

Sudan University of Science and Technology
College Of Graduate Studies

**Normal Measurement of Spleen in Pediatrics by using
Ultrasound**

قياس الطحال الطبيعي للأطفال باستخدام الموجات الصوتية.

*A Thesis Submitted For Partial Fulfillment of the Requirements
Of Msc degree in Medical Diagnostic Ultrasound*

By

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الاية

{اللَّهُ لَا إِلَهَ إِلَّا هُوَ الْحَيُّ الْقَيُّومُ لَا تَأْخُذُهُ سِنَّةٌ وَلَا نَوْمٌ لَّهُ مَا فِي السَّمَاوَاتِ وَمَا فِي الْأَرْضِ

مَنْ ذَا الَّذِي يَشْفَعُ عِنْدَهُ إِلَّا بِإِذْنِهِ يَعْلَمُ مَا بَيْنَ أَيْدِيهِمْ وَمَا خَلْفَهُمْ وَلَا يُحِيطُونَ بِشَيْءٍ مِّنْ

عِلْمِهِ إِلَّا بِمَا شَاءَ وَسِعَ كُرْسِيُّهُ السَّمَاوَاتِ وَالْأَرْضَ وَلَا يَئُودُهُ حِفْظُهُمَا وَهُوَ الْعَلِيُّ

{العظيم}

سورة البقرة الاية (255).

Dedication

To my great soft Mother

To my great Father

To my Wife

To my Sisters and Brothers

To all my Friends

Acknowledgement

My acknowledgements and gratefulness firstly to my god ,who gave us the gift of the mind and blessed and guided me to accomplish this thesis.

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Table of Contents

الاية	I
Dedication	II
Acknowledgement	III
Table of Contents	IV
List of Tables	VI
List of Figures	VII
Abstract	VIII
الخلاصة	IX
Chapter One: Introduction	
1-Introduction	1
1-2 Problem of the study:	2
1-3 Objectives	2
1-4.Thesis outlines	3
Chapter tow: Litrature Review and Back ground Studies	
2-1. Anatomy of the spleen	4
2-2physiology of the spleen	10
2-3Pathology of the spleen	11
1.4Pervious studies	21
Chapter Three :Material and Methods	
3-1 Type of the study	23
3-2 Area of study	23
3-3 Duration of study	23
3-4 Population of study	23
3-5 Sampling of the data	23
3-6 Data collection	23
3-7 Data analysis	23

3-8 Ethical considerations	23
3-9 Instrumentation	23
3-10 Scanning method	24
Chapter Four: Results	
Results	25
Chapter five :Discussion, Conclusion and Recommendation	
Chapter five	
5.1 .Discussion	33
5.2 conclusion:	35
5.3 Recommendations:	36
References:	37
Appendices	42

List of Tables

Table	Table	Page
(4.1)	study group Gender distribution	25
(4.2)	Descriptive statistics of patient body characteristics (age, height, weight).	26
(4.3)	Descriptive statistic of splenic characteristics (length, weight and thickness)	27
(4.4)	Shows correlation between splenic measurements and body weight.	33
(4.5)	Correlation between splenic length and body weight and height.	33

List of Figures

No	Name	Page
2.1	anatomy of the spleen	4
2-2	structres of the spleen	5
2-3	the white and red pulp of the spleen.	7
2-4	vascular supply of the spleen	8
2-5	splenomegaly	12
2-6	rupture of the spleen	13
2-7	splenic abscess	14
2-8	Hydatid cyst	15
2-9	splenic simple cyst	17
4.1	study group gender.	25
4.2	scatter plot shows relationship between age and length of spleen	29
4.3	scatter plot shows relationship between height and length of spleen	29
4.4	scatter plot shows relationship between weight and length of spleen	30
4.5	scatter plot shows relationship between volume of spleen and age	30
4.6	scatter plot shows relationship between volume of spleen and length	31
4.7	length	31
4.8	scatter plot shows relationship between volume heights	32
4.9	scatter plot shows relationship between volume and weights	32
4.10	scatter plot shows relationship between volume and thickness	33

Abstract:

The spleen is the largest haemolymphnodesin the body and large part of the reticuloendothelial tissue of the body is concentrated in it .This is experimental study designed to determine the application of ultrasound for estimation of splenic length,width and thickness of Sudanese pediatric population .This study was done on Fifty healthy school age, age group between 4-14 years .It look three measurements (length, width and thickness of the spleen).

The study revealed three correlations,too highly correlations between splenic measurements and children weight and height and weak correlation between splenic measurements and children age. The study also revealed there is no significant difference between both sexes.

The best correlation was between child weight and splenic length, followed by child height splenic length .and weak correlation between child age and splenic length.

The results of the study revealed that the mean of splenic length ,width and thickness were (8.20 cm with stdev 1.43cm, 2.9 cm with stdev .66 cm and 6.6 cm with stdev ,83 cm)respectively.

الخلاصة :

الطحال من اكبر العقد اللمفية الدموية وجزء كبير من انسجة الشبكة البطانية من الجسم تتركز فيه. اجريت هذه الدراسة التجريبية وقد هدفت إلى تحديد وتطبيق التصوير بالموجات الصوتية لتقدير طول الطحال وعرضه وسمكه لدى الاطفال السودانيين .وقد أجريت على 50 من طلاب أصحاء فى عمر المدارس للاعمار ما بين 4-14 سنة.تتنظر فى قياسات الطوحوال (الطول , العرض والسمك تم إجراء المسح بجهاز الموجات الصوتية و أظهرت الدراسة أن هنالك علاقة ارتباط عالية بين أبعاد الطوحوال وحالة الطفل وعمره (قوة الارتباط بين قياسات الطوحوال ووزن طول الطفل كما وجدت علاقة ضعيفة بين قياسات الطوحوال وعمر الطفل مع عدم وجود اختلاف ذو معنى بين الجنسين ووجدت افضل علاقة ارتباط كانت بين طول الطحال ووزن الطفل ثم طول الطحال وطول الطفل كما أظهرت الدراسة ضعف علاقة سمك الطوحوال وعمر الطفل .ووضحت أيضا أن متوسط طول ,عرض وسمك الطحال كانت (8.2 سم مع انحراف معياري قدره 1.43 سم ,2.9 سم وانحراف معياري قدره 0.66 سم و 6.6 سم وانحراف معياري 0.83 سم) علي التوالي

Chapter One

Introduction

1-Introduction

Ultrasonography is an established safe, quick and reliable method for the calculation of the spleen dimensions and among all the later that have been used in the past ,spleen length at the hillum is considered the most reproducible linear measurement (Mergemis cited 2016)

The spleen play an important role in the defense of the body.it is rarely the primary site of the disease process. the spleen is involved in systemic disease,spleen enlargement usually developed .

The spleen may be involved most commonly as part of multi organ systemic illness or it may be part of isolated process (Brurn,2005)

A large number of pathologic entities can affect spleen size and the clinical examination is far from accurate to detect small increases in size .the spleen may be palpable in 15%-17% of healthy neonate and 10% of healthy children.(Aga Mohammadi.2001)

The spleen play important roles in regard to red blood cells(also referred to as erythrocytes) and the immune system.it removes old red blood cells and holds a reserve of blood,which can be valuable in case of hemorrhagic shock and also recycles iron.as apart of the mononuclear phagocyte system,it metabolizes hemoglobin which removed from senescent erythrocytes, the globin portion of hemoglobin is degraded to it is constitutive amino acids and the hemoportion is metabolized to bilirubin,which is removed in the liver (Zarre,2010)

In study done by Paterson in 1999 reach to the spleen size in infant and children depends on patient age and the modality used ,at birth,the spleen weight as little as 15g and is less than 6.0 cm in length.(Partesone ,1999).

