported that spleen length was related to age, height, weight and body surface area (Megremis *et al.*). During the growth duration from infancy to adolescence, development of visseral organs like spleen demonstrated correlation with increases in height, weight and body surface area. Additionally, it was estimated that splenic length measured by ultrasonography provided an objective and safe method to evaluate spleen size (Hosey *et al.*; Megremis *et al.*; Konus *et al.*, 1998).

In this study, we measured the splenic length, width, thickness and volume (calculated with formula in adults and compared our results to other populations. The mean values

of splenic length and width were 9.91 cm and 4.74 cm in females and 11.29 cm and 5.54 cm in males in U.S.A. respectively whereas, same values were 10.1 cm, 4.0 cm in females and 11.1 cm, 4.4 cm in males in Nigerians respectively (Ehimwenma & Tagbo; Hosey *et al.*). However, corresponding values were as 8.9 cm and 4.9 cm in Africans (Mustapha *et al.*). Moreover, same values were found to be 9.34 cm and 3.45 cm in females 9.40 cm and 3.45 cm in males in Rajasthan population respectively (Mittal & Chowdhary). These dimensions were 10.34 cm and 5.61 in females and 10.91 cm and 9.74 cm in males in North Indians and 7.68 cm and 8.5 cm in Thai adults respectively (Asghar *et al.*, 2011b; Srisajjakul *et al.*, 2012). However, the mean splenic length was found as between 8.84 cm in Chinese population (Loftus *et al.*). When we analyze our data including splenic length (SL) and splenic width (SW) were found to be 9.87 cm and 7.58 cm in females respectively and in males as 11.01 cm and 8.75 cm respectively. We found differences in the mean values of splenic length of above studies except U.S.A. with our population: The Africans, Rajasthan population and Thai population having lower, and Nigerians having greater values than us. Our results are different from to those of these investigations, except the Thai population when comparing splenic width results. Moreover, mean values of splenic thickness was reported between 3.33 cm and 6 cm in Thai population, Indians, Africans, Americans and Nigerians (Mustapha *et al.*; Asghar *et al.*, 2011b; Srisajjakul *et al.*; Tonelli *et al.*, 2013). In this study this value was 4.12 cm in males, and 3.34 cm in females. According to this data our result is similar to Thai population.

Splenic volume is calculated using with standard ellipsoid formula ($0.524 \times \text{width} \times \text{length} \times \text{thickness}$). This formula is often used for predicting the volume of many irregularly shaped organs (Asghar *et al.*, 2011b; Yetter *et al.*, 2003; Sonmez *et al.*, 2007). In literature findings, it was seen that elipsoid formula was used. It was found to be 220.70 cm³ (measured with standard elipsoid formula) in males and 136.05 cm³ in females. In a studying consisting of Nigerians, in males mean value of splenic volume were 202.7 cm³ and in females 153.7 cm³ respectively (Ehimwenma & Tagbo). Moreover, the same value was 119.5 cm³ in African population (Mustapha *et al.*). Asgar *et al.* (2011a) determined that the splenic volume were 288.36 cm³ and 217.44 cm³ in males and females respectively. Furthermore, the mean volume of the spleen were 132 cm³ and 113 cm³ respectively in Japanese males and females whereas, same dimensions were 134.2 cm³ and 115.6 cm³ in males and females respectively in Thai adults (Srisajjakul *et al.*; Kaneko *et al.*,

2008). However, same value was 344 cm³ in USA (Tonelli *et al.*). Due to these data, we found differences in the mean values of splenic volume of Nigerians, Africans, Japanese population, Thai population and USA population with our population: The Thai, Japans and Africans having lower, and USA having greater values than ours.

In summary, when comparing the literature findings with this study, we observe that there are differences between Nigerians, Africans, Chinese population, Rajasthani population, Indians and our population data. However, there are similarities between Thai and our population results. We consider that these discrepancies could be a result of such factors like race, genetic variables, nutritional status, socioeconomic status and demographic variables including age, weight and height. Moreover, we found that all dimensions were greater in males than females and splenic

length decreased with increase in age in both genders. As we mentioned before, there was no differences in the mean values of the spleen volume between two calculation methods.

In conclusion, we think that the precise knowledge of the spleen morphology with USG may be essential for safe and accurate diagnose of many disorders such as infections, splenomegaly, malignant conditions and viral illnesses for surgeons and radiologist. Therefore, the observations presented in this study have defined anatomic parameters that need to be taken into consideration for evaluate splenic problems and guidelines for determine the reference values. As a result, we believe that the data obtained in this study can provide crucial information for surgeons and radiologists about spleen and they can be used as reference values for evaluating pathologic changes in the spleen region.

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RESUMEN: El objetivo fue determinar las dimensiones normales del bazo y realizar una evaluación antropométrica mediante ecografía en mujeres y hombres turcos. Fueron calculados los valores medios de edad, altura, peso, índice de masa corporal (IMC), ancho del bazo (AB), longitud del bazo (LB) y grosor del bazo (GB), junto al volumen del bazo mediante la fórmula elipsoide (largo x ancho x grosor x 0,524). Las mujeres presentaron una edad de 36,37±10,83 años, altura de 164,22±4,72 cm, peso de 60,26±7,11 kg, IMC de 22,30±2,09 kg/m², AB de 7,58±1,56 cm, LB de 9,87±1,28 cm, GB de 3,34±0,79 cm y volumen del bazo de 136,05±61,14 cm³. Los hombres presentaron una edad de 40,50±12,77 años, altura de 174,41±6,57 cm, peso de 76,33±8,54 kg, IMC de 25,06±2,10 kg/m², AB de 8,75±1,84 cm, LB de 11,01±1,186 cm, GB de 4,12±1,09 cm y volumen del bazo de 220,70±115,35 cm³. Nuestras observaciones han definido parámetros anatómicos sobre el tamaño del bazo, los cuales deben ser considerados como datos de referencia para determinar las discrepancias en la población, de utilidad para radiólogos y clínicos.

PALABRAS CLAVE: Longitud del bazo; Ancho del bazo; Grosor del bazo; Volumen del bazo.

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