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Research Article

Sonographic Determination of Normal Spleen Size and Prevalence of Accessory Spleen among Healthy Adult Nepalese in B P Koirala Memorial Medical Cancer Center

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Abstract

Objective: This study aims to establish a normal range of values using ultrasonography and its correlation with age, gender, and body mass index and determine the prevalence of accessory spleens among healthy adult Nepalese.

Material and Methods: A total of 70 healthy volunteer ages 20-40 years, from B P Koirala Memorial Medical Cancer Centre were included in the study. Sonographic measurements of spleen length, width and thickness were performed among the 70 healthy volunteers. Presence of accessory spleen was also determined. In addition, the height, weight and body mass index were recorded. Using linear regression analysis, the relation of spleen length, width, thickness and body height, weight and body mass index was evaluated. The prevalence of accessory spleen detected on ultrasound was calculated.

Results: The mean age + standard deviation (SD) of subject was 28.2 +7.2years (range: 20-40), mean body height 160.7 + 7.5 cm, mean body weight 62.2 + 12.4 kg in our study group. In terms of BMI classification, most of the subjects are normal 53.6% of them. The mean spleen length 8.50 + 1.3 cm, mean spleen width 6.80 + 1.1 cm, and mean spleen thickness was 4.0 + 0.9 cm. In this study, results show that age is significantly affecting the spleen length ($p = 0.0013$) relationship is positively linear. Likewise, height and weight are also significant resulting Pearson r of 0.2959 and 0.2754 respectively.

As to width of the spleen, age and BMI are not significantly related while height and weight are significantly affecting the splenic width with Pearson r of 0.2404 and 0.1554 respectively. In splenic thickness, no significant relation as to age and BMI, but height significantly affect resulted a Pearson r of 0.3327. The prevalence of accessory spleen was determined as 2.9%

Conclusion: It was found that among healthy Nepalese adult mean spleen length was 8.50 + 1.3 cm. This data should be taken in consideration when the diagnosis of splenomegaly is established in adult Nepalese.

Keywords: Splenomegaly; Ultrasonography; Prevalence of Accessory Spleen

Introduction

The spleen is a functionally diverse organ with active roles in immunosurveillance and hematopoiesis. It lies within the left upper quadrant of the peritoneal cavity and abuts ribs 9-12, the stomach, the left kidney, the splenic flexure of the colon, and the tail of the pancreas [1]. It is a soft, spongy organ that performs several critical jobs and can easily be damaged. Among other things, the spleen can [1] filter out and destroy old and damaged cells; [2] play a key role in preventing infection by producing white blood cells called lymphocytes and act as a first line of defense against invading pathogens; [3] store red blood cells and platelets, the cells that help in producing blood clots [2]. The average spleen dimension in adults is 12 cm in length, 7 cm in width, and 3 to 4 cm in thickness. (Brant and Helms, 2012) [13]. The presence of splenomegaly is very significant in the diagnosis of several groups of diseases: immunological and inflammatory diseases, reticuloendothelial proliferations, storage disease, and portal hypertension. While the diagnosis of gross splenomegaly by ultrasound is not well established, several complicated measurements have been described, but a single, simple sonographic measurement gives clinically useful indication of true splenic size [9].

There are previous ultrasound data suggested that there may be racial differences in splenic size, these differences in splenic size could result incorrect interpretation of splenic measurements [12]. Therefore, standards of normal spleen sizes have been developed in different areas, and knowledge of the normal range of spleen size in the population is a prerequisite. At present, there is no standard normal splenic size being established specific for Filipinos. On the other hand, the failure of fusion of splenic tissue results in the formation of accessory spleens, and detection of an accessory spleen is important for hematological conditions [9].