In study done by stylianos in 2004,relived to spleen length was highly correlation with age,height,and body surface area .there was no statistically significance difference between sexes (Aga Mohammadi 2001)In study done

by (BhavnaDhingra,2009) on research paper for 597 healthy children between ages of 1 month-12 years show that the liver and spleen length ,significantly highly correlatedwith the height(length) of the subjects.

In previous study done by(Henritta,1991) to determne the normal spleen in1991 reach to logarithmic correlation between spleen length and age, was found for total group of 230 infant and children ,no statistically difference was seen between boys and girls except in teenagers more than 15 years old(Hutlus,1991).

The spleen synthesizes antibodies in it is white pulp and removes antibody coated bacteria and ant body coated blood cell by way of blood lymph node circulation.

The spleen is the center of activity of the mononuclear phagocyte system and can be considered analogous to a large lymph node ,as it is absence causes predisposition to certain infections (Moyaya*Et-al*,1986)

The spleen is major lymphoid and blood filtration organ, is located in the left cranial abdomen. It responsible for storing and removing erythrocyte from

This study well be take normal spleen measurement in Sudanese infant and children .

1-2 Problem of the study:

There is no reference value for spleen measurement in pediatric Sudanese population.

1-3 Objectives

1-3.1 General objective :

To measurement of the spleen in pediatric by using ultrasound.

1-3.2 Specific objectives :

To establish the standard splenic measurement in normal Sudanese children by ultrasound .

To measure splenic diameters .

To correlation these measurements to the weight, height of the body
To identify the relation between spleen length and individuals age.

1-4.Thesis outlines

The study talk about measurement of spleen in pediatric Sudanese people ,it divided in to the five chapters. Chapter one, which is an introduction ,deals with theoretical frame work of the study.it presents the statement of the study problems, objectives of the study and also provides an outlines of the thesis .Chapter two provides background material for thesis and literature(previous studies).Chapter three deals with material and method used to measure the spleen. Chapter four deals with data presentation (results).Chapter five discusses the data (discussion), analysis ,conclusion and recommendation for this study ,in additional to suggestions for future researches.

Chapter two
Literature Review and Back
ground Studies

Chapter two

2-1. Anatomy of the spleen:

The spleen is an intraperitoneal Organ located in posterior portion of the left upper quadrant of the abdomen it lies parallel to the shaft of the tenth rib, superiorly to the diaphragm, laterally and posteriorly to stomach, medially and anteriorly to the kidney, inferiorly and medially to the tail of the pancreas and splenic flexure medially (Jones.2007) It is convex along its superior lateral border and concave medially. The contour is generally smooth but contour lobulation can be seen as normal variant. The splenic artery enters and splenic vein leaves medially, at the hilum with the artery being the most posterior vessel. (Jones .2007)

The spleen is organ of the lymphatic system located in the left side of the abdominal cavity under the diaphragm, the muscular portion between the abdomen and the chest in humans it is the size of a fist and is well supplied with blood, as the lymph nodes are filters for lymphatic circulation, the spleen is a primary filtering element for the blood.

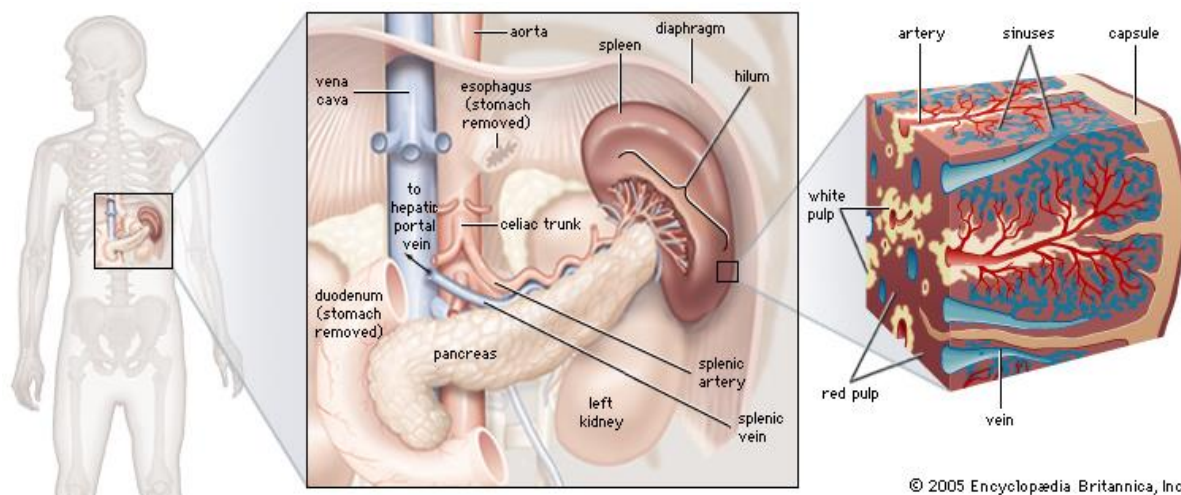


Figure 2.1 shows anatomy of the spleen (www.britannica.com/spleen-anatomy)

SPLEEN ANATOMY

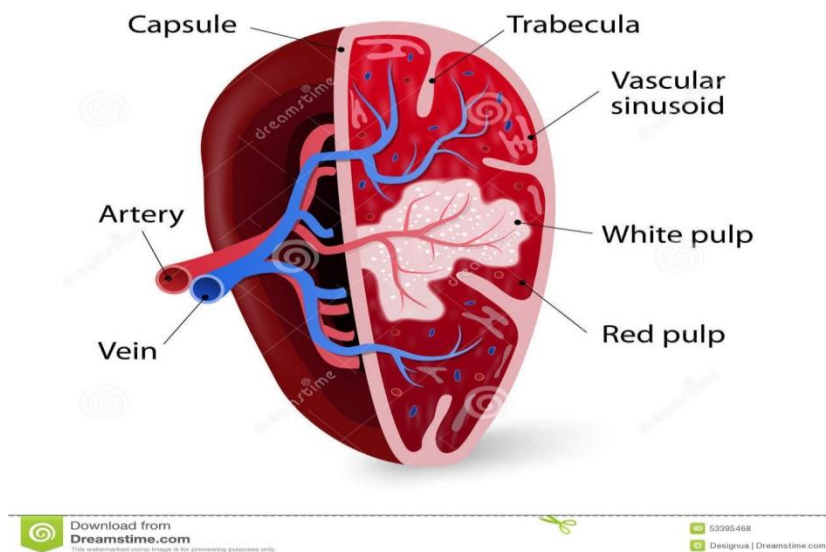


Figure 2-2 show structures of the spleen ([www. anatomy library.us/tag/gross-anatomy –of-the-spleen-ppt/](http://www.anatomylibrary.us/tag/gross-anatomy-of-the-spleen-ppt/))

In humans, spleen is brownish in color and located in the left upper quadrant of the abdomen (Brugn2005)

2-1-1 Development:

The spleen appears about the fifth week as localized thickening of the mesoderm in the dorsal mesogastrium above the tail of the pancreas with the change in position of the stomach, the spleen is carried to the left and comes to lie behind the stomach and in contact with left kidney. The part of the dorsal mesogastrium which intervened between the spleen and the greater curvature of the stomach forms the gastrosplenic ligament.

2-1-2 Structure:

The spleen is invested by two coats:

(1) An external serous (2) an internal fibro elastic.

The external coat or serous coat (tunica serosa) is derived from the peritoneum, it is thin, smooth and in the human subject intimately adherent to

the fibroblastic coat , it invests the entire organ, except at the hilum and along the lines of reflection of the phrenic lineal and gastrosplenic ligament.

