Normal Spleen Size in Adults in Kirkuk Population Using Ultrasound Scan

*Israa Mohammed Sadiq, ** Saman Anwer Nooruldeen, ***Zahraa Ahmed Hasan,

*** Mohammed Mustafa

*Department of Surgery, Medical College, Kirkuk University

**Department of Radiology, Azadi Teaching Hospital, Kirkuk

*** Department of Family and Community Medicine, Medical College, Kirkuk University

Abstract:

Background: Splenomegaly is a clinically important finding, particularly for physicians required to make decisions on variety of disease status including infectious, storage diseases and malignant disorders. Objective diagnostic measures have been proposed as a useful step in making decisions in those patients using ultrasonography, as it's a non-invasive, established, safe, quick and accurate method for measurement of spleen size.
There are racial differences in normal splenic size, as previous ultrasound data have been suggested. These differences in splenic size result in improper interpretation of splenic measurements.
Objectives: To develop standards of normal range of splenic length (as indicator for splenic size) for our adult population based on gender, age and body mass index using ultrasound scan.

Material and Methods: A cross-sectional study conducted in the department of Radiology in Azadi Teaching Hospital, Kirkuk, Iraq within a period from May 2013 to April 2016. The study was conducted among 303 adult individuals (120 males and 183 females), they were healthy individuals more than 18 years old not suffering from diseases affecting the spleen, the exclusion criteria were individuals not willing to participate; history of medical disorders affecting spleen, such as blood, metabolic and connective tissue diseases, portal hypertension, high body temperature within the last month of examination, malignancy, and pregnancy. Maximum splenic length in centimeters was assessed at level of splenic hilum on the longitudinal view using 5 MHz sector curvilinear transducer probe for trans-abdominal Ultrasonography. 2-tailed t test was used to assess the differences between continues variables. The Relationship of length of spleen with age, and body mass index (BMI) were assessed with the Pearson's correlation coefficient (r).

Results: The mean age of the study sample was 38.05±15.58 years for male and 37.23±13.98 for female, their mean body height was 173.1±46 cm for male and 159.70±4.88 cm for female, their body weight was 83.42±16.70 kg for male and 73.19±15.90 Kg for female and mean BMI were 27.86 ±5.42 for male and 28.58±6.27 for female. Mean spleen length were 10.65±1.41 for male and 9.52±1.25 for female. There was significant correlation between spleen length and gender ($p < 0.05$). There was weak negative correlation with age, and weak positive relation between the splenic length and BMI.

Conclusion: This study provides the values of normal splenic size by ultrasonography in adults' for both genders at Kirkuk city. The splenic size had weak positive correlation with body mass index (BMI), and weak negative correlation with age.
Key words: Splenic size, Ultrasound, Population, Kirkuk.

Introduction:

Splenomegaly is a clinically important finding, particularly for physicians required to make decisions on variety of disease status including infectious, hematological, storage diseases and malignant disorders [1]. The spleen is relatively large and varies with the patients' age, its normal length is 10.9 ± 1.4 cm; and the depth is 4.0 ± 0.45 cm [2, 3, 4].

Percussion and palpation are the clinical techniques to document the presence of splenic enlargement, but are unreliable and far from accurate to detect small increase in size [5, 6, 7].

Ultrasound is a very useful mean of noninvasive examination of the spleen; it's a simple, safe and accurate method of assessing the splenic size [8, 9, 10, 11], with the advantage of lack of ionizing radiation [12], low cost, non invasive, and lack of allergic reaction as compared to other diagnostic tools [13]. Imaging is generally achieved via an intercostal approach using gray scale ultrasound [14].

Previous researches concluded that there is difference in spleen size in different populations [15], and this might result in false assessment of splenic size regarding our adult population, therefore this study was done to measure the splenic size in healthy adults to establish normograms which can be used as reference values for adults in Kirkuk city, thus predicate early splenic enlargement as there is lack of these data in our country. We used the splenic length as indicator of spleen size, since previous autopsy studies revealed that sonographic values of splenic length correlate with actual splenic size [16, 17].

Materials and Methods:

The permission was obtained from the Azadi Teaching Hospital Committee and informed consent was obtained from each individual before data collection was begun. This study was a cross-sectional study conducted in the department of Radiology in Azadi Teaching Hospital, Kirkuk, Iraq within a period from May 2013 to April 2016. The study was conducted among 303 adult individuals (120 males and 183 females), the inclusion criteria were: healthy individuals more than 18 years old willing to participate; individuals suffering from diseases which did not affect the spleen, individuals with demonstrated normal homogenous echotexture without any focal splenic abnormality.

The exclusion criteria were: individuals less than 18 years old, the individuals not willing to participate; history of medical disorders affecting spleen, such as blood, metabolic and connective tissue diseases, portal hypertension, high body temperature within the last month of examination, malignancy, and pregnancy.

