بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Characterization of Normal Spleen in Pediatrics by using Ultrasound

توصيف الطوحال الطبيعي للأطفال باستخدام التصوير بالموجات فوق الصوتية

A thesis Submitted for Partial fulfillment of Requirements of M.Sc. Degree in Medical Diagnostic Ultrasound

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بسم الله الرحمن الرحيم

الآية

قال تعالى:

((وَاجْعَل لِّي لِسَانَ صِدْقٍ فِي الْآخِرِينَ (84) وَاجْعَلْنِي مِن وَرَثَةِ جَنَّةِ النَّعِيمِ (85) وَاغْفِرْ لِأَبِي إِنَّهُ كَانَ مِنَ الضَّالِّينَ (86) وَلَا تُخْزِنِي يَوْمَ يُبْعَثُونَ (87) يَوْمَ لَا يَنفَعُ مَالٌ وَلَا بَنُونَ (88) إِلَّا مَنْ أَتَى اللَّهَ بِقَلْبٍ سَلِيمٍ (89).))

صدق الله العظيم

سورة الشعراء الاية (84-89)

Dedication

I dedicate thesis

To my parents.

To my family who supported me in every thing

And to everyone who help me in this research

Acknowledgement

First of all, I would like to express my gratitude to ALLAH.

Special thanks to my supervisor **Dr/ Asma Ibrahim Ahmed** for her continuous support, guidance and unlimited assistance during this research.

I would also like to express my appreciation and sincere gratitude to my family and friends for all support and encouragement they provided.

Abstract

This was a cross-sectional descriptive study done at different Hospitals in Khartoum- Sudan during from October to December 2020. The study aimed to measurement of the spleen in pediatric by using ultrasound. therefore, there is need to establish a baseline nomogram in our locality for spleen size. This is experimental study designed to determine the application of ultrasound for estimation of splenic length, width, thickness and volume of Sudanese pediatric population. This study was done on Fifty healthy school age (38 males and 12 females), age group between 2-15 years. It looks three measurements (length, width and thickness of the spleen.

The results study showed that the Age group within the range of 2-15 years, with mean age 9.7±3.5 years. Males were 38(76%) and females were 12(24%). Male to female ratio was 3.2:1. Regarding body weight and height of the studied children, the mean values were 29.8±9.9 kg and 107.5±16.5 cm respectively. Normal values of spleen measurements in terms of length, width, thickness and volume were 7.7±1.1 cm, 6.6±1.0 cm, 4.0±0.7 cm and 559.7±72.2 cm^3. In this study the splenic length compared with age, body height and weight of the child was found to be significantly correlated with these variables.

the study concluded that the splenic length measured by ultrasound provides an objective and reliable way to assess the spleen size. Measurement of splenic length by ultrasound is reliable within and between technicians. Measurement of splenic width, however, is less reliable, as evidenced by only moderate intra- and inter-rater reliability.

الخلاصة

أجريت هذه دراسة مقطعية وصفية بعدد من مستشفيات في الخرطوم – السودان خلال الفترة من أكتوبر إلى ديسمبر 2020. هدفت الدراسة إلى قياس الطحال عند الأطفال باستخدام الموجات فوق الصوتية. لان هناك حاجة لإنشاء مخطط أساسي لحجم الطحال في الاطفال السودانيين. هذه الدراسة التجريبية لتحديد استخدام الموجات فوق الصوتية لتقدير طول الطحال وعرضها وسمكها وحجمها من الأطفال السودانيين. أجريت هذه الدراسة على خمسين سن مدرسي صحي جيدة (38 ذكر و 12 أنثى). ، الفئة العمرية ما بين 2–15 سنة. يبدو ثلاثة قياسات (طول وعرض وسمك الطحال).

أظهرت نتائج الدراسة أن الفئة العمرية في حدود 2–15 سنة بمتوسط عمر 9.7 ± 3.5 سنة. كان الذكور 38 (76٪) والإناث 12 (24٪). كانت نسبة الذكور إلى الإناث 3.2: 1. فيما يتعلق بوزن الجسم والطول للأطفال المدروسين ، كانت القيم المتوسطة 29.8 ± 9.9 كجم و 107.5 ± 16.5 سم على التوالي. كانت القيم الطبيعية لقياسات الطحال من حيث الطول والعرض والسماكة والحجم 7.7 ± 1.1 سم ، 6.6 ± 1.0 سم ، 4.0 ± 0.7 سم و 559.7 ± 72.2 سم على التوالي في هذه الدراسة ، وجد أن طول الطحال مقارنة بالعمر وطول الجسم ووزن الطفل يرتبط ارتباطًا وثيقًا بهذه المتغيرات.

خلصت الدراسة إلى أن طول الطحال المقاس بالموجات فوق الصوتية يوفر طريقة موضوعية وموثوقة لتقييم حجم الطحال. يمكن الاعتماد على قياس طول الطحال بواسطة الموجات فوق الصوتية داخل الفنيين وفيما بينهم. ومع ذلك ، فإن قياس عرض الطحال أقل موثوقية.

List of Contents

List of Tables

List of Figures

Chapter One

Introduction

Introduction

1.1 Introduction:

Measurement of spleen size is important because many disorders present with enlargement or reduction of the spleen. Serial size measurements may be used in tracking normal growth pattern of the spleen and in the follow-up of known pathology of the spleen in children. Establishment of normal values of the spleen in routine sonographic examinations can serve as a base line for diagnosis of endemic diseases in the locality associated with changes in its size such as lymphoma, sickle cell disease and tropical splenomegaly syndrome including malaria. The critical functions performed by the spleen also necessitate its sonographic biometry (Camitta BM, et al, 2007).

The morphological characterization of the spleen is one of the many parameters that assist in detecting splenic disorders and systemic infections, inflammatory and malignant pathologies. Invariably the complete characterization of the disease process may need morphological assessment of anatomical structures and laboratory reports. However, there are many conditions where organomegaly may be the only feature on ultrasonography like splenomegaly in malaria. On the contrary, clinically palpable spleen may not be pathological. Pushed down spleen due to subdiaphragmatic pathology, visceroptosis and palpable spleen in 10% to 15% of normal children are a few examples of palpable spleen without any clinical significance. Clinical assessment of changes in visceral organ size is difficult and unreliable (Tamayo, 2003).

Radiography, computed tomography and radionuclide imaging expose the patients to ionizing radiation while magnetic resonance imaging is expensive and is not readily available in developing countries. Sonography is a simple and reliable way to visualize and measure abdominal visceral organs without the risk of ionizing radiation. Ultrasonography is a non-invasive, established, safe, quick and accurate method for measurement of liver and spleen size . Refinements in ultrasound technology have advanced the use of this modality beyond the simple display of anatomy, anatomic relationships, and spatial localization of lesions. Sonography is also useful in the determination of agenesis, hypertrophy, atrophy, and / or ectopic location of visceral organs. In cases of gross enlargement of visceral organs such as the spleen, confirmation by sonography is easy. However, where there is only mild enlargement of the spleen as in malaria and typhoid fever, making decisions about the size can be difficult. Therefore, it is very important to have a set of standard normal sonographic values showing upper and lower limits (Tamayo 2003)

1.2 Problem of the study:

The problem of the study is that the absence of reference value. organ volumes obtained by using various organ dimensions and body surface areas are already used in correlation with body parameters to describe the normal dimensions and to measure the degree of pathologic deviations from normal[i]. However, these volume measurement techniques are time consuming and impractical in daily use. Therefore, use of length, width and or antero- posterior dimensions seems more practical for purpose of establishing normograms. Any other data, like age, body weight and height which are easily obtainable can be combined with the above measurements when necessary. In order to establish our own standards and suggest upper limits and to provide additional data to the literature on this subject, the main purpose of present study is to determine the normal limits and variations of the spleen dimensions in relation to age, sex, height, and weight among healthy children in a Sudanese population. The provision of these data in the present study will enable a more practical and objective evaluation during a sonographic examination involving the spleen of school age children.

1.3 Objectives of the study:

1.3.1 The general objective:

The general aim of this study was to measure of the spleen in pediatric by using ultrasound.

