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RESEARCH ARTICLE

SONOGRAPHIC DETERMINATION OF SPLEEN TO LEFT KIDNEY RATIO IN PEDIATRIC AGE GROUP FROM 5-15 YRS

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ABSTRACT

Background: To standardize expected splenic and renal length and to determine non-palpable splenomegaly.
Objective: To measure the normal values of normal kidney and splenic length; to determine constant ratio of the length of the spleen to the length of the left kidney related to anthropometric measurements; to determine a value to assess splenomegaly in children.
Methods: A cross sectional study was done on pediatric population of 5-15 years age groupat Raja Muthiah Medical College, Annamalai University for a period of one year. Ultrasonogram of abdomen was performed with high-resolution real time scanner-Siemens Acuson X 300 color Doppler Ultra sonogram machine. The splenic length was measured from the dome to the splenic tip through the splenic hilum. The longitudinal length of the left kidney was measured as a longest distance from upper to lower pole. These parameters were analyzed using somatometric parameters.
Results: The mean spleen length in the pediatric population studied was 81.8mm among the boys and 79.01mm among the girls. The mean value of left renal length was 85.5mm among the boys and 83.07mm among the girls. The mean ratio of spleen to left kidney ratio was constant around 1.05mm and using 2 standard deviation as a guide a ratio more than 1.2 was considered the upper limit of normal. Any measurement of spleen more than 1.2 times the adjacent kidney could be used as criteria for mild splenomegaly.
Conclusion: Splenic length and renal length increases with age and somatometric parameters like height, weight and body surface area without significant relationship with gender or body mass index. Mild splenomegaly may be considered if the spleen to left kidney ratio is more than 1.2 in the absence of the renal disease.

INTRODUCTION

Childhood is an important period of growth for many organ systems. Mild splenomegaly cannot be determined clinically. The aim of this study is to standardize expected splenic and renal length and to determine non-palpable splenic enlargement. Measuring kidney and spleen size using ultrasound is a reliable method. Sonographic estimation remains popular due to its availability, ease of performance, absence of ionizing radiation, absence of contrast agents, less cost, portability, repeatability and reproducibility.

Objectives

To measure the normal values of normal kidney and splenic length; to determine constant ratio of the length of the spleen to the length of the left kidney related to anthropometric measurements; to determine a value to assess splenomegaly in children

MATERIALS AND METHODS

The study was carried out using a cross sectional research design at Raja Muthiah Medical College, Annamalai University for a period of one year. A total of 100 children of age 5-15 years were included. Ultrasonogram of abdomen was performed with high-resolution real time scanner-Siemens Acuson X 300 color Doppler Ultra sonogram machine. The examination was done either in a supine and right lateral decubitus position. The splenic length was measured from the dome to the splenic tip through the splenic hilum. The longitudinal length of the left kidney was measured as a longest distance from upper to lower pole. Then the spleen to left kidney ratio was obtained. The spleen and left kidney lengths were measured three times and the mean values were recorded. Demographic data were collected on each participant at the time of their pre-participation physical examination. This information included age, sex, and height and body

weight. BSA and BMI were computed from measured height and weight.

Inclusion Criteria

- Subjects with no history of malaria, typhoid fever, sickle cell disease or obesity.
- Subjects with no evidence of splenic parenchymal mass lesions.
- Subjects without accessory spleens or splenic cysts.
- Subjects with normal sonographic appearance of the kidneys.
- Subjects without congenital anomalies of kidneys like ectopic kidney, horse shoe kidney etc.
- Apparently healthy subjects.
- Subjects who are normotensive.
- No acute or chronic disease capable of renal damage.

Exclusion Criteria

- Subjects with tropical splenomegaly, lymphadenopathy, and splenic parenchymal disease.
- Subjects with congenital anomalies of spleen.
- Subjects with splenic cysts.
- Subjects with congenital anomalies of the kidney.
- Subjects with acute or chronic kidney disease.
- Subjects with hydronephrosis.
- Subjects with renal cysts.
- Subjects with renal parenchymal lesions.

Statistical analysis: Difference of continuous variables is tested using two –way analysis of variance (ANOVA). Statistical package was done with SPSS version 17. Statistical significance was considered at p value <0.05.