The fibroblastic coat (tunica albuginea) invests the organ , and at the hilum is reflected inward upon the vessels in the form of sheaths. From these sheaths, as well as from the inner surface of the fibroblastic coat, numerous small fibrous bands, trabeculae (figure 2-2), are given in all directions; these uniting constitute the frame of the spleen. The spleen then consists of a number of small spaces or areolae, formed by trabeculae in these areolae contained the splenic pulp.

The fibroblastic coat, the sheaths of the vessels and the trabeculae , are composed of white and yellow elastic fibrous tissues, the latter predominating. It is owing to the presence of the elastic tissue that the spleen possesses a considerable amount of elasticity, which allows of the very great variation in size that is presented under certain circumstances .

In addition to these constituents of this tunic , these are found in man , in a small amount of non –striated muscular fiber; and in some mammalian e-g dog, pig and cat a large amount, so that the trabeculae appear to consist chiefly of muscular tissue.

The spleen is enclosed in a thick connective tissue capsule, inside, the mass of splenic tissue of two types: (1) Red pulp (2) white pulp , (which do not separate into regions but intermingle distributed throughout the spleen. Figure 2-2

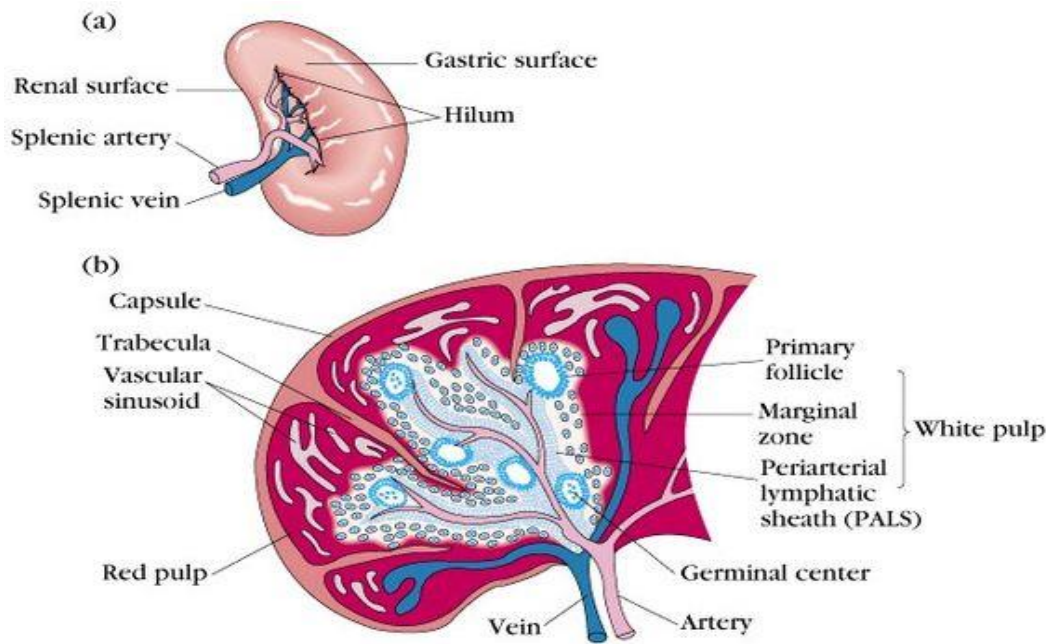


Figure 2-3 shows the white and red pulp of the spleen. (faculty. ksu. edu. sa/hhkami/blog/default.aspx)

The white pulp is lymphatic tissue that usually surrounds splenic vessels. The red pulp is net work of cannels (sinuses) filled with blood and it is in the red pulp that most of the filtration occurs.

The splenic pulp (pulpalienis) is a soft mass of a dark reddish –brown color, resembling grumous blood ;it is consist of a fine reticulum of fibers ,continuous with those of trabeculae, to which are applied fat ,branching cells.The meshes of the reticulum are filled with blood, in which however the white corpuscles are found to be in large proportion than they are in ordinary blood .the large rounded cells,termed splenic cells,are also seen ; these are capable of ameboid movement and often contain pigment and red blood corpuscles in their anterior.

The cells of the reticulum each prossess around or oval nucleus, and like the splenic cells they may contain pigmnt granules in their cytoplasm, they do not stain deeply with carmine and in this respect differ the cell of the malpighian bodies .In the yang spleen ,gian cells may be found, each containing numerous nuclei or one compound of nucleus .

2-1-3 Neurovascular supply:

Spleen is a highly vascular organ. It receives its arterial supply from the splenic artery. This vessel arises from the celiac trunk, running laterally along the superior aspect of the pancreas, within the splenorenal ligament.

As the artery reaches the spleen, it branches into five vessels, each supplying a different part of the organ. These arterial branches do not anastomose with each other, giving rise to vascular segments of the spleen. This enables a surgeon to remove one of these segments without affecting the others

(a procedure known as a subtotal splenectomy). Venous drainage occurs through the splenic vein. It combines with the superior mesenteric vein to form the hepatic portal vein. Figure (2-3)

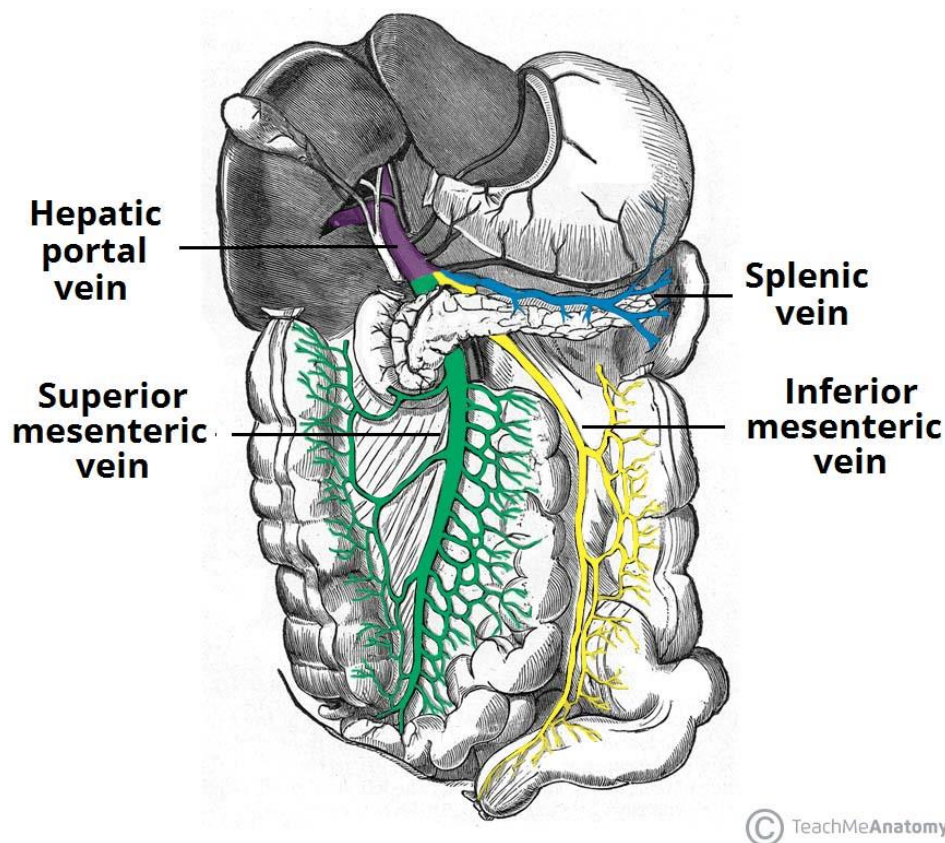


Figure 2-4 an overview venous portal system-draining into the hepatic portal vein (teachme anatomy .info/abdomen viscera/spleen/)

The lienal artery is remarkable for its large size in proportion to the size of the organ, and also for its tortuous course. It divides into six or more

branches, which enter the hilum of the spleen and ramify throughout its substance, receiving sheaths from an involution of the external fibrous tissue. Similar sheaths also invest the nerve and vein.