Demographic data were collected on each individual at the time of their examination. The data included the age, gender, measurement of height in centimeters, the weight in kilograms, and age in years. The Body mass index (BMI) was recorded from the height and weight through the following formula (weight [kg]/height [m2]), and the BMI was grouped the patients in to underweight persons when BMI was less than 18.5 kg/m2, normal when it was between 18.5 and 24.9, overweight adults their BMI were between 25 and 29.9, those with BMI between 30-39.9 were obese and those who had BMI more than 40 were morbidly obese [18].

The sonographic examination was performed on Fukoda Denshi machine with 3.5 MHz sector curvilinear

transducer probe for trans-abdominal Ultrasonography. All the included adults underwent measurement of maximum splenic length in centimeters, at level of the hilum on the longitudinal view as the patients were assessed in the right oblique position, and the spleen was scanned while they were in maximum inspiration figure (1). All the ultrasonic examinations were conducted by two experienced radiologists having minimum of 13 years of experience.

Afterwards the data was collected and was entered in the master chart and statistical analysis was performed with Microsoft Office Excel 2007 and Statistical Package for the Social Science (SPSS) version 20 software.

2-tailed t test was used to assess the differences between continues variables. The correlation of length of spleen with age, and body mass index (BMI) were assessed with the Pearson's correlation coefficient (r). Pearson's r values between 0 and 0.3 indicate a weak positive relationship, between 0.3 and 0.7 indicate a moderate positive relationship, and values between 0.7 and 1.0 indicate a strong positive relationship.

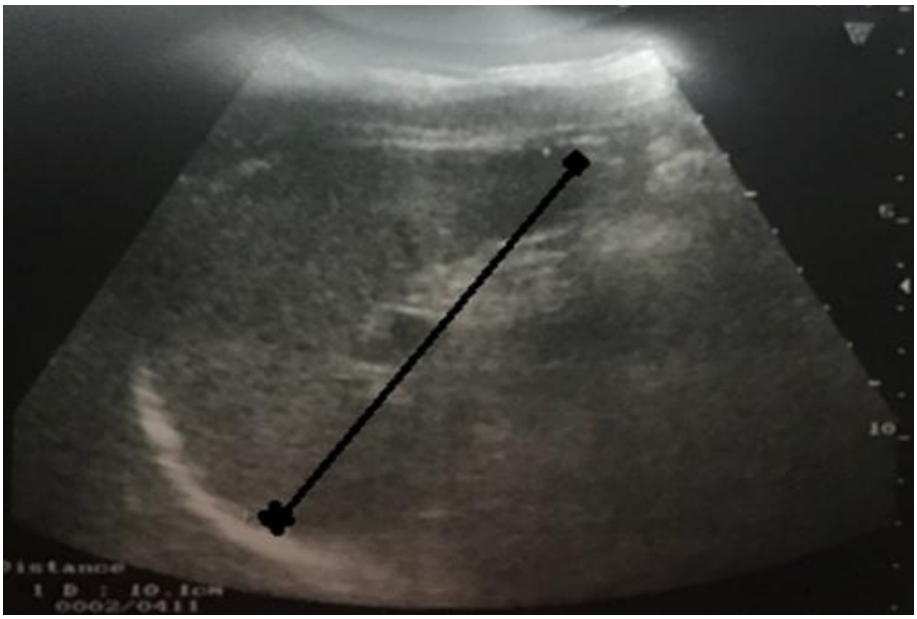

Figure (1): longitudinal section of spleen through the hilum with splenic length equals to10.1 cm.

Results:

The age average of the total three hindered and three adults was 37.64±14.78. For female, the mean age was 37.23±13.98, the mean body height was 159.70±4.88 cm, mean body weight was 73.19±15.90 Kg, and mean BMI was 28.58±6.27; For male, the mean age was 38.05±15.58, the mean body height was 173.46±6.41, mean body weight was 83.42±16.70 kg, and mean BMI was 27.86 ±5.42. There was significant statistical difference between males and females in height, and weight (P<0.05); but there was no significant difference in term of age and BMI (p >0.05), table (1)

More than 96.4 % of the adult's splenic length was equal or less than 12 cm. Most of the adults' splenic length was between 9 and 12 cm (83% of males and 70% of females), those with splenic length 13-14 cm were only seen in males which represented in (9.2%) of them. The percentage of female with

splenic length between 7 and 8 cm is significantly more than male (29.2% versus7.5%). all of these data are from the table (2).

The mean spleen length for female was 9.52±1.25, and the mean spleen length for male was 10.65±1.41.

Maximum length of splenic length in male was 12.06 cm and 10.76 cm in females.