There is no gold standard in determining splenic size. Many imaging techniques can be used to determine spleen size. Ultrasonography is particularly useful because of lack of radiation exposure. Radionuclide imaging is also used for estimating the splenic size but its accuracy depends upon the vascular integrity of the organ and it unduly exposes the patient to gamma radiations [4]. Angiography is another method but it exposes the patients to the radiations and the allergic reactions of the dye and is also invasive. Sulfur colloid and scintigraphy [5] can also be used for measuring the splenic size but these procedures are time consuming and have potential hazard of the radiation. CT scan and MRI can also be used but they are very expensive. Ultrasound has been found to be both accurate and reliable [6] The most common mathematical method in determining splenic volume is based on the standard prolated ellipsoid formula (length x width x thickness x 0.523).

Objectives

This study aims to establish a normal range of values using ultrasonography and its correlation with age, gender, and body mass index and determine the prevalence of accessory spleens among healthy adult Nepalese.

Methodology

A cross-sectional prospective study conducted in the Nepal specifically at the B P Koirala Memorial Medical Cancer Centre.

Subjects

A total of 70 healthy volunteers from B P Koirala Memorial Medical Cancer Centre were included in the study. The study group consisted with men and women from the medical interns, employees, radiologic technology interns, and residents who were randomly selected. The subjects did not have any conditions likely to be associated with splenomegaly. None of them had immunologic or any pathology, like malaria or schistosomiasis, and hematologic conditions.

Inclusion Criteria are as follows

- Age within 20 to 40 years old healthy.
- Must have no history of splenic diseases and other diseases.

Exclusion criteria as follows

- Subjects with pathologies potentially involving spleen.
- Findings of structural abnormalities of the spleen.
- Subjects in whom the entire length of the spleen could not be properly documented and those with previous splenectomy.
- Gravid women.

A Hi-vision Philips Ultrasound Machine was used to obtain images using a curvilinear real time probe, with scan frequency of 2.5 to 5 mega Hertz (MHz).After the informed consent was obtained, each patient was assigned a case number. The reason for the study, possible effects, and stages of examination were explained to the subjects as a group or individually. A medical history was asked from each subject to exclude any previous or current conditions that might involve the spleen. Vital data was taken such as age, sex, height, weight and body mass index (BMI). Participants in this study were able to know their splenic size and any findings were relayed to the subjects of this study. No identifiable risk to the subjects, since ultrasound does not produce ionizing radiation.

Each subject was placed in supine position, with arms away from the chest wall; and coupling gel was applied on abdominal wall in the left hypochondriac region in order to assure optimal transmission of energy between the patient and probe. Splenic measurement was taken during deep inspiration, to minimize masking by the lung. Splenic length was measured on longitudinal coronal image from dome to tip of the spleen through the hilum (Figure 1). On transverse plane, the width was measured at the hilum as the longest organ diameter (Figure 2). Thickness measurement was taken in between the center (inner) and peripheral (outer) surface at the level of the splenic hilum on the transverse plane (Figure 3). Each dimension was rescanned and recorded three different times to the nearest millimeter and the median value was obtained for accuracy of result. Presence of accessory spleen was noted if present (Figure 4). Actual measurements were recorded by the primary author and approved by a single certified sonologist. The demographic data (age, gender, and body mass index) was summarized. To be able to determine the normal values of the spleen size, mean and standard deviation were computed additionally, 95% percentile was computed. Furthermore, prevalence of accessory spleen was also computed with 95% confidence interval. Lastly, linear regression analysis was utilized to determine whether there exist significantly correlation between spleen size and age, weight, height and BMI. Using the resulting prevalence of accessory spleen on the study "Sonographic evaluation of spleen size and prevalence of accessory spleen in a healthy male Turkish population" [9] as the basis of the anticipated prevalence of accessory spleen among Nepalese and setting the type 1 error significance at 5% and power of test at 90%, the resulting minimum required sample size should at least 65 healthy volunteers. Med Calc Statistical Software was used to compute the sample size.

