



Original article

Splenic volume in a malaria endemic region using ultrasound

Njeze N R^{1*}, Ibezim E O²

¹Department of Radiation Medicine, University of Nigeria Medical School, Nsukka

²Department of Radiology, Imo State University Teaching Hospital, Orlu, Imo State

ABSTRACT

Introduction: Malaria is a menace in the tropics and majority of changes related to it involve the blood, blood forming system, spleen and liver. This study aims to determine splenic size (volume) in adults in a malaria endemic area, and compare the findings with those in a malaria non endemic area. **Materials and methods:** a prospective study was carried out on 267 adults (141 females and 126 males) using a Siemens Sonoline SL-250 ultrasound machine to measure the splenic dimensions. Data analysis was done using SPSS 16 software. **Results:** The splenic volume increased between the ages of 20 and 59 years with subsequent decrease in both sexes. The correlation between the splenic size and age is statistically poor. The average splenic volume was 259.4cm³. Female subjects had a greater average splenic dimensions than males, however, this was not statistically significant $p>0.05$. **Conclusion:** There is a weak positive correlation of splenic volume with age in this study. This is unlike other studies which showed no significant difference in adult splenic volume in our communities as elsewhere. The normative values for adult splenic volume in Enugu referral region have been defined by this study.

KEYWORDS: Malaria, Sonography, Splenic volume.

INTRODUCTION

Enugu State is in South Eastern part of Nigeria. Enugu South has a land area of 70,980 km²[1]. Malaria is known to be hyperendemic in this state. The size of normal spleen in an adult is 12 – 15 cm long; 4 – 8 cm in antero-posterior diameter & 3 – 4 cm thick.[2] Its oblique orientation has limited the use of these linear measurements. Splenic volume varies significantly from one individual to another. Normal in-vivo splenic volume range is from 107 – 314 cm³. [2] The spleen is readily visualized on ultrasound, and its long axis is less than 12 cm in 95% of the population. On cross-sectional imaging, a more accurate method for assessment of spleen volume is the splenic index and this is the product of the length, width & thickness. Normal splenic index is between 120 and 480 cm³.

Splenic enlargement is an important entity in a variety of diseases which include tropical splenomegaly syndrome (associated closely with malaria), liver diseases, portal hypertension, leukemias, lymphomas, and hematologic diseases.[3-5] Many workers stated that people living in malaria zones have large spleens.[6-12] Splenomegaly is prevalent in New Guinea where *Plasmodium vivax* is

commoner as against *falciparum* species in our environment[12].

The spleen is usually palpated only when it is significantly enlarged, hence evaluation of splenic size by palpation has a very poor sensitivity and specificity index[13]. Ultrasonography is cheap[7], relatively accurate and a realistic means of estimating splenic volume in our resource poor environment[6]. Yetter et al[5] showed that the best formula for estimating splenic volume using ultrasonography is the percentage difference between measured and calculated computerized tomography (CT) and sonographic splenic volume, by using an average length measurement. Splenomegaly commonly occurs in malaria infection[6-15]. In acute clinical malarial attack, the spleen enlarges, and then regresses as the attack resolves[15]. In recurrent malaria which is common in malaria endemic areas, there is slowing down of splenic regression by frequent splenic enlargement, resulting in persistence of splenomegaly[11]. This study aims at establishing a relationship between splenic volume, age and gender in a malaria endemic region.

MATERIALS AND METHODS

This is a prospective study carried out between January 2010 and December 2011 on adults scanned in a Radiology clinic. They were referred for varied clinical indications. Excluded were as follows: acute malaria, pregnancy and medical history consistent with other diseases affecting splenic size. The residue came up to 267 adults. Each subject was scanned in supine position by a Radiologist with Siemens Sonoline SL-250 machine fitted with an electronic caliper and a 3.75MHz sector probe.

Splenic length, width and thickness were measured and recorded and presented as mean \pm standard deviation (SD). Primary data collection was done using Excel software

(Microsoft USA). Data analysis was done using SPSS 16 software. Differences in splenic volume between the sexes were compared using the simple student T-Test, while Pearson correlation analysis was used to test the relationship between splenic volume and age. A P- value $<$ 0.05 was considered to be statistically significant.

RESULTS

Of the 267 adults aged between 20 and 90years (47.33 ± 18.02 years), there were 141 females and 126 males(1.1:1). The splenic volume increased between 20 and 59 years, as shown in tables 1 and 2, and subsequently decreased gradually with age in both sexes.