Each branch runs in the transverse axis of the organ, from within outward, diminishing in size during its transit, and giving off in its passage smaller branches—some of which pass to the anterior, and others to the posterior part. These ultimately leave the trabecular sheaths and terminate in the proper substance of the spleen in small tufts or pencils of minute arterioles, which open into the interstices of the reticulum formed by the branched sustentacular cells. Each of the large branches of the artery supplies chiefly that region of the organ in which the branch ramifies, having no anastomosis with majority of the other branches. (www.bartteby.com/107/278Hlmi).

The nerve supply to the spleen is from the celiac plexus. (teachmeanatomy.infi/abdomen/visceral/spleen). The nerves are chiefly non-medullated. They are distributed to the blood vessels and to smooth muscle of the capsule and trabeculae. (x1.splanchnology-4g.the spleen-Gray, Henry).

2-1-4 Accessory spleen:

An accessory spleen is a small splenic nodule extra to the spleen usually formed in early embryogenesis. Accessory spleens are found in approximately 10% of the population. And are typically around, 1 cm in diameter.

Splenosis is a condition where displaced pieces of the spleen tissue (often following trauma or after splenectomy, autotransplant in the abdominal cavity as accessory spleens) (Jump up, 2009).

Polysplenia is a congenital disease manifested by multiple small accessory spleens (Freeman, 1993) rather than the single, full-sized normal spleen.

Poly splenia sometimes occur alone , but is often accompanied by other developmental abnormalities, such as intestinal malformation, biliary atresia or cardiac abnormalities such as dextrocardia. These accessory spleens are non-functional.(Freema.1993)

2-2physiology of the spleen:

The spleen is an organ found in virtually all vertebrates, similar to a large lymph node, it acts primarily as a blood filter .

The spleen plays important roles in regard to red blood cells and the immune system (2).it removes old red blood cells and holds a reserve of blood, which can be valuable in case of hemorrhagic shock, and also recycles iron.

As part of the mononuclear phagocyte system, it metabolizes hemoglobin removed from senescent erythrocytes –the globin portion of the hemoglobin is degraded to its constituent amino acids and The spleen synthesizes antibodies in its white pulp and removes antibody coated bacteria and antibody coated blood cells by way of the blood and lymph node circulation.

A study published in 2009 using mice found that the red pulp of the spleen forms a reservoir that contains over half of the body of monocytes (Hotli.1991).These monocytes ,upon moving to injured tissues (such as heart after myocardial infarction) , turn into dendritic cells and macrophages , while promoting healing (Dhingra,2010).

The spleen is the center of activity of mononuclear phagocyte it is absence causes a predisposition to certain infections (Willims ,*Et-al*,1995)

The red pulp of the spleen has a specialized role in addition to filtration, it is the major site of the red blood cells destruction which normally have a life span of only 120 days .degenerate red blood cells are removed from circulation in the spleen , and the hemoglobin that

they contain is degraded a readily excretable pigment and an iron molecule that is recycled (i-e, used to produce a new hemoglobin elsewhere).

In some species the spleen also acts as a reservoir for blood during periods of activity. When such an animal is aroused for defence or flight, the capsule of the spleen contracts, forcing additional blood reserves into circulation. In human, spleen probably does not have this capability. (<https://www.britannica.com/science/spleen-anatomy>).

In addition, humans who have had their spleen removed (splenectomy) appear to be at increased risk of cardiovascular disease as they age. It is suspected absence of immune-regulating factors released from the spleen is related to the increased susceptibility to cardiovascular diseases in individuals who undergo a splenectomy (because the monocyte response is not observed at the site of tissue injury and healing is less in individuals who have splenectomy):

2-2-1 Immunological function:

White pulp is largest single accumulation of lymphoid tissue in the body, which contains 25% of T cells (in the periarteriolar sheaths) and 10% of B cells (in the germinal centers in the white pulp).

Circulating immune complexes are removed by macrophage phagocytosis, if they are large, and B cells if they are small.

Spleen can make V111. Also functions as a reserve pool for platelets (www.ihematology.com/general-hematology/splenic-physiology)

2-3 Pathology of the spleen :

A large number of pathologic entities can affect the spleen size. The spleen may be palpable in 15%-17% of healthy neonates and 10% of healthy children.

2-3-1 Splenomegaly:

Splenomegaly is enlargement of the spleen, and is one of the four clinical signs of hypersplenism, which includes; some reduction in the number of circulating blood cells affecting granulocyte, erythrocytes or platelets in any combination, a compensatory proliferative response in the bone marrow, and the potential to correct these abnormalities by splenectomy. Splenomegaly is usually associated with increased workload (such as in anemias, which suggests that it is response to hyper function). Figure 2-4. It is therefore not surprising that splenomegaly is associated with any disease process that involves abnormal red blood cells being destroyed in spleen. Other common causes, include -congestion due to hypertension and infiltration by leukemia and lymphoma (<https://en.wikipedia.org/wiki/splenomegaly>).

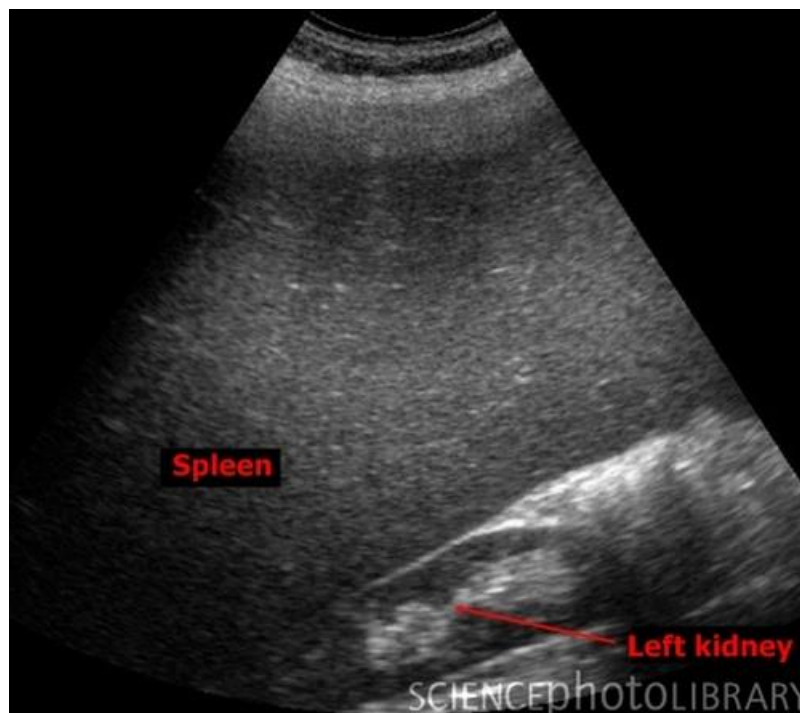


Figure 2-5 shows splenomegaly(www.stefajir.cz/?q=spleen-sonography)

Ultrasound physics

Ultrasound is high frequency sound of frequencies 2-50 MHz is used in medical ultrasound system. This is above the human hearing range of 20-20 kHz .Sound is propagate through a medium as the molecules are vibrated by pressure waves with areas of compression and rarefaction. The wave have a characteristic features of wavelength, frequency and amplitude.([www.critical-echo.com/content/tutorial-1-basic-physics-ultrasound-and Doppler-phenomenon](http://www.critical-echo.com/content/tutorial-1-basic-physics-ultrasound-and-Doppler-phenomenon))