1.3.2 The specific objective to:

1. To establish the standard splenic measurement in normal Sudanese children by ultrasound.
2. To measure splenic diameters.
3. To correlation these measurements to the weight, height of the body
4. To identify the relation between spleen length and individual’s age

Chapter Two

Background & Literature review

Chapter Two

Literature Review and Pervious Studies

2.1 Anatomy of spleen:

The spleen is an organ shaped like a shoe that lies relative to the 9th and 11th ribs and is located in the left hypochondrium and partly in the epigastrium. Thus, the spleen is situated between the fundus of the stomach and the diaphragm. The spleen is very vascular and reddish purple in color; its size and weight vary. A healthy spleen is not palpable (Joshi R, et al, 2004).

The spleen develops in the cephalic part of dorsal mesogastrium (from its left layer; during the sixth week of intrauterine life) into a number of nodules that fuse and form a lobulated spleen. Notching of the superior border of the adult spleen is evidence of its multiple origin (Joshi R, et al, 2004).

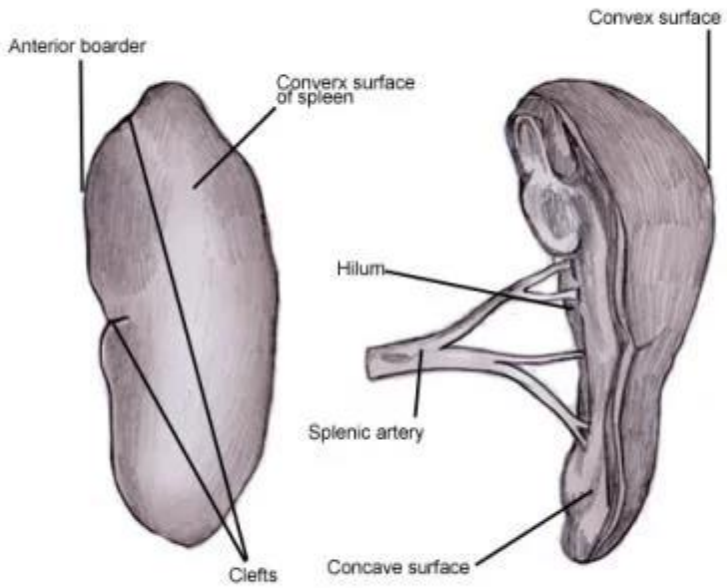


Figure (2.1) spleen anatomy (Joshi 2004).

The spleen's 2 ends are the anterior and posterior end. The anterior end of the spleen is expanded and is more like a border; it is directed forward and downward to reach the midaxillary line. The posterior end is rounded and is directed upward and backward; it rests on the upper pole of the left kidney (Joshi 2004).

The spleen's 3 borders are the superior, inferior, and intermediate. The superior border of the spleen is notched by the anterior end. The inferior border is rounded. The intermediate border directs toward the right. The 2 surfaces of the spleen are the diaphragmatic and visceral. The diaphragmatic surface is smooth and convex, and the visceral surface is irregular and concave and has impressions. The gastric impression is for the fundus of the stomach, which is the largest and most concave impression on the spleen. The renal impression is for the left kidney and lies between the inferior and intermediate borders. The colic impression is for the splenic flexure of the colon; its lower part is related to the phrenic colic ligament. The pancreatic impression for the tail of the pancreas lies between the hilum and colic impression [ii]. The hilum can be found on the inferomedial part of the gastric impression (see the image above). The hilum transmits the splenic vessels and nerves and provides attachment to the gastrosplenic and splenorenal (lienorenal) ligaments. (Joshi 2004).

2.1.1 splenic relations:

The spleen is surrounded by peritoneum and is suspended by multiple ligaments, are gastrosplenic ligament extends from the hilum of the spleen to the greater curvature of the stomach; it contains short gastric vessels and associated lymphatics and sympathetic nerves. The splenorenal ligament extends from the hilum of the spleen to the anterior surface of the left kidney; it contains the tail of the pancreas and splenic vessels. The phrenic colic ligament is a horizontal fold of peritoneum that extends from the splenic flexure of the colon to the diaphragm along the midaxillary line; it forms the upper end of the left paracolic gutter (Lee McGregor, 2002)

The visceral surface of the spleen contacts the are Anterior surface of the left kidney, Splenic flexure of the colon, The fundus of the stomach andTail of the pancreas. The diaphragmatic surface is related to the diaphragm; the diaphragm separates the spleen from the pleura and the lung (Lee r, 2006).

2.1.2 Vascular supply:

The splenic artery supplies blood to the spleen. This artery is the largest branch of the celiac trunk and reaches the spleen's hilum by passing through the splenorenal ligament. It divides into multiple branches at the hilum. It divides into straight vessels called penicillin, ellipsoids, and arterial capillaries in the spleen. The splenic circulation is adapted for the separation and storage of the red blood cells. The spleen has superior and inferior vascular segments based on the blood supply. The 2 segments are separated by an avascular plane. Its terminal branches aside, the splenic artery also gives off branches to the pancreas, 5-7 short gastric branches, and the left gastro-omental (gastroepiploic) artery (Guyton, et al, 2005).

The splenic vein provides the principal venous drainage of the spleen. It runs behind the pancreas (after forming at the hilum) before joining the superior mesenteric vein behind the neck of the pancreas to form the portal vein. The short gastric, left gastro-omental, pancreatic, and inferior mesenteric veins are its tributaries, Proper splenic tissue has no lymphatics; however, some arise from the capsule and trabeculae and drain to the pancreaticosplenic lymph nodes (Guyton, 2005).

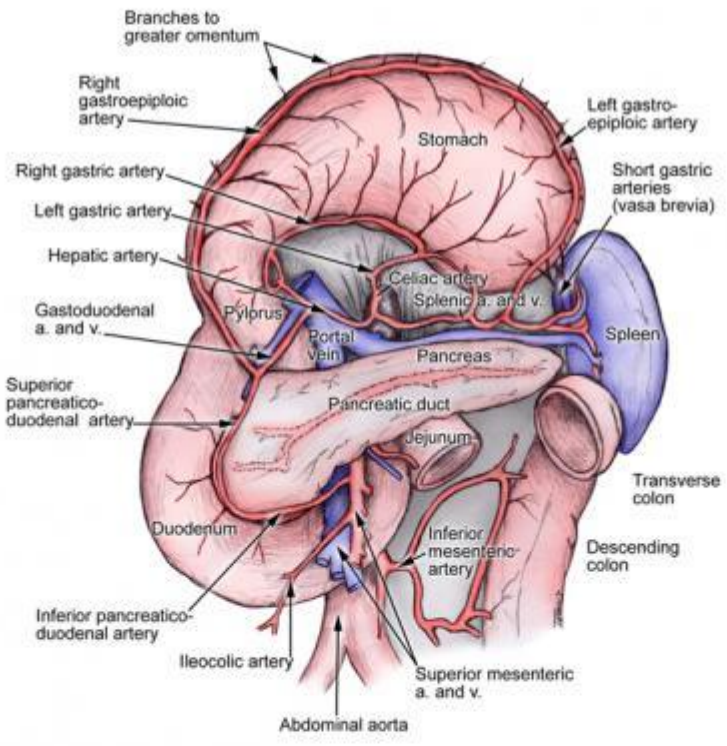


Figure (2.2): vascular supply of the spleen (Guyton 2005).

2.1.3 Nerve supply:

Sympathetic fibers are derived from the celiac plexus[The spleen is marked on the left side of the back with the long axis of the 10th rib. The upper border is marked along the upper border of the ninth rib; the lower border, along the 11th rib. The medial end lies 5 cm from the midline. The lateral extension ends at the midaxillary line (Guyton 2005).

2.2 Functions of the Spleen:

After antigenic stimulation, increased formation of plasma cells for humoral responses and increased lymphopoiesis for cellular responses occurs (Kwirski, FK, et al, 2000)

One of the spleen's most important functions is phagocytosis. The spleen is a component of the reticuloendothelial system. The splenic phagocytes include reticular cells, free macrophages of the red pulp, and modified reticular cells of the ellipsoids. Phagocytes in the spleen remove debris, old and effete red blood cells (RBCs), other blood cells, and microorganisms, thereby filtering the blood.