Table 1: Average splenic dimensions by age in males

Age (years)	Length (cm)	Width (cm)	Thickness (cm)	Splenic Volume (cm ³)
20 – 29	9.79 \pm 0.90	8.67 \pm 1.20	6.01 \pm 1.07	281.90 \pm 85.43
30 – 39	9.96 \pm 1.25	9.02 \pm 1.46	5.74 \pm 1.08	287.60 \pm 108.60
40 – 49	9.93 \pm 1.3	8.58 \pm 1.05	5.59 \pm 0.77	261.40 \pm 77.26
50 – 59	9.88 \pm 1.4	8.75 \pm 1.28	5.65 \pm 1.04	268.80 \pm 104.07
60 - 69	9.38 \pm 1.78	8.08 \pm 1.22	5.38 \pm 1.34	237.08 \pm 121.59
70 – 90	9.40 \pm 1.42	7.82 \pm 1.36	5.34 \pm 1.10	221.70 \pm 102.67

Table 2. Average splenic dimension by age in females.

Age (years)	Average Length (cm)	Average Width (cm)	Average Thickness (cm)	Splenic Volume (cm ³) For Females
20 – 29	9.81 \pm 1.34	8.53 \pm 1.26	5.77 \pm 1.40	275.90 \pm 122.09
30 – 39	10.12 \pm 1.28	8.85 \pm 1.37	5.80 \pm 1.32	291.74 \pm 130.04
40 – 49	9.71 \pm 1.51	8.58 \pm 1.31	5.63 \pm 1.16	268.51 \pm 132.18
50 – 59	9.82 \pm 1.23	8.29 \pm 0.97	5.53 \pm 0.90	247.20 \pm 79.09
60 - 69	9.51 \pm 1.41	7.94 \pm 1.8	5.55 \pm 1.24	247.75 \pm 145.62
70 – 90	8.50 \pm 1.57	6.94 \pm 1.60	4.63 \pm 1.09	153.94 \pm 85.43

The average splenic volume was 259.4 cm³ as shown in table 3. Male to female ratio of 1:1.1. The volume of the spleen was greater in females than in males, from 264.48 \pm 126.41 cm³ to 253.65 \pm 103.07 cm³, as shown in table 3. The difference is, however, not statistically significant as $p > 0.05$.

The average dimensions (length, width and thickness) were all greater in females than in males as shown in table 3. These differences are also not significant as $p > 0.05$. The correlation between splenic volume and age is statistically poor as shown in table 4.

Table 3: The average dimensions of the spleen among males and females

Sex	Length (cm)	Width (cm)	Thickness (cm)	Vol. (cm ³)
Males	9.67 \pm 1.41	8.39 \pm 1.31	5.56 \pm 1.09	253.65 \pm 103.07
Females	9.76 \pm 1.41	8.43 \pm 1.45	5.62 \pm 1.28	264.48 \pm 126.41
Total	9.72 \pm 1.41	8.41 \pm 1.38	5.69 \pm 1.19	259.36 \pm 115.90
P-value	0.612	0.697	0.807	0.447

Table 4: The distribution of splenic volume by age among males and females

Age (years)	Splenic Volume (cm ³) For Males	Splenic Volume (cm ³) For Females	P- Value
20 – 29	281.90 \pm 85.42	275.95 \pm 122.09	0.848
30 – 39	287.56 \pm 108.70	291.74 \pm 130.04	0.903
40 – 49	261.36 \pm 77.26	268.51 \pm 132.18	0.825
50 – 59	268.75 \pm 104.07	247.20 \pm 79.09	0.527
60 - 69	237.09 \pm 121.60	247.75 \pm 145.62	0.817
70 – 90	221.68 \pm 102.67	153.94 \pm 85.43	0.024

DISCUSSION

It is known that the spleen in majority of people living in “malaria-belt” are enlarged.[6-12] An explanation by many workers is that splenic size regressed with acquisition of immunity to malaria or treatment with chloroquin or other prophylactic drugs.[9-18] This may be the reason for the normal splenic size in the subjects of this study. Personal communications also reveal that residents in Enugu State consume antimalarials (orthodox drugs and local herbs alike) freely with or without consultations. Chauhan et al[19] observed small spleens in people living in falciparum zones. Marsden and co-workers[14] have similar findings that there is no variation in splenic size in

CONCLUSION

Our study showed a weak positive correlation of splenic volume with age. This correlation is only evident beyond the age of 39 years unlike other studies which showed that there is no significant difference in splenic volume in adults in our communities as elsewhere. Our study showed a higher splenic volume in females than in males unlike other studies in the same environment. Further studies may offer explanations for the female predominance. We have defined normative values for splenic volume of adults in the Enugu referral region. These values will enable clinicians monitor changes in splenic volume during both progress and treatment of diseases.