Results

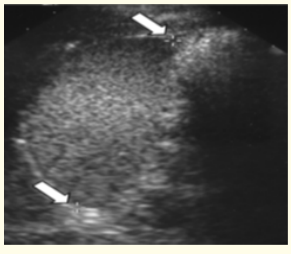

Figure 1

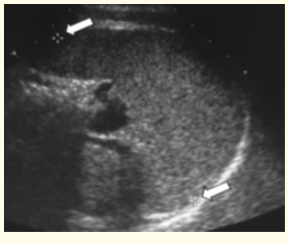

Figure 2

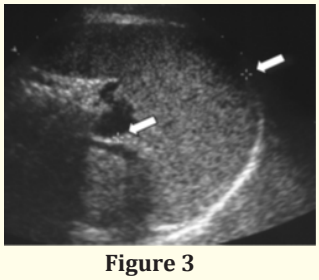

Figure 3

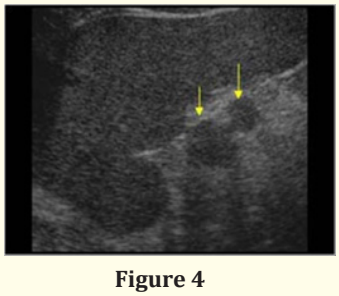

Figure 4

Profile of Patients

Results show that the mean age of the study patients is 28.1 with standard deviation of 7.2. The youngest patient included is 20 years old, while the oldest is 40. Moreover, results reveal that the gender distribution is almost equal where 52.2% are female, while 47.8% are male. Furthermore, the resulting average height of study patients is 160.7cm, where the shortest height recorded is 142cm while the tallest is 175cm. Moreover, in terms of their weight, the mean turns out to be 62.2kg which deviates from 12.4 SD. Lastly, in terms of BMI classification, most of the study patients are normal (53.6%), while 11.6% are obese, 27.5% are overweight and 7.2% are underweight.

Profile of Patients	
Age	
Mean	28.2
SD	7.2
Range	20 to 40
Sex, n %	
Female	36 (52.2)
Male	33 (47.8)
Height (cm)	
Mean	160.7
SD	7.5
Range	142 to 175
Weight (kg)	
Mean	62.2
SD	12.4
Range	45 to 95
BMI, n, %	
Underweight	5 (7.2)
Normal	37 (53.6)
Overweight	19 (27.5)
Obesity	8 (11.6)

Table 1

Spleen Summary Statistics

Length

Results below show that the average spleen length of the patients is 8.5cm which deviates from a standard deviation of 1.3. Moreover, the shortest length is 6.3cm while the longest turns out to be 13.4cm. Furthermore, 95% of the patient's spleen length is at most 11.41cm, while 90% of them have spleen length that is at most 9.96cm. Lastly, 50% of the patients have at most 8.50cm length.

Width

Results reveal that the average spleen width of the patients is 6.80cm which deviates from a standard deviation of 1.10. Moreover, the shortest width is 4.8cm while the widest turns out to be 9.2cm. Furthermore, 95% of the patient's spleen width is at most 8.91cm, while 90% of them have spleen width that is at most 8.40cm. Lastly, 50% of the patients have at most 6.80 width.

Thickness

Results reveal that the average spleen thickness of the patients is 4.00cm which deviates from a standard deviation of 0.90. Moreover, the thinness is 2.5cm while the thickness turns out to be 6.6cm. Furthermore, 95% of the patient's spleen thickness is at most 5.51cm, while 90% of them have spleen thickness that is at most 5.10cm. Lastly, 50% of the patients have at most 4.00 thickness.

Spleen	
Length (cm)	
Mean	8.50
SD	1.30
Range	6.3 to 13.4
50% Percentile (Median)	8.50
95% Percentile	11.41
90% Percentile	9.96
Width (cm)	
Mean	6.80
SD	1.10
Range	4.8 to 9.2
50% Percentile (Median)	6.80
95% Percentile	8.91
90% Percentile	8.40
Thickness (cm)	
Mean	4.00
SD	0.90
Range	2.5 to 6.6
50% Percentile (Median)	4.00
95% Percentile	5.51
90% Percentile	5.10

Table 2

Prevalence of accessory spleen

Results show that the prevalence of accessory spleen is 2.90%. Moreover, 95% confident that the true proportion of accessory spleen will fall from 0.12% to 8.7%.