Phagocytosis of circulating antigens initiates the humoral and cellular immune responses (Jia, , 2009)

The spleen is an important hematopoietic organ during fetal life; lymphopoiesis continues throughout life. The manufactured lymphocytes take part in immune responses of the body. In the adult spleen, hematopoiesis can restart in certain diseases such as chronic myeloid leukemia and myelosclerosis (Shephard, R, rt al, 2015)

The RBCs are stored in the spleen. Approximately 8% of the circulating RBCs are present within the spleen; however, this function is seen better in animals than humans (Megremis, 2019).

2.3 Ultrasound machine:

Medical ultrasound machine generate and receive ultrasound waves brightness mode is the basic mode that is usually used ,ultrasound waves are emitted from piezoelectric crystals of the ultrasound transducer depending on the acoustic impedance of different materials, which depends on their density, there are different methods that can control the quality of ultrasound waves including timing of ultrasound wave emission, frequency of waves ,the received ultrasound signal can be amplified by increasing the gain ,the operator should know sonographic artifacts which may distort the studied structures or even show un real ones probes of low frequencies should be used for deep structures while probes of high frequencies should be used for superficial structures ,ultrasound waves are emitted perpendicular to the surface of the transducer, it is possible to widen the deep sonographic field by bending the surface of the transducer (convex array transducer),waves will be parallel to each other when the probe surface is flat (linear array transducer) ,linear array transducers usually have high frequencies (10- 12MHz),less penetration and excellent resolution (Rosenberg 2001).

Ultrasound is made up of mechanical waves that can transmit through different materials like fluids , soft tissues and solids. It has a frequency higher than auditory limit of 20 kHz, Ultrasound frequency is defined as the number of ultrasound waves per second ,the velocity of ultrasound in a specific medium equals the frequency of ultrasound multiplied by its wave length ,there are different method that control the way ultrasound waves are emitted from the ultrasound transducers they can be either interrupted or continues , interrupted emission generates brightness (B) mode images while continues emission generates Doppler mode ,imaging one line over time is called the moving mode (M mode),changing the frequency of ultrasound waves will control the penetration and resolution of the images (Rosenberg, 2001)

2.4 Ultrasound technique:

The left upper quadrant may be imaged as the sonographer carefully manipulates the 2.5 MHz curvilinear transducer between costal margins to image the left kidney, spleen, and diaphragm. The sector transducer may fit between the intercostal margins better than the larger curved-array transducer. The spleen generally lies in an oblique pathway in the posterior left upper quadrant; therefore, the transducer may be placed in the intercostal margin and with a slow anterior to posterior sweep may demonstrate the long axis of the spleen (Sandra, 2012).

When the patient is lying supine, the problem of overlying air-filled stomach or bowel anterior to the spleen may interfere with adequate visualization; thus the patient should be rotated into a steep right decubitus position to permit better transducer contact between the ribs without as much bowel interference. The patient should be instructed to raise his or her left arm over his or her head to further open up the intercostal spaces to allow the transducer better access to the spleen. The right lateral decubitus, or axillary, position enables the sonographer to scan in an oblique fashion between the ribs (Sandra, , 2012).

2.5 Ultrasonographic aspects and techniques:

Ultrasonography (US) is the frst imaging method used to assess and measure the spleen in the examination of neonates and children (Megremis, 2004). The easy method of scanning the spleen is to place patients in the supine or slightly right lateral decubitus position and place the probe on the posterior axillary line in one of the lower left intercostal spaces. Longitudinal and transverse dimensions are measured using a coronal or oblique coronal view that includes the hilum. The length of a normal spleen depends on age and body size (Safak AA, et al, 2005).

Normal ranges of pediatric spleen dimensions determined by US are available in the literature. The normal appearance of splenic parenchyma is homogeneous and uniform, with mid- to low-level fine tissue echotexture, and relatively hypervascularity on color Doppler imaging. More recently, some authors have focused on the distinctive features of normal splenic echotexture in children. It has been proven that splenic echotexture can appear rather heterogeneous when high-frequency transducers are used. In particular, high-frequency transducer US can depict nodules (“reticulonodular patterns”) in the splenic parenchyma of children between the ages of 1 and 5, which likely represent white-pulp lymphoid follicles. Another recent study documented an ultrasound pattern of bands of hypoechogenicity distributed throughout the spleen, which resembles the zebra spleen pattern in the arterial phase of enhancement during CT and MRI. This “zebra pattern” was found in 5% of the children evaluated in the study and they had no evidence of splenic abnormalities. During US, these patterns should be considered to be normal findings, and not be misinterpreted as pathology (Konus OL, et al, 2088).

2.6 Ultrasound appearance of the spleen:

The normal spleen has a fine, homogeneous texture, with smooth margins and a pointed inferior edge. The texture of the spleen is actually considered to be more echogenic than that of the liver. As the spleen enlarges, echogenicity further increases. The shape of the spleen has considerable variation. The spleen has two components joined at the hilum: a super medial component and an inferolateral component. On transverse scans, it has a “crescent” inverted comma appearance, usually with a large medial component and a thin component extending anteriorly. This part of the spleen may be seen to indent the fundus of the stomach. Moving inferiorly, only the lateral component is imaged. On longitudinal scans, the superior component extends more medially than the inferior component. The superomedial component or the inferolateral component may enlarge independently. The irregularity of these components makes it difficult to assess mild splenomegaly accurately (Sandra, , 2012).

2.6.1 Ultrasound measurements:

The spleen is of variable size and shape (e.g., "orange segment," tetrahedral, triangular) but generally is considered to be ovoid with smooth, even borders and a convex superior and concave inferior surface. The size of a normal spleen depends on gender, age, and body-height. The wide range of what a normal sized adult spleen is, combined with its complex three-dimensional shape makes it particularly difficult to establish a normal range of sonographic measurements (Devin Dean, 2005).

2.7 Previous studies:

Eze et al in Nigeria determining sonographically the normal limits of the spleen size according to age, sex, and somatometric parameters among school age children. Measurement of spleen length was reliable while measurement of spleen width was less reliable within and between sonographers. Dimensions of the spleen were not statistically different in boys and girls ($p > 0.05$). Height correlated best with spleen dimensions (Eze et al, 2013).

Study done by Sharifa Sulimanin 2017 the aim of the study is to measure the Normal Spleen in Primary School Age using Ultrasonography conducted in (151 children 80 F and 71 M) and the result showed A significant relation was found between spleen measurements and age, weight, height and body mass index, also a significant difference between the spleen measurements in males and females was found with the mean spleen measurements in males is greater than in females (Sharifa Sulimanin, 2017)

Stylianos D. Megremis et al (2001) investigated with ultrasonography (US) normal spleen length in healthy children. The study comprised 512 Greek children 274 girls and 238 boys) with ages ranging from 1 day (full- term neonate) to 17 years. The results showed that Spleen length was highly correlated with age, height, and weight there was no statistically significant difference between the sexes. The exact pattern of these relationships was nonlinear (polynomial type of third order for age, height, and weight). Multiple regression analysis indicated that age, height, and either weight or BSA had significant positive associations with spleen length. The spleen lengths among the sample of 58 children whose height and weight were outside the normal ranges of growth parameters did not influence the proposed upper limits (almost all were within the 90% UCLs with respect to height and weight for the main sample) (Megremis, et al, 2001)

Bhavna et study aimed to establish normative data for the ultrasonographic measurement of liver and spleen size in healthy Indian children. Normal liver and spleen length and range were obtained sonographically. The liver and spleen length significantly correlated highly with the height/length of the subjects (P=0.0001) (Bhavna D., et al, 2010).

Pelizzo et al in Austria determined the range of normal spleen dimensions evaluated by ultrasonography (US) in children according to sex and age and the relationship between splenic measurements, auxological data and body proportions, in order to define splenomegaly parameters in support of the surgical mini-invasive approaches in pediatrics**.** For caucasian subjects, in different age groups spleen volume, transverse area and diameter increased while the spleen/abdominal volume ratio decreased significantly ($p < 0.001$) decrease in longitudinal spleen diameter/xipho-pubic distance ratio was noted between the 0–3 years group and both 4–10 and 11–18 years group. Age and auxological data, except BMI, showed a high correlation with spleen dimension **(**Pelizzo G, et al, 2018).