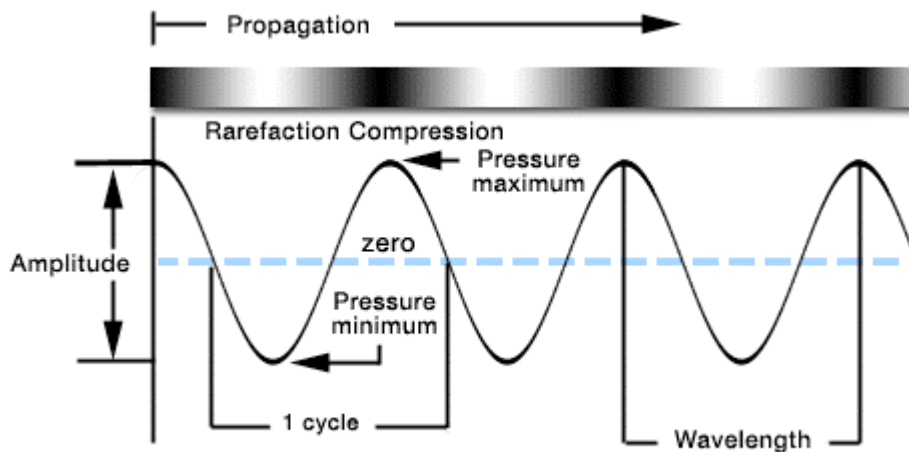


Figure 2-6 ultrasound waves and properties (courses [.washington.edu/bioen508/lecture6-US.pdf](http://www.washington.edu/bioen508/lecture6-US.pdf))

Mechanical waves are longitudinal compression waves

Ultrasound refer to frequencies greater than 20 kHz the limit of human hearing

The medical imaging typically 100 times higher than audible by human typically 2 to 20 MHz (www.critical-echo.com/content/tutorial-1-basic-physics-ultrasound-and-Doppler-phenomenon)

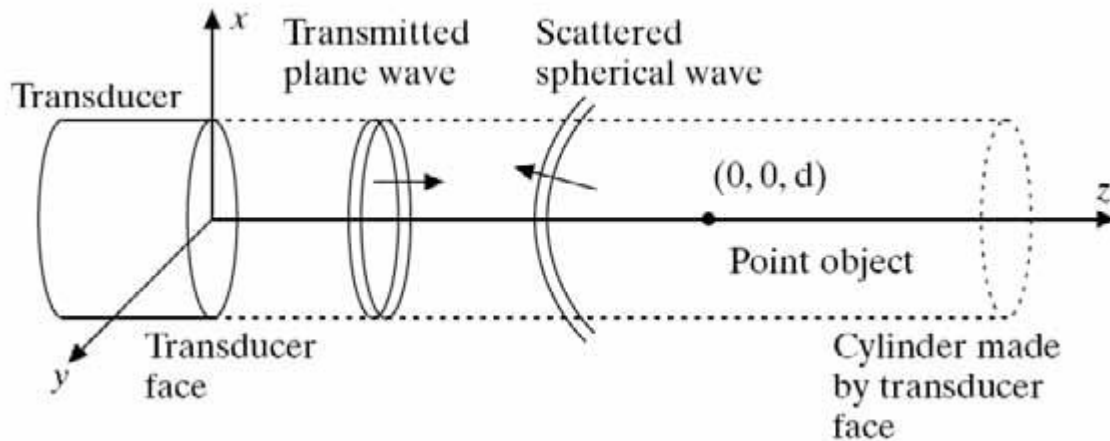


Figure 2-7 shows transmission and reflection (courses
[.washington.edu/bioen508/lecture6-US.pdf](http://www.washington.edu/bioen508/lecture6-US.pdf))

Wavelength

Wavelength is the distance between two areas of maximal compression (or rarefaction). The importance of wavelength is that the penetration of the ultrasound wave is proportional to wavelength and the image resolution is no more than 1-2 wavelength (Dorland, 1965).

Frequency

Frequency is number of wavelengths that pass per unit time, it is measured as cycles (or wavelengths) per second that the particles in the medium make as vibrate about their resting position and the unit is Hertz (Hz) (Dorland, 1965). The frequency is specific feature of the crystal used in the ultrasound transducer. It can be varied by the operator within set limits- the higher the frequency, the better the resolution but lower penetration. (www.criticalecho.com/content/tutorial-1-basic-physics-ultrasound—and-Doppler-phenomenon)

Amplitude and Intensity:

.When discussing reflection, attenuation and scatter, we often must make a quantitative statement regarding the magnitude of strength of sound wave. One variable that can be use here is the pressure amplitude. The acoustic pressure amplitude was defined as the maximum increase (or decrease) in the

pressure relative to ambient conditions in the absence of the sound wave.(James,Essentials of ultrasound physics).

speed in tissue:

The sound speed of sound in biological tissues is an important parameter in imaging applications .The lowest sound speed for lung tissue; the low value is due to air-filled alveoli in the tissue.Generally the average speed of sound in soft tissues(excluding the lung) is1540m/s ,and range-measuring circuits on most diagnostic ultrasound instruments are calibrated on this basis.(James, Essential ofultrasound physics).

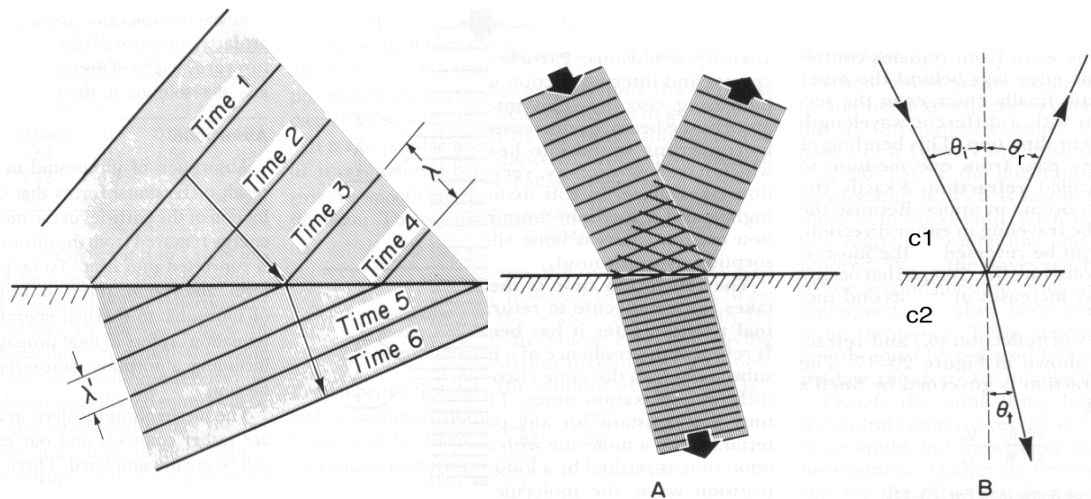


Figure 2-8 ultrasound waves in tissue

courses ashington.edu/bioen508/lecture6-US.pdf)

Production of ultrasound:

Pierre currie discovered that when an electrical current is applied to quartz crystal it is shape changes with polarity .This causes expansion and contraction, that in turn leads to the production compression and rarefaction of sound waves .This is termed piezo-electric effect. The reverse is also true, an electrical current being generated on exposure to the pressure of returning echoes.

Ultrasound transducers contain an array of piezo-electrical crystals functioning as transmitter and receiver. The frequency of the generated wave is a function of the crystal used.

Modern transducers use multiple small elements to generate the ultrasound wave. If a single small element transducer is used the waves from it in a circular fashion as do ripples in a pool. If multiple small elements fire simultaneously however the individual curved wave fronts combine to form a linear wave front moving perpendicularly away from the transducer face. This system, that is multiple small elements fired individually, is termed phased array.

The transducer contains a backing block and acoustic insulator to prevent reverberation within the probe. Quarter wave matching and electronic focusing allows the sound profile produced to be controlled. Some machines allow the focus point to be user defined whilst in others it is set automatically according to a scan depth. (www.critical-echo.com/content/tutorial-1-basic-physics-ultrasound-and-Doppler-phenomenon)

Ultrasound imaging modes:

Echo Display modes:

A-mode (Amplitude):

Display of processed information from the receiver versus time.