Acknowledgements

We appreciate the enormous constructive criticism and meticulous proof reading of Professor Wilson Onuigbo. We also thank Chika for type setting this work.

Competing interest: The authors declare that they have no competing interests.

REFERENCES

1. Iyi EA. A review of Enugu (Enugu state Nigeria) Urban Growth and Development. Review of Environmental and Earth Sciences. 2014;(1)3:44-51
2. Aslam S, Sohaib A, Reznek RH. Reticuloendothelial Disorders: The Spleen: Grainger & Allison's Diagnostic Radiology, 5th ed. Vol. 2, chapter 73. Churchill Livingstone (Elsevier) 2008.
3. Iris DO, Kathy AS, Dolores HP, Anna SLT, Ted BB, Thomas RN. Normal Splenic Volumes Estimated Using Three-Dimensional Ultrasonography, J Ultrasound Med 1999; 18: 231 – 236.
4. Asghar A, Dushyant A, Yunus SM, Sharma PK, Zaidi SHH, Aruna S. Standard Splenic Volume Estimation in North Indian Adult population: Using 3-D reconstruction of abdominal CT scan images. Anat res int 2011(2011),707325
5pages.http://dx.doi.org/10.1155/2011/707325
5. Yetter EM, Acosta KB, Olson MC, Blundel K. Estimating splenic volume: Sonographic measurement correlated with helical CT determination. AJR 2003;181:1615-1620.

6. Okoye IJ, Agwu KK, Ochie K. Splenic Sizes in Normal Adult Nigerian Population. WAJR. 2005.12(1).
7. Rees PH, Gatei DG, de Cock, Tosswill. Some Preliminary Observations on the Investigation of Splenomegaly in Kenya. East African Medical Journal. 1982: 59(10).
8. Greenwood BM. Asymptomatic Malaria Infection- do they matter? Parasitol Today 1987; 3 (7):206-214. PMID:15462957.
9. Crane GG. Hyperreactive Malarious Splenomegaly (Tropical Splenomegaly Syndrome) Parasitology Today 1986 .2(1) 4-9.
10. Jaime TR, Oscar NG, Ale Jandro, Mondolfi G, Carelina P, Carlos BA. Hyperreactive Malarial Splenomegaly in Venezuela. Am J Trop Med Hyg 1988. 39(1):11-14.
11. Emodi IJ, Ikefuna AN. Hyper-reactive malaria Splenomegaly. A case report & review of the management & pathogenesis. Niger Med. J 2009; 50:97-9.
12. Pitney WR, Pryor DS, Smith AT. Morphological Observation on Livers and Spleens of Patients with Tropical Splenomegaly in New Guinea. J Path Bact .1968.95. 417-422.
13. Dial H Jr, Pitchmumoni. Balliere's Clinical Gastroenterology 1987, 1(2):319-333.
14. Marsden PD, Crane GG. The Tropical Splenomegaly Syndrome, A Current Appraisal. Rev. Inst Med Trop Sao Paulo 1976; 18(1):54-70.
15. Hosey RG, Mattacola CG, Kriss V, Armsey T, Quarles JD, Jagger J. Ultrasound Assessment Of Spleen in Collegiate Athletes. Br J Sports Med 2006; 40:251-254.
16. Awotua-Efebo O, Alikor EAD, Nkanginieme KEO. Malaria Parasite Density and splenic Status by Ultrasonography in Stable Sickle-Cell Anemia (HbSS) Children. Nig Jour of Med, 2004,13(1):40-43.
17. Hoefs JC, Wang FW, Lillian DL, Walker B, Kanel G. A novel, simple method of functional spleen volume calculation by liver spleen scan. J Nucl Med 1999, 40: (10) 1745-1755.
18. Imo AO, Eze JC, Udoh BE. Ultrasonic evaluation of splenic volumes in normal subjects in South East Nigeria. WAJR, April, vol 18, no 1 pg 42-47.
19. Chauhan R, Kapoor V, Vohra PA, Jhala PJ, Upadhyaya AK, Pathak KJ. The ‘small spleen’ in malaria. J Assoc Physicians India. 1996.44 (7):483-5.
20. Ogbeide E, Marchie TT. Determination of normal dimension of the spleen by ultrasound in an endemic tropical environment. Niger Med J 2011.52(3):198-203.

*Corresponding author: Njeze N R
E-Mail: rosemarynjeze@gmail.com