Number of Patients with Accessory Spleen	% of Patients with Accessory Spleen	95% CI Accessory Spleen
2	2.90	0.12% to 8.7%

Table 3

Relationship between Profile and Spleen Size

Length

Results show that age is significantly affecting the spleen length (p = .0013). Specifically, the resulting Pearson r of 0.3797 indicates that their relationship is positively linear which means that the older a person, the more likely that their spleen length will also increase. Likewise, height and weight are also significant. Specifically, the resulting Pearson r of 0.2959 and 0.2754 respectively denotes that the taller, or the heavier they are, the more likely that their spleen length will also increase.

Spleen Length Vs	Pearson r	p value
Age	0.3797	0.0013*
Height	0.2959	0.0136*
Weight	0.2754	0.0220*
BMI	0.1680	0.1677ns
	Point Visceral	p value
Gender	-0.1900	0.1143

Table 4

*Significant at 5%, ns: Not Significant.

Width

Results showed that age (p = .6230) and BMI (p = .2024) are not significantly related to the spleen width. On the other hand, height and weight are significantly affecting the spleen width. Specifically, the resulting Pearson r of 0.2404 and 0.1554 indicates that the taller or heavier they are, the more likely that they will have a wider spleen width.

Spleen Width vs	Pearson r	p value
Age	0.0623	0.6230
Height	0.2507	0.0377
Weight	0.2404	0.0466
BMI	0.1554	0.2024
	Point Biseral	p value
Gender	0.1800	0.1357

Table 5

Thickness

Results showed that age (p = .9976), Weight (p = .3632) and BMI (p = .7073) are not significantly related to the spleen thickness. On the other hand, height is significantly affecting the spleen thickness. Specifically, the resulting Pearson r of 0.3327 indicates that the taller they are, the more likely that they will have a thicker spleen.

Spleen Thickness vs	Pearson r	p value
Age	0.0036	0.9976
Height	0.3327	0.0052
Weight	0.1112	0.3632
BMI	-0.0460	0.7073
	Point Biseral	p value
Gender	-0.2300	0.0601

Table 6

Discussion

There are many previous ultrasound data have suggested that there may be racial differences in splenic size, these differences in splenic length could result in incorrect interpretation of splenic measurements. Spleen size may give rise information about the diagnosis and course of gastrointestinal and hematologic diseases. A total of 70 healthy adults subjects were evaluated by ultrasound. The mean age + standard deviation (SD) of subject was 28.2 +7.2years (range: 20-40). The mean body height was 160.7 + 7.5 cm, while mean body weight 62.2 + 12.4 kg in our study group. In terms of BMI classification, most of the subjects are normal 53.6%

of them. The mean spleen length was 8.50 + 1.3 cm while mean spleen width 6.80 + 1.1 cm, and mean spleen thickness was 4.0 + 0.9 cm. In this study, results show that age is significantly affecting the spleen length (p = 0.0013) which indicates that their relationship is positively linear, means that the older the person, the more likely that their spleen length increase. Likewise, height and weight are also significant. Specifically, the resulting Pearson r of 0.2959 and 0.2754 respectively denotes the taller or the heavier they are, the most likely that their spleen length will also increase. In children, there is an expected increase in splenic length with age and body weight and height. (Rosenberg HK, et al, 1991) [14]. In adult populations, some reports demonstrate that splenic size is not dependent on physical data, since it does not correlate with the patient's weight, height or BMI. Selim Serter., *et al.* study showed no statistically significant correlation of splenic length with patient's weight, height or BMI, based on linear measurements of the spleen in ultrasonogram. This is not true in our study, may be because of our wide range of age group (range: 20 -40). Loftus and Metreweli (1997), observed rapid growth in the splenic length up to the age of 20 followed by a mild decrease up to the age of 50 years and rapid fall after the age of 50 years.