Maha Nouri et al (2012) established a local ultrasonic splenic length which can be used as reference for Sudanese healthy school age children. This study conducted in 215 (104 males, 111 females) healthy school-aged Sudanese children (7–13 years) and the results showed that there is significant relation between spleen length and age, weight, height and BMI. The mean length of the spleen was found to be 9.5-10. 4cm.There was significant difference between the spleen length in males and females (P value 0.000), the mean length of spleen in females is greater than in males (Maha N, et al, 2012)

Chapter Three

Material &Methodology

Chapter three

Material and methods

3.1 Types of the study

Cross –sectional descriptive study conducted at different Hospitals in Khartoum-Sudan during from October to December 2020.

3.2 population of the study

Normal healthy children, male and female.

3.3 Sampling of the data:

The sample of the data was 50 children selected randomly.

3.4 Data collection:

The data had been collected by using a questionnaire and ultrasound machine

3.5 Data analysis

Data had been analyzed by software program SPSS version 16 and presented in table and figures.

3.6 Instrumentation:

the instruments used in this study are General ultrasound machine 3.5Mz ,convex probe, height meter and weight measurement instrument

3.7 Scanning method:

Trans abdominal ultrasound technique was performed with patient lying in supine position angle the probe between the ribs intercostal from posterolateral approach. Each subject from sample will be fasting for 4 hours . The spleen was scanning in full inspiration in order to a clear diaphragm and to push a bowel loops down (to avoid gas) . Longitudinal and transverse views for the spleen were executed, we scan the spleen dimensions (length, width, thickness).

3.6 Ethical considerations

Permission from ultrasound department was obtained. No personal identification data or detail published. Safe uses ultrasound.

Chapter Four

Results

Chapter Four

Results

Results:

The following tables and figures show summary of the results including distribution of gender, age, body weight and height of the sample of the study. They also include frequency of distribution of width, length and thickness of the spleen and the correlation of these variations with male and female.

Table (4.1) Distribution of children according to gender

Gender	N	%
Male	38	76.0
Female	12	24.0
Total	50	100.0

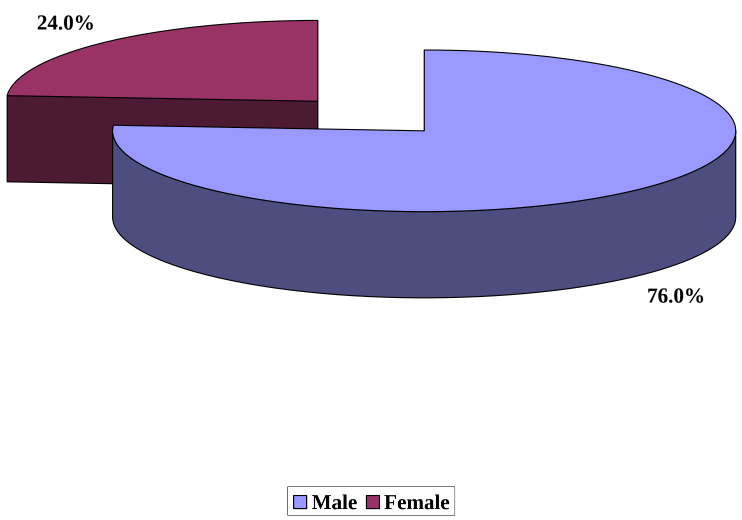


Figure (4.1) Shows gender distribution of the children

Table (4.2) Shows minimum, maximum, mean, Std. deviation for age, height and weight of child and length, width, thickness and volume of spleen

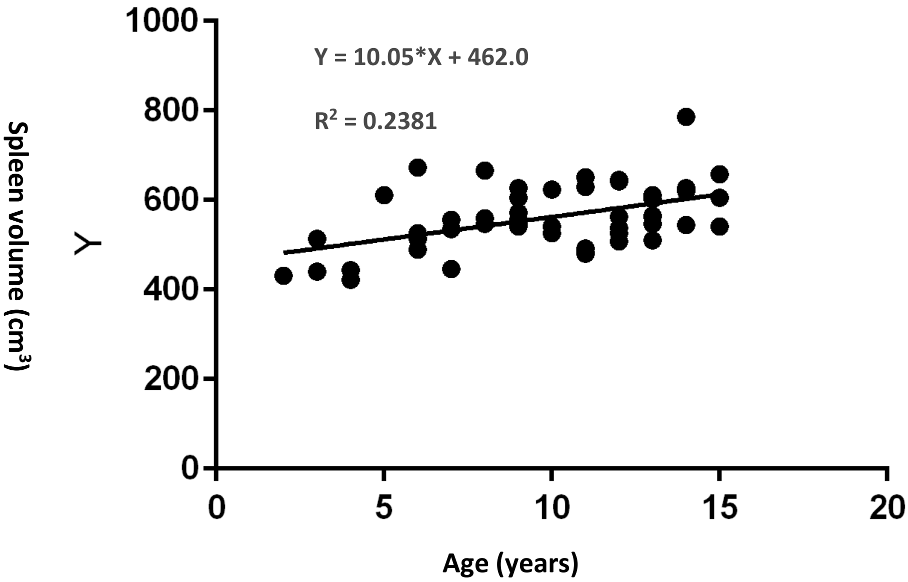
Variables	N	Mean	Maximum	Minimum	Std Deviation
Age	50	9.7	15.0	2.0	3.5
Weight (kg)	50	29.8	53.0	15.0	9.9
Height (cm)	50	107.5	138.0	69.0	16.5
Length	50	7.7	10.6	5.5	1.1
Width	50	6.6	9.4	4.8	1.0
Thickness	50	4.0	6.0	2.7	0.7
Volume	50	559.7	785.9	422.0	72.2

Table (4.3) Shows minimum, maximum, mean, Std. deviation for age, height and weight of child and length, width, thickness and volume of spleen in Males

Variables	N	Mean	Maximum	Minimum	Std Deviation
Age	38	10.8	15.0	3.0	3.1
Weight (kg)	38	32.0	53.0	15.0	9.4
Height (cm)	38	111.3	138.0	69.0	15.1
Length	38	8.0	10.6	6.0	1.1
Width	38	6.7	9.4	5.0	1.0
Thickness	38	4.1	6.0	2.7	0.7
Volume	38	573.0	785.9	440.4	67.9

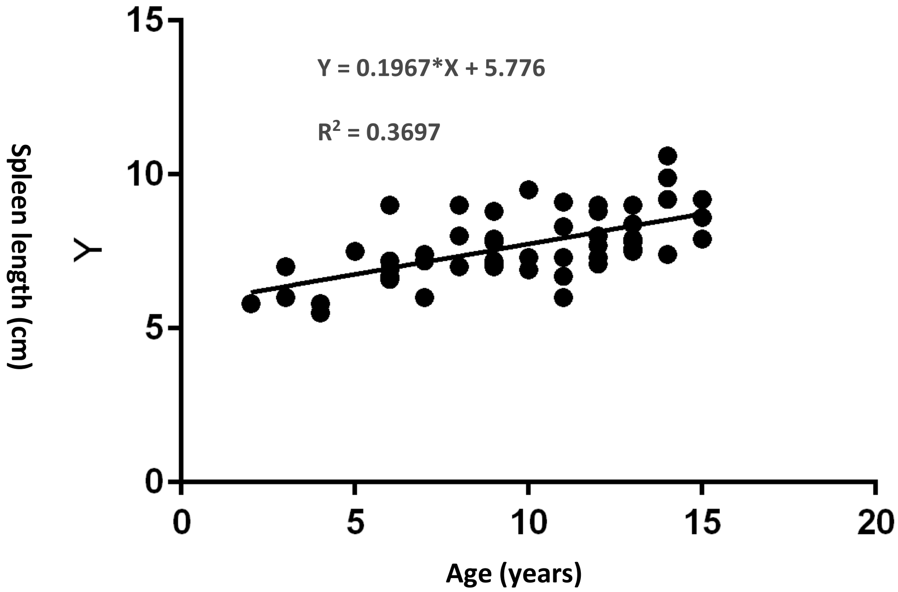
Table (4.4) Shows minimum, maximum, mean, Std. deviation for age, height and weight of child and length, width and thickness and volume of spleen in females

Variables	N	Mean	Maximum	Minimum	Std Deviation
Age	12	6.4	9.0	2.0	2.6
Weight (kg)	12	22.8	40.0	15.0	8.3
Height (cm)	12	95.3	124.0	71.0	15.4
Length	12	6.9	9.0	5.5	1.0
Width	12	6.4	8.3	4.8	1.0
Thickness	12	3.7	4.5	3.0	0.4
Volume	12	517.6	666.6	422.0	71.9