RESULTS

The children under study were grouped into certain age groups. Pie diagram shows the sex distribution in the children included in the study. The age wise distribution of spleen and left renal length was evaluated ad shown in Tables 1 & 2. The mean spleen length in the pediatric population studied was 81.8mm among the boys and 79.01mm among the girls. The mean value of left renal length was 85.5mm among the boys and 83.07mm among the girls. The correlation between the spleen length and somatometric parameters like height (p=0.018), weight (p=0.007) and body surface area (p=0.012), showed significant relationship. The correlation with body mass index and spleen size, did not show significant relationship (p=0.858).

The correlation between left renal length and somatometric parameters like height (p=0.025), weight (p=0.32) and body surface area (p=0.003), showed significant relationship. The correlation between the left renal length and body mass index (p=0.836), did not show significant relationship.

The spleen /left kidney ratio distribution in the different age groups is shown in table 3. The mean ratio of spleen to left kidney ratio was constant around 1.05 and using 2 standard deviation as a guide, a ratio more than 1.2 was considered the upper limit of normal. Any measurement of spleen more than 1.2 times the adjacent kidney could be used as criteria for mild splenomegaly.

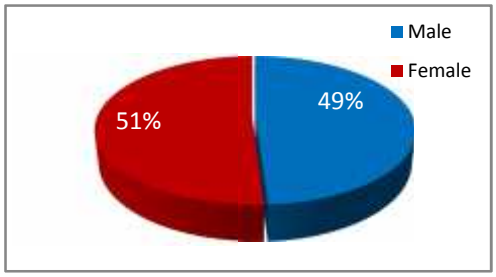


Fig.1 Sex distribution

Table - 1 Spleen size (cm) according to each age group and sex

Age	Male			Female			F value & Sig.
	No	Mean	SD	No	Mean	SD	
5	5	72.2000	3.03315	2	75.0000	1.41421	Sex
6	3	79.6667	2.08167	4	72.7500	3.86221	F 7.811
7	1	76.0000	0	3	74.0000	4.00000	Sig. 0.015
8	2	82.0000	2.82843	5	77.4000	2.88097	
9	2	77.0000	2.82843	6	76.0000	4.73286	Age
10	8	79.5000	6.54654	4	77.0000	8.75595	F 6.140
11	7	83.4286	3.15474	4	76.0000	2.16025	Sig. 0.004
12	3	83.6667	3.51188	5	79.8000	3.34664	
13	7	87.1429	6.28301	6	81.3333	5.27889	Sex vs
14	6	84.5000	4.27785	4	81.2500	2.98608	Age
15	5	86.0000	3.53553	8	87.5000	3.54562	F 1.098
Total	49	81.8776	6.09177	51	79.0196	5.97157	Sig. 0.375

Table - 2 Left kidney length (cm) according to each age group and sex

Age	Male			Female			F value & Sig.
	No	Mean	SD	No	Mean	SD	
5	5	74.8000	2.94958	2	78.0000	.00000	Sex
6	3	83.6667	0.57735	4	78.0000	6.73300	F 8.643
7	1	80.0000	0	3	77.6667	2.51661	Sig. 0.011
8	2	83.0000	1.41421	5	81.0000	2.23607	
9	2	84.5000	4.94975	6	81.3333	6.12100	Age
10	8	82.5000	5.34522	4	80.2500	8.42120	F 7.791
11	7	87.2857	4.42396	4	79.5000	1.91485	Sig. 0.002
12	3	89.0000	1.00000	5	84.0000	2.82843	
13	7	90.5714	4.68534	6	86.1667	3.48807	Sex vs
14	6	88.3333	4.22690	4	85.5000	1.00000	Age
15	5	90.0000	1.41421	8	90.6250	4.03334	F 1.020
Total	49	85.5510	5.94790	51	83.0784	5.82355	Sig. 0.435

Table - 3 Spleen to Left kidney ratio according to each age group and sex

Age	Male			Female		
	No	Mean	SD	No	Mean	SD
5	5	1.0360	0.03286	2	1.0400	0.01414
6	3	1.0500	0.03000	4	1.0725	0.06131
7	1	1.0500	0.03000	3	1.0500	0.02000
8	2	1.0150	0.02121	5	1.0480	0.02864
9	2	1.0950	0.02121	6	1.0717	0.03817
10	8	1.0412	0.03091	4	1.0425	0.01708
11	7	1.0457	0.02820	4	1.0475	0.01708
12	3	1.0633	0.05033	5	1.0540	0.04561
13	7	1.0400	0.03559	6	1.0633	0.05538
14	6	1.0450	0.01761	4	1.0525	0.03686
15	5	1.0500	0.04899	8	1.0338	0.02615
Total	49	1.0457	0.03260	51	1.0525	0.03616