As to width of the spleen, our study showed that age and BMI are not significantly related. On the other hand, height and weight are significantly affected the splenic width resulting in a Pearson r of 0.2404 and 0.1554 respectively. This further explains in our study that the taller or heavier they are, the more likely they have wider spleen width. In splenic thickness, this study did not show significant relation as to age and BMI, but height resulted a Pearson r of 0.3327 indicates that the taller they are, the more likely that they have a thicker spleen. Spleen length at the hilum is considered the most reproducible linear measurements of spleen size. Splenomegaly is considered as moderate if the biggest dimension is 11-20 cm, severe if biggest dimension of greater than 20 cm. (Elmakki A, 2012) [15]. The mean spleen length in our study was 8.50 + 1.3 cm, therefore caution is required in defining splenomegaly in our population. Decrease in the size of the spleen due to aging reported in previous literature was not evident in this study since our age range is 20-40 years old. However our findings were in agreement with results described by African and Indians studies of Mustapha et al and Ehimwenma et al, respectively.

Badran et al study showed moderate positive relationships between splenic volume and height, weight, BSA and BMI, this was similar to the data from sonography and autopsy study of Caglar V., *et al.* The body weight and height might show variation in the body fat for the same BMI might also be caused by different physical activities, diet and ethnicity. The variations of body parameters could be attributed to different splenic measurements in different areas. [17] On the other hand, Selim Serter., *et al.* and Mustapha., *et al*. studies, a Turkish and African adults studies respectively show no correlation between spleen size and body parameters. From a physiologic point of view, our findings would make more sense, as patients with a bigger body habitus will have larger blood volume requiring larger spleens for filtration, this is in agreement with the study of Darwish., *et al*.

The failure of fusion of splenic tissue results in the formation of accessory spleen. The prevalence of accessory spleen detected by ultrasound in our study was calculated as 2.9%, moreover 95% confident that the proportion of accessory spleen will fall from 0.12% to 8.7%. Selim Serter et. Al reported 2.2 % accessory spleen detected by ultrasound. Mortele., *et al*. reported that accessory spleens are detected in 16% of patients undergoing contrast-enhanced abdominal CT. Chen et al found accessory spleen in 5% (5/103) of patients in ultrasound examinations. In addition, detection of accessory spleen is important since the ultimate goal of surgery for hematological disorders is complete removal of both spleen and accessory spleens in order to avoid disease recurrence. In agreement with previous studies, our study revealed a lower prevalence of accessory spleen. Ultrasound is less sensitive in detection of the accessory spleen. The lower prevalence can be explained particularly by the imaging method.

Conclusion

Ultrasound is the modality of choice in diagnosis and monitoring of splenomegaly because of its diagnostic efficiency. There are different standards for normal splenic size that have been devel-

oped for different areas in the world. This study aims to establish a normal range of values using ultrasonography and its correlation with age, gender, and body mass index among healthy adult Nepalese and found to have an average splenic length to be 8.50 ± 1.3 cm. The splenic length showed relationship that has positive linear correlation as to age, height and weight. The splenic width is 6.80 ± 1.1 cm which is significantly correlated as to height and weight. Likewise, height and weight are significantly affecting splenic thickness 4.0 ± 0.9 cm in this study. In addition, this study showed normal spleen data for a healthy adult Nepalese. This should be taken into consideration when the diagnosis of splenomegaly is established among adult Nepalese.

The prevalence of accessory spleen in this study is 2.90%, this study showed low prevalence. In agreement with other study ultrasound therefore does not allow adequate detection of accessory spleen.

Recommendations

The main limitation of this study was the small number of the sample size, which certainly has affected generalizability of our result. A larger sample population is required to improve the accuracy of our measurements. Furthermore, we recommend in future studies to have a monogram of age on its results according to Loftus and Metreweli (1997), rapid growth in the splenic length up to the age of 20 followed by a mild decrease up to the age of 50 years and rapid fall after the age of 50 years. It will further define normal splenic size as to definite age range.

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