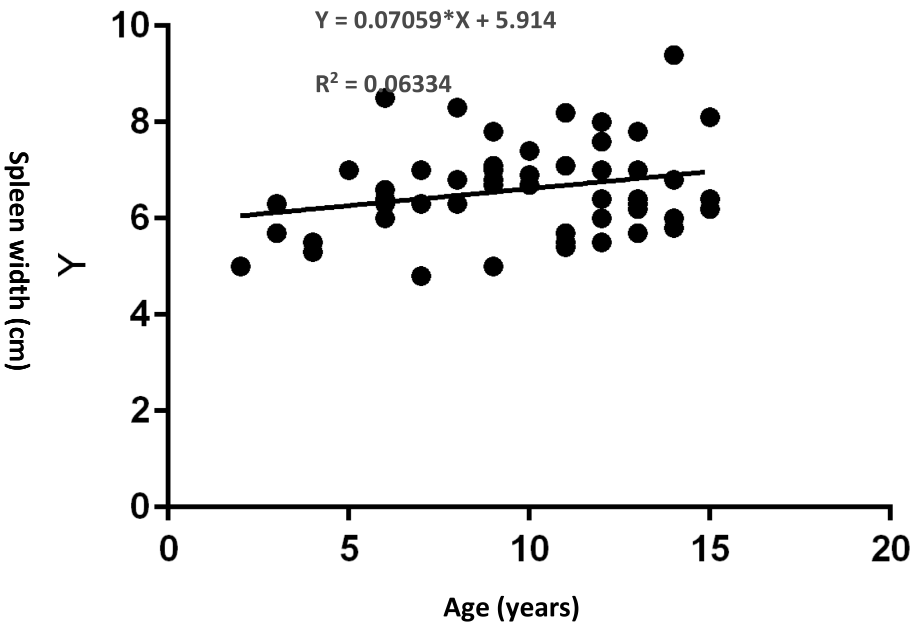
P value = 0.003 < 0.05 (Significant correlation)

Figure (4.2) Scatter plot shows relationship between age and volume of spleen



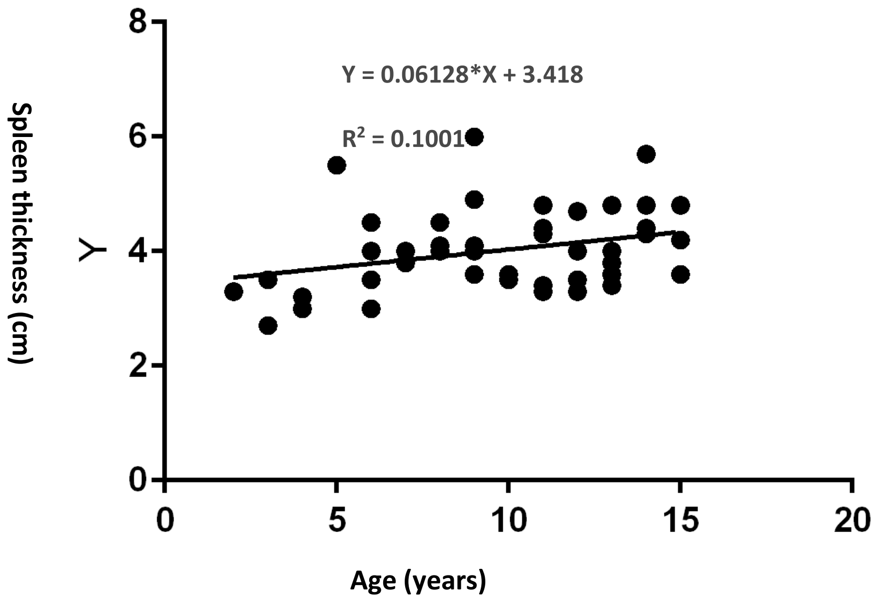
P value = 0.0001 < < 0.05 (Significant correlation)

Figure (4.3) Scatter plot shows relationship between age and length of spleen



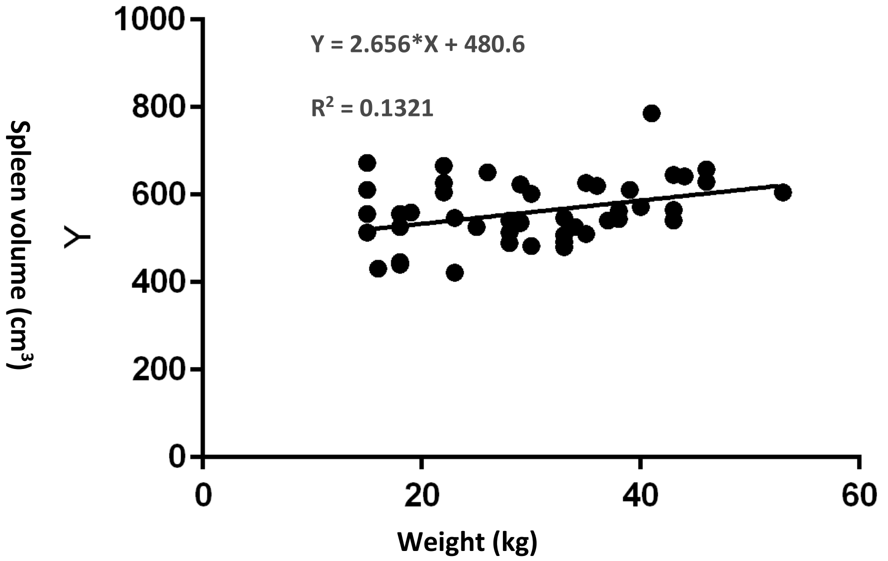
P value = 0.077 > 0.05 (No significant correlation)

Figure (4.4) Scatter plot shows relationship between age and width of spleen



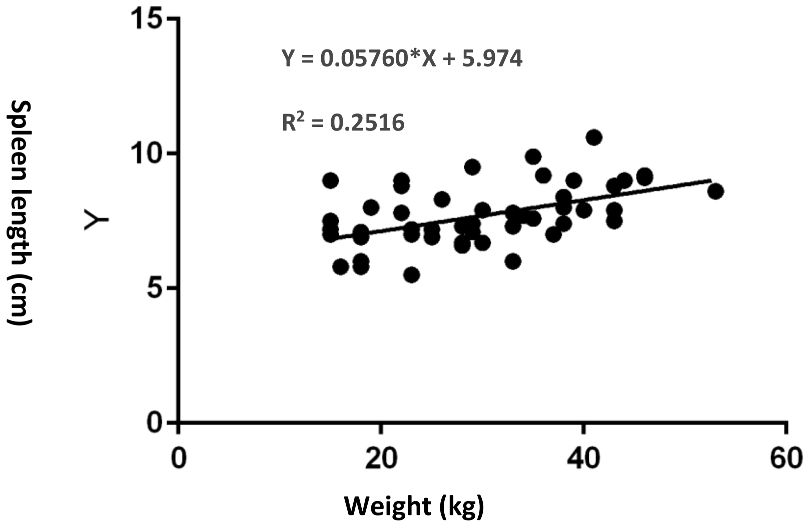
P value = 0.025 < 0.05 (Significant correlation)

Figure (4.5) Scatter plot shows relationship between age and thickness of spleen



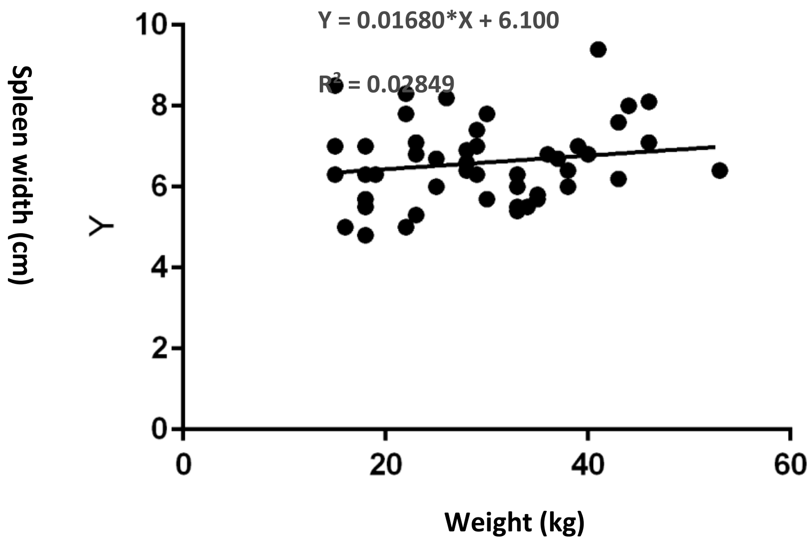
P value = 0.0095 < 0.05 (Significant correlation)