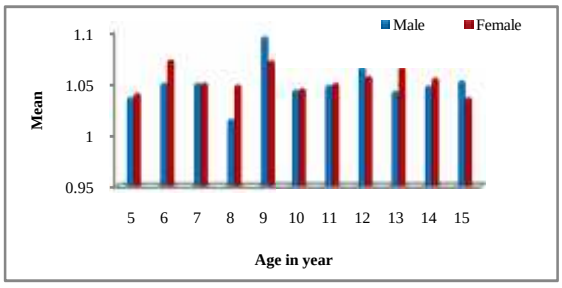
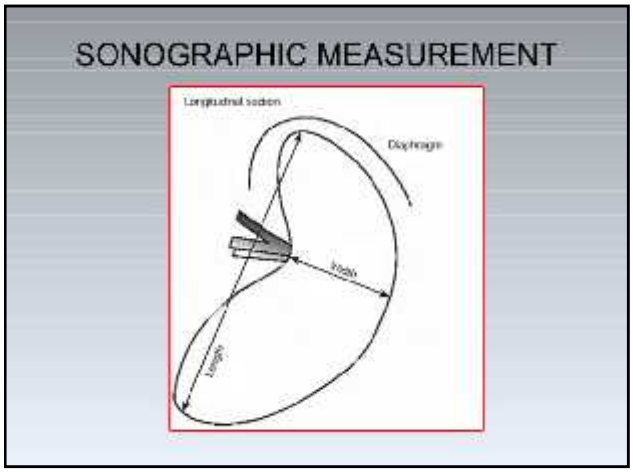


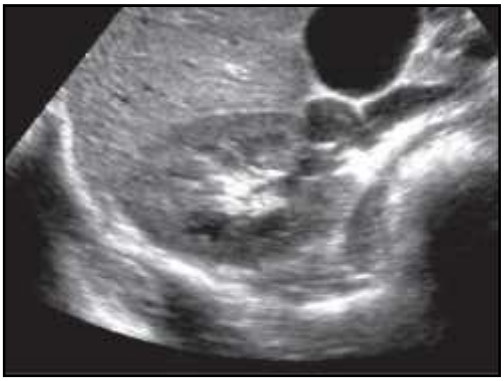
Fig. 2 Spleen to Left kidney ratio according to each age group and sex

Longitudinal ultrasound image through the spleen. Note the diaphragm above and the kidney below. The spleen is usually hyperechoic compared to the kidney.

Improved visualization of the spleen on coronal oblique scan aligned with the 10th interspace between the ribs.



Splenic measurement. Diagram shows sonographic approach to measuring splenic length and width. Splenic size is best measured by obtaining a coronal view that includes the hilum.



Normal kidney. A, Sagittal, and B, transverse, sonograms of normal anatomy with corticomedullary differentiation show relatively hypoechoic medullary pyramids, with cortex slightly less echogenic than the liver and spleen.

Normal left kidney dimensions

DISCUSSION

The morphology of visceral organs varies from person to person. During the maturation process from infancy through adolescence growth of visceral organs including the spleen shows a high correlation with gains in height, weigh and body surface area[1]. Various methods are defined for the evaluation of the spleen and kidney size in the literature. However sonography is a simple, practical, low cost, accurate and reproducible method without use of ionizing radiation. In the literature, the normal splenic and kidney size in different age groups has been reported. In 1970 Deland[2] stated that size of the spleen in 440 adults autopsy specimen shows variation according to sex and age. He reported that splenic size in female was smaller than male in all age groups. In 1983 Niederau *et al*[3] in their sonographic study found that spleen size decreased with increasing age.

In our study school children ranging from 5-15 years were included. We grouped the subjects into definite age groups. Splenic length and left renal length increased with increasing age.

Many studies have shown that height best correlates with the renal length[4]. In the univariate analysis, renal length shows the highest correlation with patient's height and weight. Univariate equation was formulated using simple linear regression to estimate renal length and volume through respective body indices. The results of univariate and multivariate analyses were also considered with the ease of use in clinical practice[4].
There are also controversies regarding the correlation between gender and kidney size in children. Some studies suggest that girls have smaller kidneys and other studies indicate no

difference in renal size between genders. These differences may be due to the low statistical power of a small number of study groups. Multivariate analysis demonstrated that gender was not a significant independent factor on renal length and volume[4].