Speed of sound equates to depth

Only used in ophthalmology application now.

B- mode (brightness):

Conversion of A-mode information to brightness-modulated dots.

M- mode (motion)

Used B-mode information to display the echoes from a moving organ.

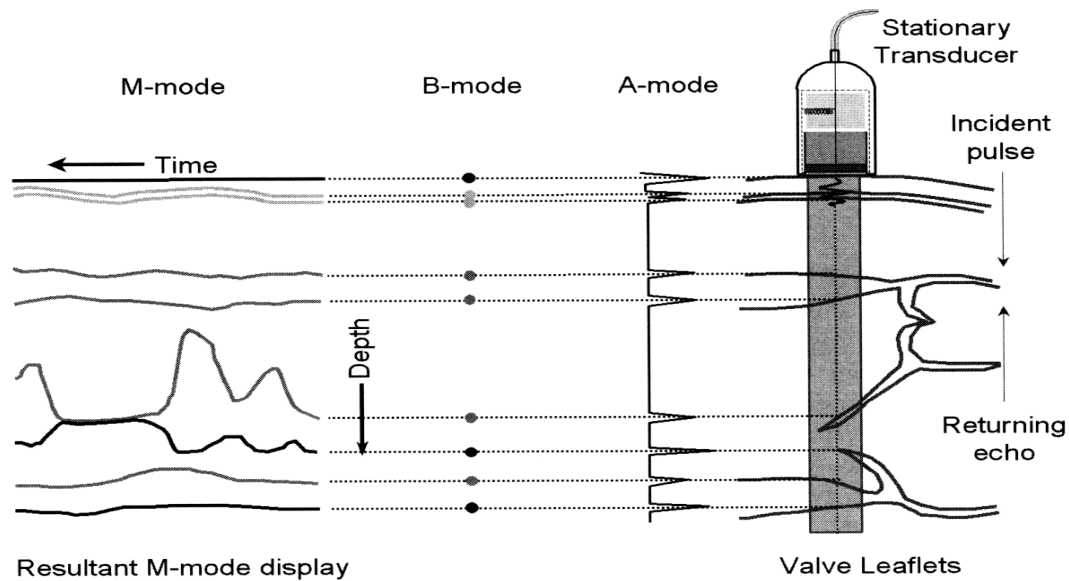


Figure 2- 9show ultrasound imaging modes (courses
ashington.edu/bioen508/lecture6-US.pdf)

Sonographic appearance :

The parenchyma of the spleen is homogeneous, mild gray or medium level echoes with even texture that is usually the same as the normal liver but may appear slightly less echogenicity. Interspersed within the spleen are small vascular structures that are seen as branches , an echoic and round or tubular. Closer to hilum the larger venous structures can be distinguished from the arterial branches . The outer contour of the normal spleen should appear smooth (Syed Amir)

The splenic parenchyma is extremely homogeneous and therefor the spleen has uniform mid to low echogenicity .The echogenicity is usually slightly greater than that of the normal renal cortex. In longitudinal scans, the diaphragm will be at the head end of the patient. In transverse scans, apportion of diaphragm will be on the left of the patient.

Splenic measurement:

The wide range of that a normal sized adult spleen is combined with it is complex three dimensional shape makes it particularly difficult to establish a

normal range sonographic measurement .Nonetheless, study of almost 800 normal.

The spleen is tend to increase as they grow in the age .In children aged 10 15 years, this typically around 10cm and is similar in boys and girls. In children more than 15 years ,it was found that the spleen grow another one cm in length boys(Andrewes,2010).

The following guideline are proposed for the upper limit of the normal spleen length based on a simple, easy to use one measurement technique show that the spleen length no greater than 6 cm at 3months. 6.5cm at 6months ,7 cm at 12 months, 8 cm at 2 years, 9 cm at 4 years ,9.5 cm at 6 years , 10 cm at 8 years,11 cm at 10 years ,11.5 cm at 12 years ,12 cm at 15 years or older for girls and 13 cm at 15 years or older for boys .Normal values of a single measurement of greatest longitudinal distance of the spleen from the dome to tip measured at the hillum in the coronal plane, where obtained in patient from newborn to 20 years old.(Andrewes, 2010)

The length was highly correlated with age ,height and body surface or weight, but there was no significance different between sexes .(Agha Mohammadi,2001)

The spleen size in infant and children depend on age of the subject and modality used,at birth the spleen weight as little as15g and less than 6 cm in length(Patersone,1999).

Spleen scanning preparation :

-Patient preparation

Non

-Patient position

Supine ,sitting semi erect and prone as needed. Different patient positions should be used when ever the suggested position does not give the desired result.(Syed Amir)

-Transducer

5.0 MHz for intercostals or lateral sub costal approaches.

3.0 or 3.5MHz for anterior or posterior scanning approaches (Gilani)

-Breathing technique

Deep held inspiration

-Spleen scanning:

Longitudinal - Coronal plane left lateral approach-

Although this approach can be performed with patient supine, it is generally easier to patient in the right decubitus position. Imaging quality might be improved by placing a sponge or rolled towel under the right side of the patient. This open the rib spaces.

Beginning must be with transducer perpendicular , mid coronal plane,in the mast inferior intercostals spaces. In the most cases the superior and inferior margins of the spleen can be visualized from this space. How much of spleen you see, however, will depend on it is shape and body habitus. If the spleen is not seen in the inferior intercostals space, the transducer must be move to adjacent superior intercostals spaces .Once the spleen located, the transducer must be rotated varying degree to visualize the long axis of the spleen. Note the adjacent pleural space superiorly at the left kidney and perephric space inferiorly. The splenic hillum also be seen medially .Slightly rotating the transducer can be aid to evaluation of the hillum. While visualizing the long axis of the spleen, the transducer must be moved or angled within the inter costal space toward the patient front scanning through the anterior portion of the spleen until you beyond it .Then moved the transducer toward the patient back scanning through the posterior portion of the spleen until you are beyond it.

Transverse scanning:

Transverse plane left lateral approach:

Still in the coronal scanning plane , the long axis of the spleen must be located, then the transducer must be rotated 90 degree in to the transverse scanning plane and transverse spleen .The transducer must be angled superiorly, scanning through the superior portion of the spleen until you are beyond it.(Gilani)

2.4 Pervious studies:

Normal liver , spleen and kidney dimensions in neonate , infant and children evaluation with sonography.(citiation: American Journal of Roentgenology,1998;1693;171.1693.10.2214/ajr.171.6.9843315

The objective of this study was to determine the normal range of dimensions for the liver , spleen and kidney in healthy neonate , infant and children .This prospective study involved 307 pediatric subjects (169 girls and 138 boys)with normal physical or sonographic findings who were examined because of problems unrelated to the measured organs. The subjects were 5 days to 16 years old. All measured organs were sonographically normal. At least two dimensions were obtained for each liver , spleen and kidney. Relationships of the dimensions of these organs with sex, age ,body weight and height were investigated .Suggested limits of normal dimensions were defined. Dimensions of the measured organs were not statistically different in boys and girls .Longitudinal dimension of all these organs showed the best correlation with age ,weight ,height and body surface. Height showed the strongest correlation of all .This correlation was a poly nominal correlation. Determination of pathologic changes in size of the liver ,spleen and kidney necessitates knowing the normal range of dimensions for these organs in healthy neonate, infant and children. Presented data are applicable in daily routine sonography.