The splenic length more than 13 cm was mostly seen in those within 30-49 year old, and not seen in those more than 70 years old; most of those of more than 60 years old ,had splenic length was less than 10 cm table (3). There was weak negative correlation of spleen length with the age (r = 0.09) which was not significant ($p > 0.05$).

The splenic size of more than 13 only was seen in overweight, obese and morbidly obese persons, all underweight people's spleen length was less than10 cm. There was weak positive correlation between splenic length with BMI (r = 0.29) which was significant ($p < 0.05$), table (4).

Table (1): Descriptive data of the study sample.

category	Male N=120	Female N=183	t value	P value
	Mean ±SD			
Age	38.05±15.58	37.23±13.98	0.458	>0.05
Height	173.46±6.41	159.70±4.88	20.235	<0.05
Weight	83.42±16.70	73.19±15.90	2.765	<0.05
Body mass index(BMI)	27.86+-5.42	28.58±6.27	0.086	>0.05

Table (2): Splenic length among the males and females.

Spleen length in cm	sex				No.	Percentage
	Male		Female			
	No.	Percentage	No.	Percentage		
7-8	9	7.5	54	29.2	63	20.8
9-10	59	49.1	99	54.1	158	52.2
11-12	41	34.2	30	16.4	71	23.4
13-14	11	9.2	0	0.0	11	3.6
Total	120	100.0	183	100.0	303	100.0

There was significant correlation ($p < 0.05$) between the gender and splenic length, using 2 tailed t test.

Table (3): Splenic length according to the age.

Splenic length	Age (years)								Total
	<20	20-29	30-39	40-49	50-59	60-69	70-79	> 80	
7-8	5	12	14	15	8	4	3	2	63
9-10	8	51	41	26	12	14	6	0	158
11-12	6	20	23	9	5	6	0	2	71
13-14	0	1	6	2	1	1	0	0	11
Total	19	84	84	52	26	25	9	4	303

The Statistical test is Pearson's correlation coefficient (r).

Table (4): Splenic length according to BMI.

Splenic size (cm)	BMI(kg/m2)					Total
	< 18.5	18.5-24.9	25-29.9	30-39.9	> 40	
7-8	4	18	23	17	1	63
9-10	2	44	57	51	4	158
11-12	0	23	22	23	3	71
13-14	0	0	2	7	2	11
Total	6	85	104	98	10	303

The Statistical test is Pearson's correlation coefficient (r).

Discussion:

In our population the mean splenic length was 10.65±1.41 cm for males and 9.52±1.25 cm for females, which was comparable to other studies done at different countries like China (spleen length for male was 9.9 ± 2.2 cm, and for female was 9.1 ± 2.5), Jordan (spleen length for men was 11±1.3 cm and 10±1.22 cm), and Turkey (11.01±1.186 for male and 9.87±1.28 for female) [12, 19, 20].

In a study done by Mittal and Chowdhary DS in India [21], the result was comparable with our study in female, while our male population had larger spleen, as the mean splenic length for males was 9.41cm, and 9.35cm for females in India [21].

On the other hand, our values were less than others, like a study done by Spielmann et al [22], as their mean length of the spleen was 11.4 cm in males and 10.3 cm in females; and less than a Nigerian [8] study as their results were11.1 cm (±0.9 SD) for male splenic length and 10.1 cm (±0.7 SD) for women [22]. These differences in spleen length among different populations are probably related to difference in both genetic and environmental factors unique for each population.

In this study the weak positive correlation between splenic lengths with BMI were similar to the result of **Ehimwenma** [22], this was also true about the significant correlation of the gender.

This result is also the same for gender but not the BMI, as a study performed by Darwish et al [12] and a study done by Chow KU et [23] al where they found that taller and heavier men had longer and larger spleen.

The weak negative correlation of the splenic size and the age was similar to the study done by Adil et al [24] as splenic volume was slightly smaller in older subjects; this was also the same result from Turkey done by Çeliktas et al [20].

Conclusion:

More precise splenic size values for our adult population is achieved to avoid misleading radiological information about spleen pathology using ultrasound scan which is widely used for diagnosis of splenic diseases.

Male have significantly larger spleen than female, there is weak positive correlation but significant relation between splenic size and body mass index (BMI), and negative non significant correlation with age.

Recommendation:

Further studies are recommended to provide normal values about splenic size in children in our population.

Further normal values regarding different organs using different radiological modalities designed for our population are also recommended for more accurate diagnosis of diseases.

References:

[1]. R G Hosey, C G Mattacola, V Kriss, T Armsey, J D Quarles, and J Jagger. Ultrasound assessment of spleen size in collegiate athletes. *Br J Sports Med*. 2006 Mar; 40(3): 251–254.

[2]. J. Kaneko, Y. Sugawara, Y. Matsui, T. Ohkubo,and M. Makuuchi. Normal splenic volume in adults by computed tomography. *Hepatogastroenterology*. 2002; 49: 1726–1727.