In our study, 51 girls and 49 boys were included. There is a significant increase in splenic length (p=0.018) and renal length (p=0.025) as height of the children increases. But there is no significant difference in the measured lengths with respect to sex (p>0.05). These findings are similar to other studies[7,8].

Eze *et al*[6]showed that there was no significant differences in the measured spleen and left kidney lengths with respect to sex. Therefore sex certainly is not a determining factor for spleen and left kidney lengths in school age children in this population. The absence of gender difference in the dimension of both ultrasound of left kidney and spleen suggests a non-involvement of sex hormones in the development of these organs until the age of 18 years.

BMI is one of the widely used parameters for measuring obesity. There have been several studies that evaluated BSA and lean body mass as a predictor of renal size in children. However there are a far fewer studies about the relationship between renal length and body mass index. Pantoja Zuzuarregui et[5] al suggested that BMI well correlates with renal length. Jun Hwee Kim *et al*[4] found much weaker correlation between renal length and BMI compared with that of height and weight. This suggests that BMI might not be a significant confounder in estimating the renal sizes.

In our study, splenic length (p=0.007) and renal length (p=0.032) increases as weight increases. Splenic length (p=0.012) and renal length (p=0.003) increases as body surface area increases. No significant relationship was found between BMI and the splenic (p=0.858) and renal length(p=0.836).

Loftus and Metreweli *et al*[7] as well as Al Iman *et al*[8] found that spleen to left kidney ratio was constant at all groups with mean value of 1 and proposed a ratio of 1.25 as the upper limit of normal in a pediatric population. Eze, Agwu *et al*[6] found that spleen and left kidney ratio according to age and somatometric parameters was constant at about 1.13 with 1.3 as the upper limit of normal in the studied population and mild splenomegaly was suspected if the ratio is greater than 1.3 in the absence of renal disease among school age children.

In our study mean spleen to left kidney ratio according to age and somatometric parameters was 1.05 and using 2 standard deviations above the mean the upper limit of normal for the spleen to left kidney ratio is 1.2. Thus mild splenomegaly can be considered in the pediatric age population if the spleen to left kidney ratio is more than 1.2 in the absence of renal disease.

Kim and Park *et al*[9] reported close relationship between renal length and height using Ultrasound in normal children.

Although spleen in general has known anatomical features, they widely differ in their measurement in pediatric age group. Ultrasonogram provides probably the most dependable information for assessing the splenic length because of its relatively established stage, quick and reliable method. Very few studies have been done in the past including performance of a nomogram analysis of the splenic size in childhood. They were exclusively concerned with spleen or included more parenchymal organ[10]. In splenomegaly anterior border, anterior diaphragmatic surface and notched superior border may become clearly palpable below the left costal margin. The notches are often exaggerated and may be clearly palpable. The transverse colon and splenic flexure are displaced downward[10].

There is numerous advantage of Ultrasonogram in determining renal size. These include lack of ionizing radiation exposure, radiographic magnification and osmotic effect of the iodinated contrast material. The examination is real time, tridimensional, independent of organ function and phase of respiration[11].

Bhavna, Suvasini *et al*[12] have found that conventional method of recording hepatic and splenic size by clinical examination has been reported to lack both accuracy and reliability.

Alev Kaioglu *et al* [13] found that renal length gradually increased with age. Carrico and Zerin *et al*[14] compared supine (sagittal) and contralateral decubitus (coronal) and prone positions and reported that renal length measured in supine or contralateral decubitus position was longer than that measured in children in the prone position. Michel *et al*[15] compared the supine with the prone position and reported that renal length measured in children in the supine position is greater than that measured in the prone position. De Sanctis *et al*[16] compared sagittal, coronal and prone positions and reported that coronal and sagittal views yielded the longest measurements whereas prone views yield the shortest measurements.