-Normal values of liver and spleen size by using ultrasonography in Indian children:

The objective of this study is to establish normative data for the ultrasound measurement of the liver and the spleen size in healthy Indian children. The setting of the study is tertiary-care pediatric teaching hospital. The design of the study is cross-sectional, hospital-based study.597 health children between the ages 1 month to 12 years were participate in this study .The

ultrasonographic evaluation for the assessment of the liver and spleen size. These were correlated with age, sex, height and weight of the participants. The result shows that the normal liver and spleen length and range were obtained sonographically. The liver and spleen length significantly correlated highly with height of the subjects ($p=0.0001$). The conclusion of the study shows that the study provides the normal values of liver and spleen size by ultrasonography in healthy Indian children.

-Spleen length in childhood with ultrasound: Normal values Based on sex, age and somatometric parameters.

The purpose of this study is to investigate with ultrasonography (u/s) normal spleen in healthy children. The study comprised 512 healthy children (274 girls) with ages ranging from 1 day (full term neonate) to 17 years who were examined between 1996 and 2001. The main sample comprised 454 children (299 girls, with body measurements (height and weight)). None had problems that could affect spleen size. The relationships between the ultrasound measured spleen length with age, weight and height of the subjects. The result of the study shows that the spleen length was highly correlated with age, weight, height and body surface area and there was no statistical significance difference between sexes.

Chapter Three

Material and Methods

Chapter Three

Material and Methods

3-1 Type of the study:

This study is a descriptive and analytical study dealing with normal volunteers.

3-2 Area of study :

- Omer Eldori primary school for boys
- Thowyba primary school for girls

3-3 Duration of study:

This study started from June 2016 up to December 2016.

3-4 Population of study:

Normal healthy children, male and female.

3-5 Sampling of the data:

The sample of the data was 50 children selected randomly.

3-6 Data collection:

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

3-7 Data analysis :

Data had been analyzed by software program SPSS and presented in tables and figures.

3-8 Ethical considerations:

- Permission from ultrasound department was obtained.
- No person identification data or details published.
- Safe use of ultrasound

3-9 Instrumentation:

- General ultrasound machine 3.5Mz, convex probe.
- Height meter
- Weight measurement instrument.

3-10 Scanning method:

Trans abdominal ultrasound technique was performed with patient lying in supine position angle the probe between the ribs intercostally from postero lateral 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)

Chapter Four

Results

Chapter Four

Results :

The following tables and figures shows 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) Frequency distribution of sex

Sex	Frequency	Percent	Valid Percent	Cumulative Percent
Male	25	50.0	50.0	50.0
Female	25	50.0	50.0	100.0
Total	50	100.0	100.0	

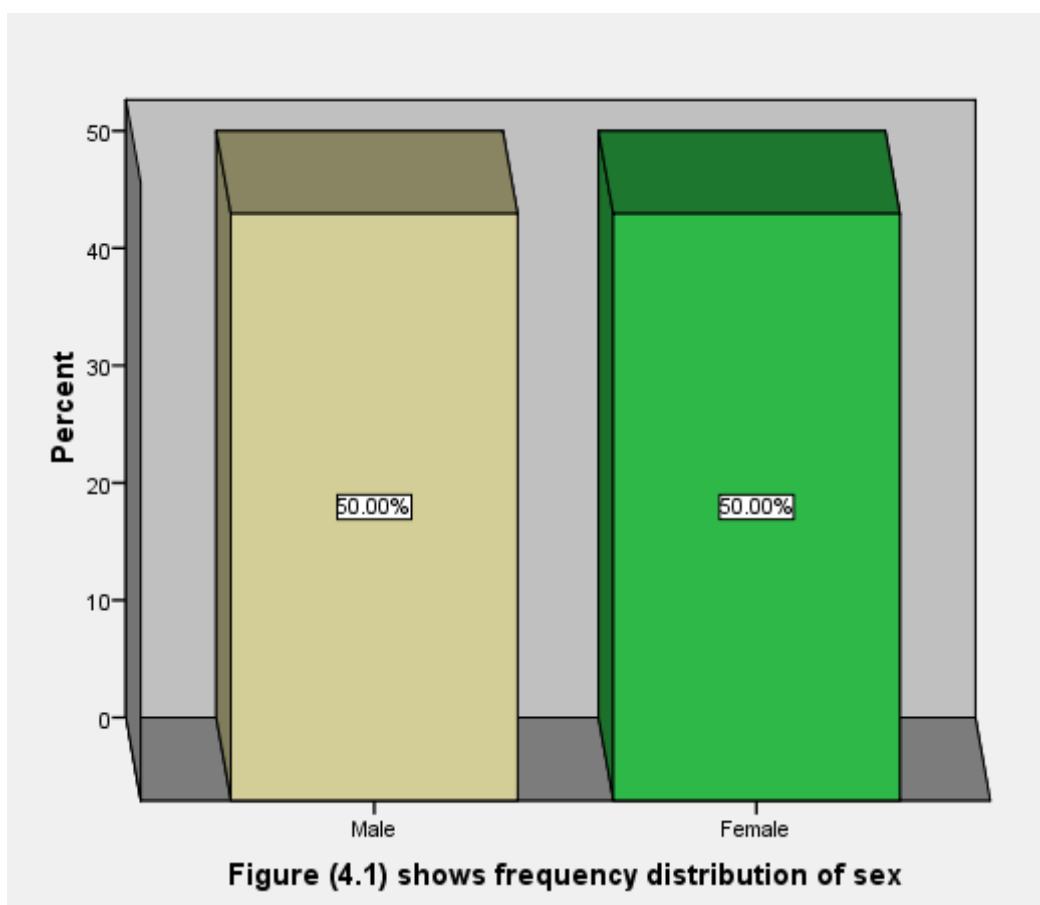


Table (4.2) Shows minimum, maximum, mean, Std. deviation for age , height and weight of child and length , width and thickness of spleen .

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	4.00	14.00	9.5200	2.53940
Height	50	100.00	148.00	129.54	11.66577
Weight	50	13.00	43.00	26.6300	6.68597
Length	50	6.00	10.50	8.3120	.97764
Width	50	2.00	4.20	2.8760	.55790
Thickness	50	5.10	8.70	6.6480	.82888
Volume	50	35.2	176.06	85.5391	30.19828
Valid N (listwise)	50				

Table (4.3) Shows correlation between gender, age , height , weight of child and length , width and thickness of spleen .

		sex	Age	Heig ht	Weig ht	Lengt h	Widt h	Thickne ss
sex	Pearson Correlatio n	1	-.032	-.019	-.068	-.289 [*]	-.326 [*]	-.341 [*]
	Sig. (2- tailed)		.826	.896	.639	.042	.021	.015
	N	50	50	50	50	50	50	50
Age	Pearson Correlatio n	-	1	.822 ^{**}	.721 ^{**}	.535 ^{**}	.493 [*]	.433 ^{**}
	Sig. (2- tailed)	.032		.000	.000	.000	.000	.002
	N	50	50	50	50	50	50	50
Height	Pearson Correlatio n	-	.822 [*]	1	.736 ^{**}	.468 ^{**}	.447 [*]	.262
	Sig. (2- tailed)	.019	.000		.000	.001	.001	.066
	N	50	50	50	50	50	50	50
Weight	Pearson Correlatio n	-	.721 [*]	.736 ^{**}	1	.672 ^{**}	.342 [*]	.434 ^{**}
	Sig. (2- tailed)	.068	.000	.000		.000	.015	.002
	N	50	50	50	50	50	50	50

Length	Pearson Correlation	-	.535*	.468**	.672**	1	.414*	.627**
	Sig. (2-tailed)	.289*	.000	.001	.000		.003	.000
	N	50	50	50	50	50	50	50
Width	Pearson Correlation	-	.493*	.447**	.342*	.414**	1	.372**
	Sig. (2-tailed)	.326*	.021	.001	.015	.003		.008
	N	50	50	50	50	50	50	50
Thickness	Pearson Correlation	-	.433*	.262	.434**	.627**	.372*	1
	Sig. (2-tailed)	.341*	.015	.066	.002	.000	.008	
	N	50	50	50	50	50	50	50
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