[3]. Ardene Harris et al. Splenic volume measurements on computed tomography utilizing automatically contouring software and its relationship with age, gender, and anthropometric parameters. *European Journal of Radiology*. 2010; 75 (1): Pages e97–e101.

[4]. Benter T, Kluhs L, Teichgraber U. Sonography of the spleen. *J Ultrasoud Med*. 2011; 30: 1281-1293.

[5]. Joshi R, Singh A, Jajoo N, Pai M, Kalantri SP. Accuracy and reliability of palpation and percussion for detecting hepatomegaly: a rural hospital based study. *Indian J Gastrenterol*. 2004; 23: 171-174.

[6]. Audrey L. Spielmann, David M. DeLong, and Mark A. Kliewer. Sonographic Evalution of Spleen Size in Tall Healthy Athletes. *AJR*. 2005; 184:45–49.

[7]. Mitchell Lee et al. Estimation of Spleen Size with Hand-Carried Ultrasound. *J Ultrasound Med*. 2014; 33:1225–1230.

[8]. Okoye J, Agwu K, Ochie K, "Sonographic splenic sizes in normal adult Nigerian population," *West African Journal of radiology*. 2005; 12 (1): 37-43.

[9]. Ahmed H, Soror A, Prabhakar B, et al., "Sonographic assessment of spleen size in Saudi patients with sickle cell disease," *Annals of Saudi Medicine Journal.* 1998; 18 (3): 217-220.

[10]. Ul Hadi Noor et al. To determine Average spleen size of local pediatric population by ultrasonography. *KJMS*.2015; 8 (3): 445-449.

[11]. Bin Abdul-Aziz Salman. Assessment of Normal Spleen Size. *Int J Pharm Bio Sci*. 2015; 6(3): 46 – 57.

[12]. H. Darwish et al. Ultrasonographic assessment of splenic volume and its correlation with body parameters in a Jordanian population. *Saudi Med J*. 2015; 36 (8): 967-972.

[13]. Alka singh et al. Ultrasonographic measurement of splenic length in relation with height in Bihari adult population a prospective study. *J. Anat. Soc. Indi.,* 2011; 60(2):188-189.

[14]. Mustafa Z. Mahmoud. Splenic Weight versus Body Height and Weight in Sudanese Adults by Using Ultrasound. *Asian J Med Radiol Res.* 2013; 1: 56-59.

[15]. Megremis SD, Vlachonikolis LG, and Tsilimigaki AM. Spleen length in childhood with US: Normal values based on age, sex and somatometric parameters. *Radiology*. 2004; 23:129-134.

[16]. Lamb PM, Lund A, Kanagasabay RR, Martin A, Webb JA, and Reznek RH. Spleen size: how well do linear ultrasound measurements correlate with three-dimensional CT volume assessments? *Br J Radiol*. 2002; 75:573-7.7.

[17]. Salim Serter, Cengiz Ceylan, Özüm Tunçyürek, ebnem Örgüç, and Yüksel Pabuçcu.
Sonographic evaluation of spleen size and prevalence of accessory spleen in a healthy male Turkish population. *Turk J Hematol*. 2010; 27: 25-8.

[18]. Frank Q. Nuttall. Body Mass Index Obesity, BMI, and Health: A Critical Review. *Nutr Today*. 2015 May; 50(3): 117–128.

[19]. Loftus WK, Metreweli C. Normal splenic size in Chinese population. *J Ultrasound Med*. 1997 May; 16(5):345-7.

[20]. Çeliktas, M.; Özandac, S.; Goker, P. & Bozkir, M. G. Sonographic determination of normal spleen size in

Turkish adults. *Int. J. Morphol. 33(4)*:1401-1405, 2015.
[21]. Mittal R,and Chowdhary DS. A Pilot Study of the Normal Measurements of The Liver and Spleen by Ultrasonography in the Rajasthani Population. *Journal of Clinical and Diagnostic Research*. 2010 August 15; 4:2733-2736.
[22]. Ehimwenma O, Tagbo MT. Determination of normal dimension of the spleen by ultrasound in an endemic tropical environment. *Niger Med J*. 2011; 52:198–203.
[23]. Chow KU, Luxembourg B, Seifried E, and Bonig H. .Spleen Size Is Significantly Influenced by Body Height and Sex: Establishment of Normal Values for Spleen Size at US with a Cohort of 1200 Healthy Individuals. *Radiology*. 2016 Apr; 279(1):306-13.
[24]. Asghar A, Naaz S, Agrawal D. Estimation of standard splenic index (SI) in Indian population: A CT scan based study. *Indian Journal of Basic and Applied Medical Research*. 2014; 3: 332–337.