Figure (4.6) Scatter plot shows relationship between weight and volume of spleen



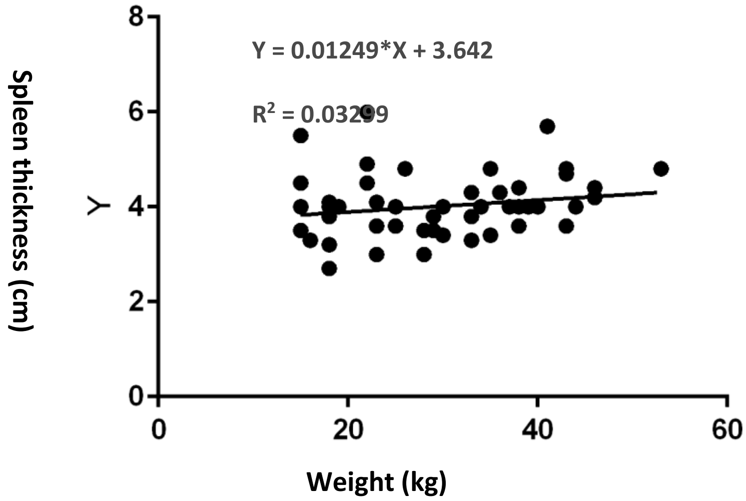
P value = 0.0002 < 0.05 (Significant correlation)

Figure (4.7) Scatter plot shows relationship between weight and length of spleen



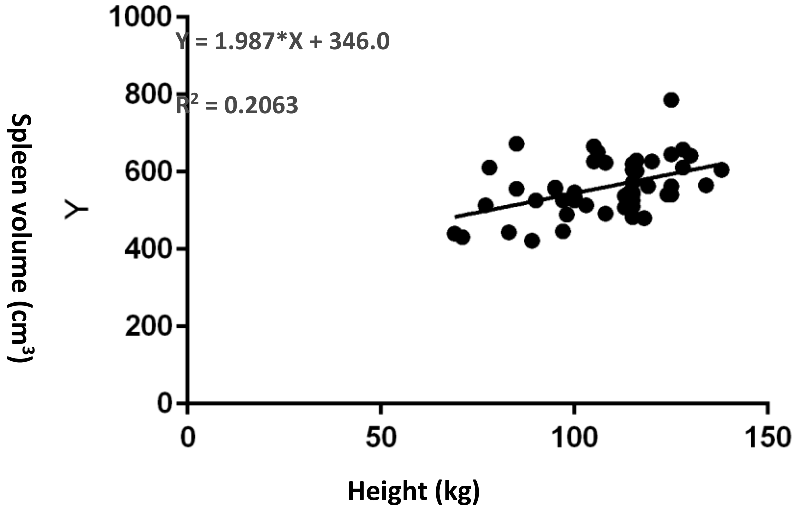
P value = 0.241 > 0.05 (No significant correlation)

Figure (4.8) Scatter plot shows relationship between weight and width of spleen



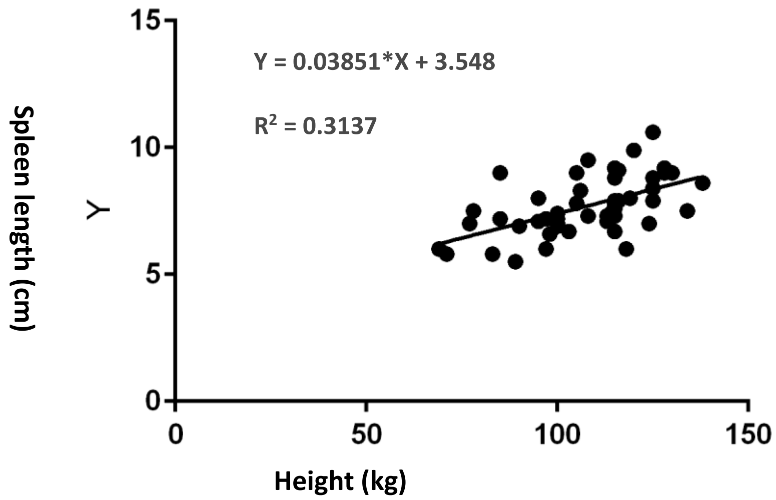
P value = 0.206 > 0.05 (No significant correlation)

Figure (4.9) Scatter plot shows relationship between weight and thickness of spleen



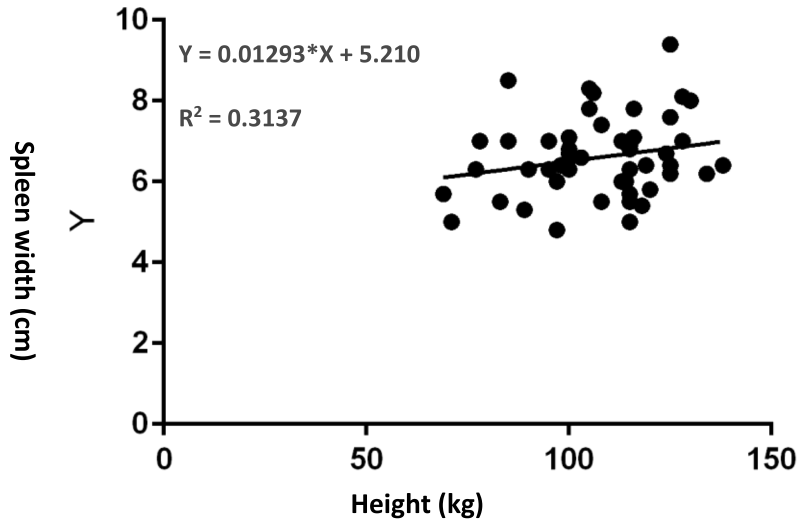
P value = 0.0009 < 0.05 (Significant correlation)

Figure (4.10) Scatter plot shows relationship between height and volume of spleen



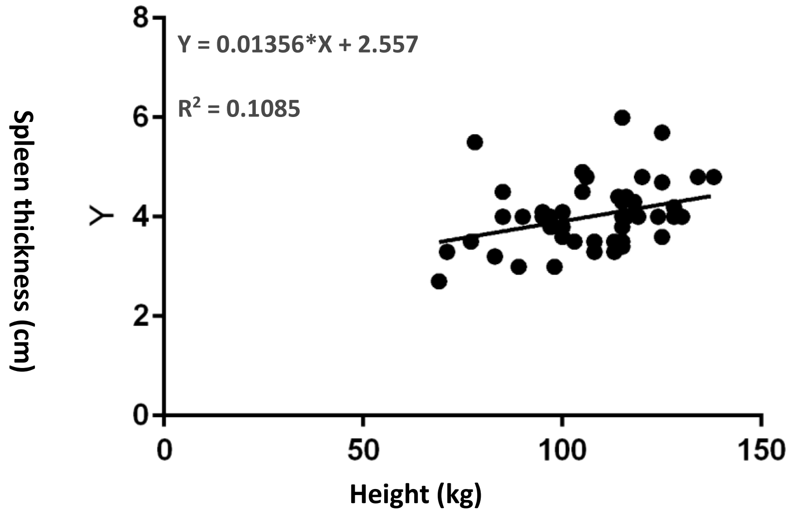
P value = 0.0001 < 0.05 (Significant correlation)

Figure (4.11) Scatter plot shows relationship between height and length of spleen



P value = 0.130 > 0.05 (No significant correlation)

Figure (4.12) Scatter plot shows relationship between width and volume of spleen



3

4 P value = 0.0019 < 0.05 (Significant correlation)

Figure (4.13) Scatter plot shows relationship between height and thickness of spleen

Chapter Five

Discussion, Conclusion & Recommendations

Chapter five

Discussion, Conclusion and Recommendations

5.1 Discussion:

This is experimental study designed to determine the application of ultrasound for estimation of splenic length, width and thickness of healthy Sudanese children.