Limitations

We examined the renal size only by ultrasound, which has a relatively high intra, and inter-observer variability as indicated by previous studies by Sargent *et al*. The differences in the ultrasound positioning and cursor placement can affect the reproducibility of the measurements of splenic and renal lengths. Third limitation is that there is no evaluation of renal function measurements such as serum creatinine and GFR. We evaluated sonographically normal kidneys. There have been several studies showing that renal function influences the renal size. Fourth limitation is that the small sample size in certain groups may affect the generalization of the values to those age groups. The socio economic status of the children examined was not recorded although they belonged to lower middle and lower income group.

Recommendations

A single radiologist performing the study can reduce the intra and inter –observer variability. Future prospective study evaluating the intra and inter-observer variability is necessary. Future studies with comparison with of renal or splenic length and volume with CT or MRI may be performed. Further study showing the relationship with the renal function and renal size has to be evaluated. In a population where is obesity rate is higher the effects of BMI needs to be further evaluated.

CONCLUSION

Splenic length and renal length increases with age and somatometric parameters like height, weight and body surface area without significant relationship with gender or body mass index. The mean spleen to left kidney ratio was constant at all age groups taken in our study. Mild splenomegaly may be considered if the spleen to left kidney ratio is more than 1.2 in the absence of the renal disease.

References

1. Hosey, Mattacola, Kriss, Armse, Quarles, Jagger *et al*. Ultrasound assessment of spleen size in athletes.*Br J Sports Med* 2006; 40:251-254.
2. Deland FH. Normal spleen size radiology 1970; 97:589-592.
3. Niederau C, Sonnenberg A Muller je. Erckenbrecht JF, Scholten J. Fritsch WP. Sonographic measurements of normal liver, spleen, pancreas and portal vein, Radiology, 1983; 149:537-540.
4. Jun-HweeKim,Myung-JoonKIm,Sok Hwan Lim,JieunKim, MI-Jung Lee *et al*. Length and volume of morphologically normal kidneys in Korean children: Ultrasound measurement and estimation using body size. *Korean Journal of radiology14*(4),July/Aug 2013.
5. Pantoja Zuzuarregui JR, MalliosR, Murphy J. The effect of obesity on kidney length in healthy pediatric population. Pediatric Nephrol 2009; 24:2023-2027.
6. Eze, Agwu, Agwuna, Ezeasor, Aronu *et al* Sonographic determination of spleen to left kidney ratio among Igbo school age children of southeast Nigeria : African health sciences2014;14(1):246-254http//dx.doi.org/10. 4314/ahs.v14i1.38
7. Loftus WK, Metreweli C *et al*. Ultrasound assessment of mild splenomegaly: Spleen/kidney ratio. Peadiatric Radioln.1998 Feb: 28 920 : 98-100.
8. Al-Iman, Suleiman, Khukeifat *et al*. Ultrasound assessment of normal splenic length and spleen-to-kidney ratio in children. Eastern Mediterranean Health Journal, Vol.6, Nos 2/3,2000.
9. Kim KS, Park JH. Sonographic of renal size in normal children. Korean J Nephrol 1989; 8: 384-9.
10. Tanna NA, Ambiye MV, TannaVA,Joshi HA *et al*. Ultrasonic measurement of normal splenic size in infants and children in pediatric Indian population. Natl J community med.2012; 3(3); 529-533.
11. A Otiv, K Mehta, U Ali, M Nadkarni *et al*. Sonographic measurement of renal size in normal Indian children. Department of radiology and ultrasonography, Indian pediatrics, volume 49-July 2012.
12. Bhavna Dhingra, Suvasini Sharma, Devendra Mishra,ReemaKumari, ravindra Mohan Pandey, Shailendra Aggarwal *et al*. Normal values of Liver and Spleen size by Ultrasonography in Indian children. Department of pediatric radiology, January, 2009.
13. Alev Kaioglu *et al*. Renal measurements including length, Parenchymal thickness and medullary pyramid thickness in healthy children: What are the normative ultrasound values? ALKA radiologic diagnosis centerAJR 2010; 194:509-515.
14. Carrico CW, Zerin JM. Sonographic measurement of renal length in children: does the position of the patient matter? Pediatric Radiol 1996; 26: 553-555.
15. Michael SC, Forster I, Seifert B, Willi UV, Huisman TAGM. Renal dimensions measured by ultrasonography in children: variations as a function of the imaging plane and patient position. Eur Radiol 2004; 14:1508-1512.
16. De Sanctis JT, Connoly SA, Bramson RT. Effect of patient position on sonographically measured renal length in neonates, infants and children. AJR 1998; 170: 1381-1383.