This study was done on 50 healthy school age children. Age group within the range of 2-15 years, with mean age 9.7±3.5 years. Males were 38(76%) and females were 12(24%). Male to female ratio was 3.2:1.

Regarding body weight and height of the studied children, the mean values were 29.8±9.9 kg and 107.5±16.5 cm respectively.

Normal values of spleen measurements in terms of length, width, thickness and volume were 7.7±1.1 cm, 6.6±1.0 cm, 4.0±0.7 cm and 559.7±72.2 cm^3.

In this study the splenic length compared with age, body height and weight of the child was found to be significantly correlated with these variables. Thus, observation probably results from the cessation of rapid body growth that occurs with attainment of body morphology. Thus, it is difficult to predict spleen size reliably on the basis of these variables alone. These measurements are consistent with previous normal values reported for the general pediatric population

Splenic length measured by ultrasound provides an objective and reliable way to assess the spleen size. Measurement of splenic length by ultrasound is reliable within and between technicians. Measurement of splenic width, however, is less reliable, as evidenced by only moderate intra- and interrater reliability. This finding supports the historical assessment of splenomegaly based on splenic length. Pelizzo et al in Austria determined the range of normal spleen dimensions evaluated by ultrasonography (US) in children according to sex and age and the relationship between splenic measurements, auxological data and body proportions, in order to define splenomegaly parameters in support of the surgical mini-invasive approaches in pediatrics**.** For Caucasian subjects, in different age groups spleen volume, transverse area and diameter increased while the spleen/abdominal volume ratio decreased significantly ($p < 0.001$) decrease in longitudinal spleen diameter xipho-pubic distance ratio was noted between the 0–3 years group and both 4–10 and 11–18 years group. Age and auxological data, except BMI, showed a high correlation with spleen dimension [28].

The study revealed high correlation between splenic dimensions (length, width and thickness and volume) and body weight followed by body height then weak correlation between splenic dimensions and subject age. No significant differences between splenic dimensions and sexes. The fact that these significant differences persisted when controlling for height and weight independently, the spleen varies more as a product of these two variables.

The results of this study could be used as a practical and comprehensive guide to indicate the normal spleen length, according to age and body habitus for ages between 2-15 years. With this in mind, so as to distinguish and thus better assess individuals with markedly long spleen outside the normal range but whose body parameters are within the normal range. Bhavna et study aimed to establish normative data for the ultrasonographic measurement of liver and spleen size in healthy Indian children. Normal liver and spleen length and range were obtained sonographically. The liver and spleen length significantly correlated highly with the height/length of the subjects (P=0.0001) [27].

5.2 Conclusion:

In this study the splenic length compared with age, body height and weight of the child was found to be significantly correlated with these variables. Thus, observation probably results from the cessation of rapid body growth that occurs with attainment of body morphology. Thus, it is difficult to predict spleen size reliably on the basis of these variables alone. These measurements are consistent with previous normal values reported for the general pediatric population

Splenic length measured by ultrasound provides an objective and reliable way to assess the spleen size. Measurement of splenic length by ultrasound is reliable within and between technicians. Measurement of splenic width, however, is less reliable, as evidenced by only moderate intra- and interrater reliability.

5.3 Recommendation:

- Assessment of splenic size by clinical examination Is relatively insensitive, so when clinical decisions about return to play need to be made ultrasound is the most frequent diagnostic tool used.
- It is helpful to have such a large serious of measurements in healthy individuals, taking into consideration sex and race.

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Appendices

Appendix (A)

Sudan University of Science and Technology

College of Graduate Studies

Characterization of Spleen in Pediatrics using Ultrasound

<u>Data collection sheet</u>

1.Gender: Male:……………… 2. Female:…………..

2. Age:………………………………… years

4. Weight …………Kg

5. Height…………..cm

6. Pleen Length ………………………………Cm

7. Spleen With: ………………………………Cm

8. Spleen Thickness: ………………………………Cm

9. Spleen Volume: ……………………………………Cm3

Appendix (B)

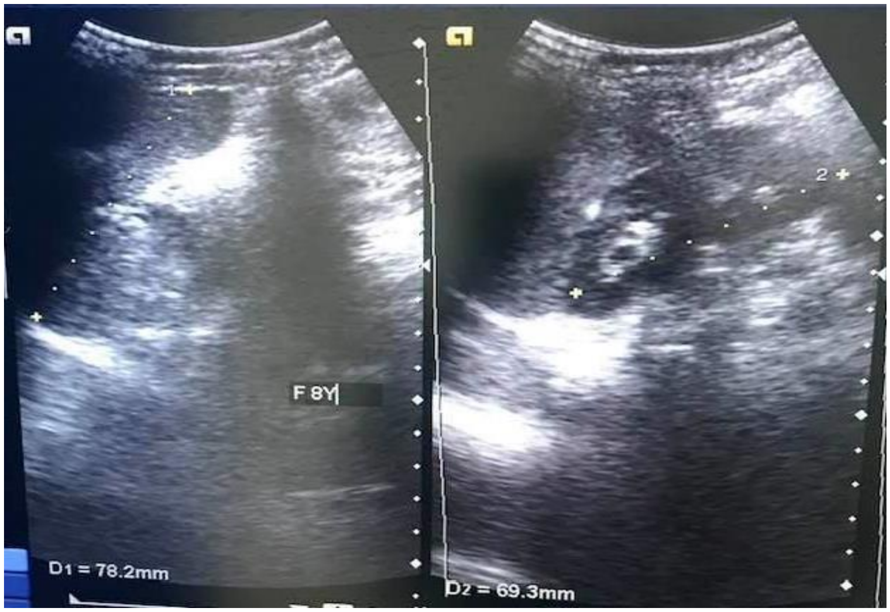

Image (1) Sonogram of spleen and left kidney lengths of 8years old female child.

Image (2) Sonogram of left kidney lengths of 10 years male child.

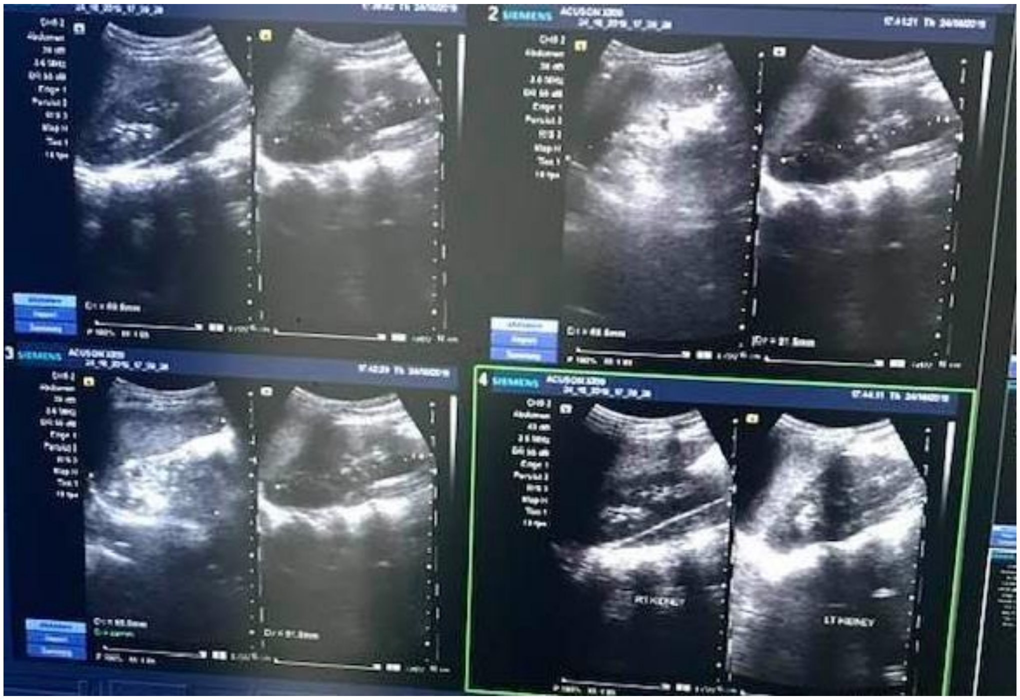

Image (3) Sonogram of main values of spleen and left kidney in 11year male

Image (4) Sonogram of left kidney and spleen lengths of 7year female child.

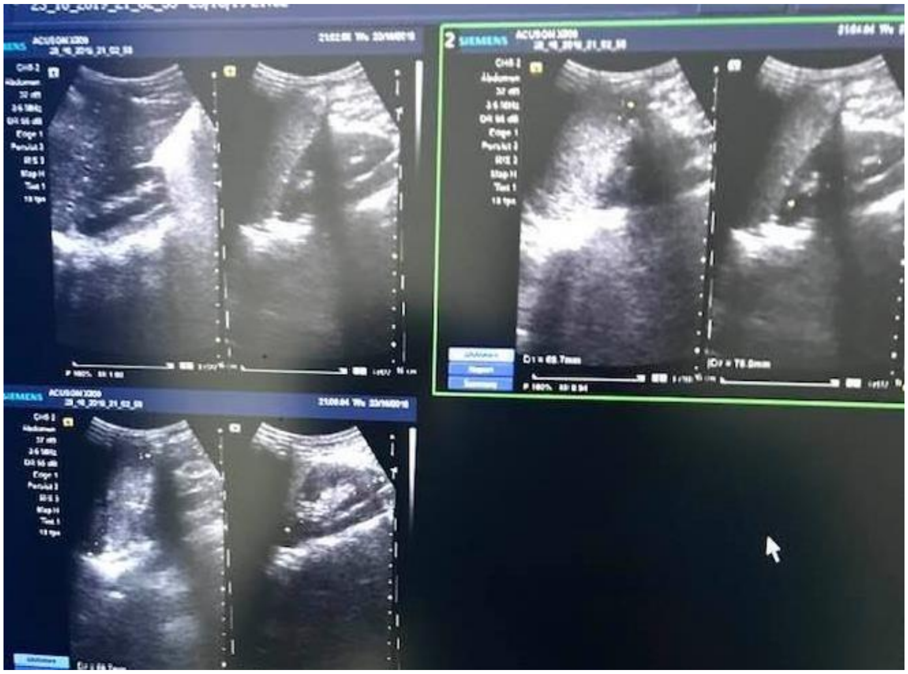

Image (5) Sonogram of left kidney and spleen lengths of 12year female child

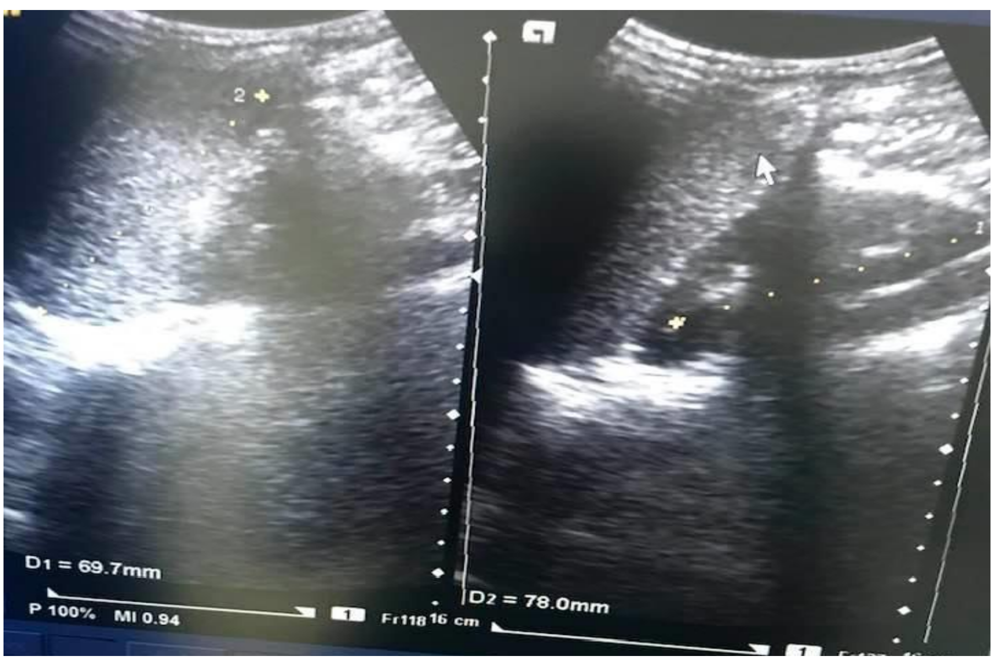

Image (6) Sonogram of left kidney and spleen lengths of 9year male child

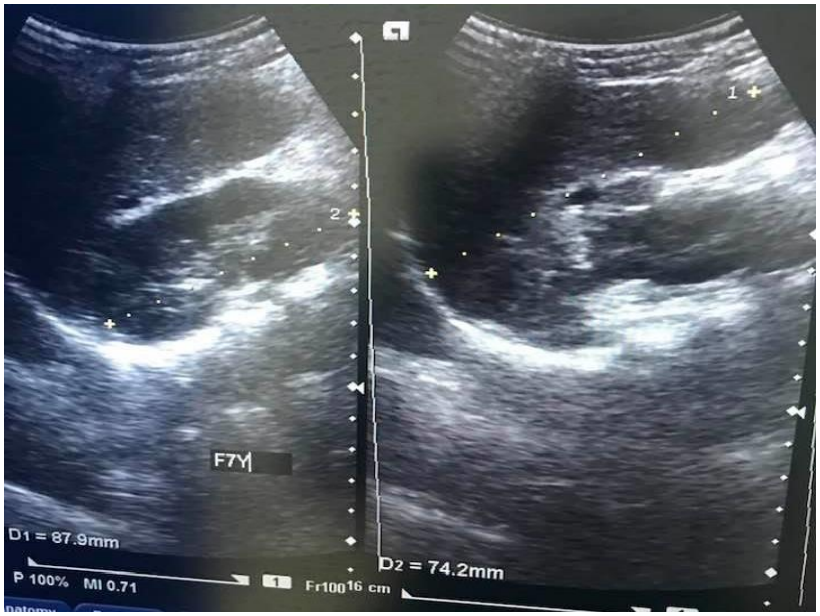

Image (7) Sonogram of left kidney and spleen lengths of 7year female

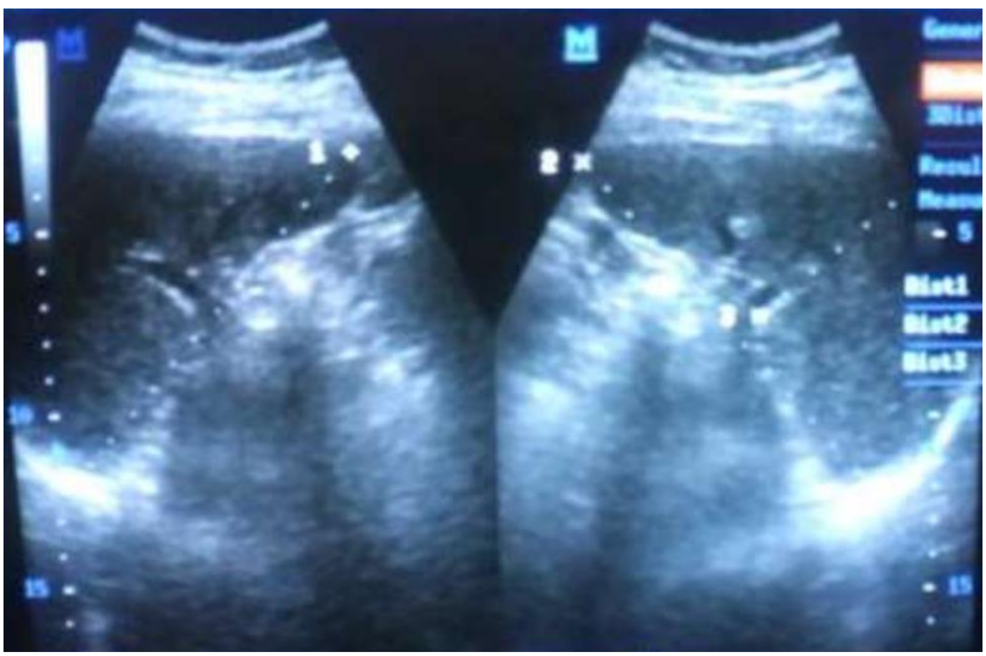

Image (8) Sonogram of spleen lengths of 9 year female