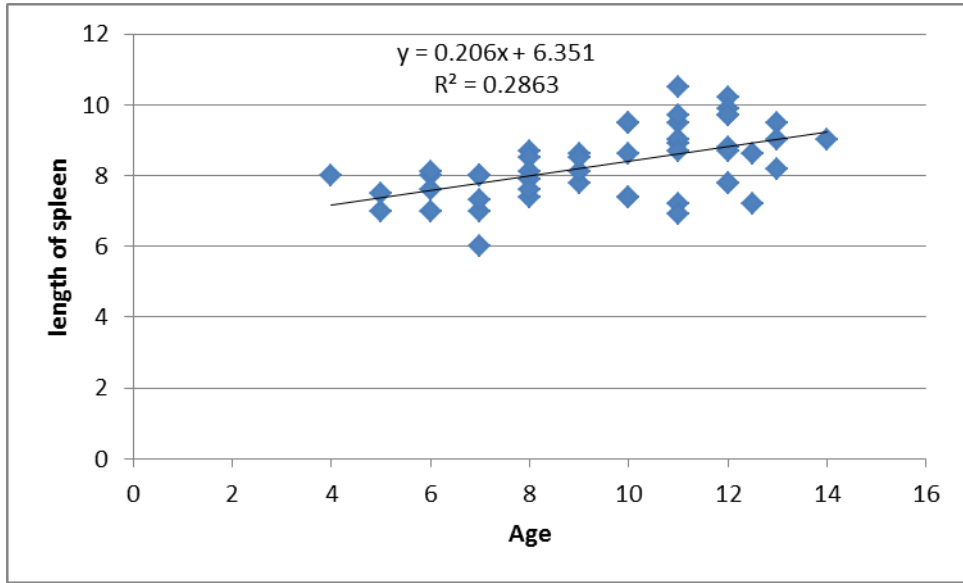


Figure (4.2) scatter plot shows relationship between age and length of spleen

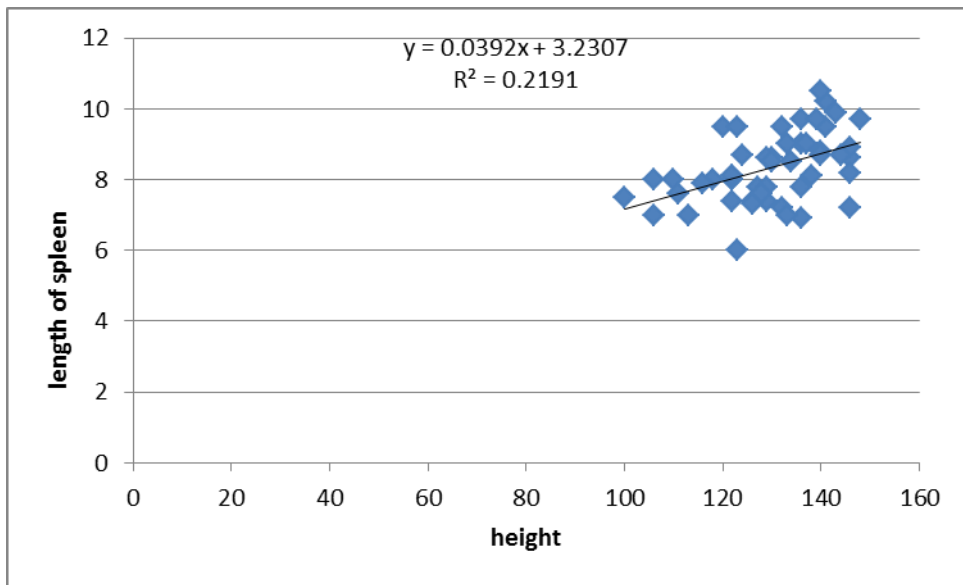


Figure (4.3) scatter plot shows relationship between height and length of spleen

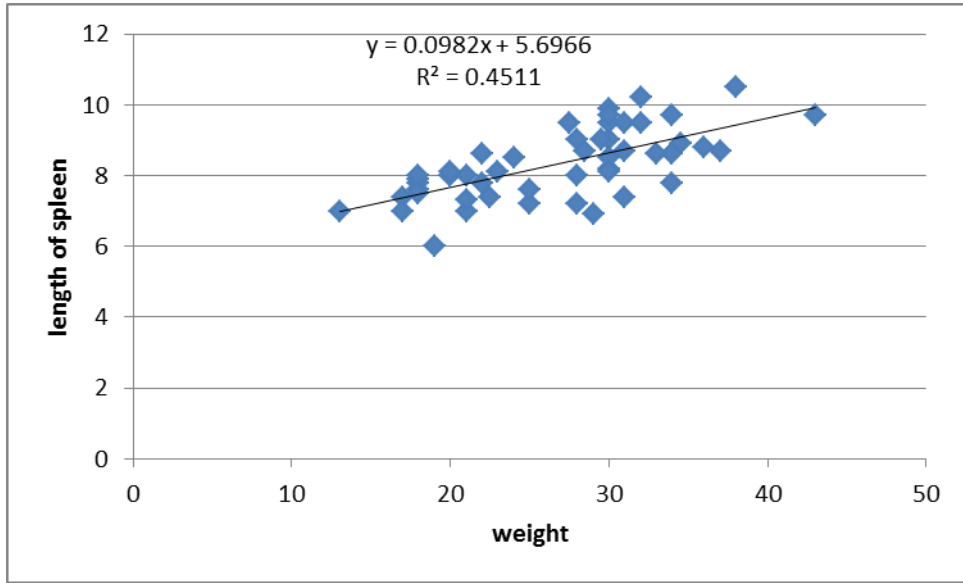


Figure (4.4) scatter plot shows relationship between weight and length of spleen

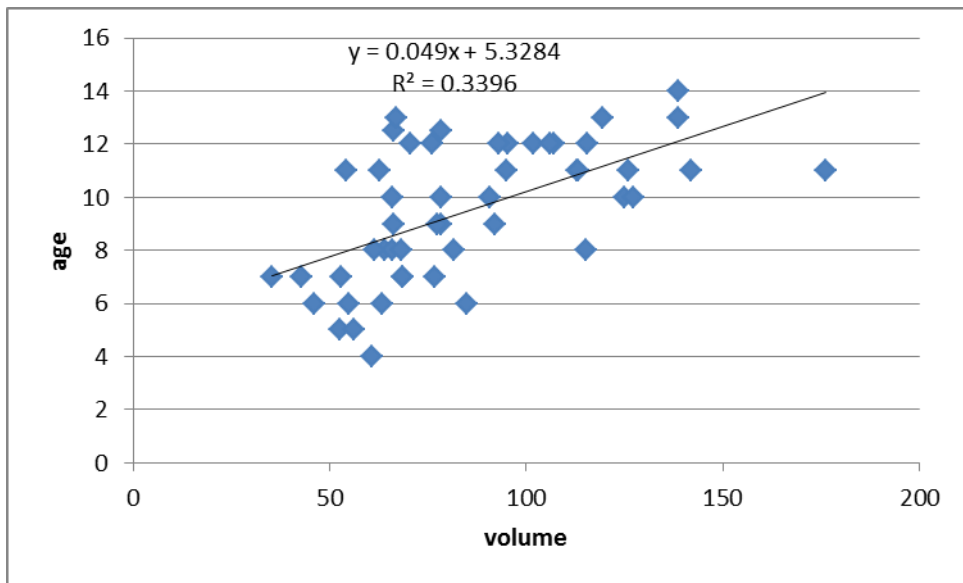


Figure (4.5) scatter plot shows relationship between volume of spleen and age

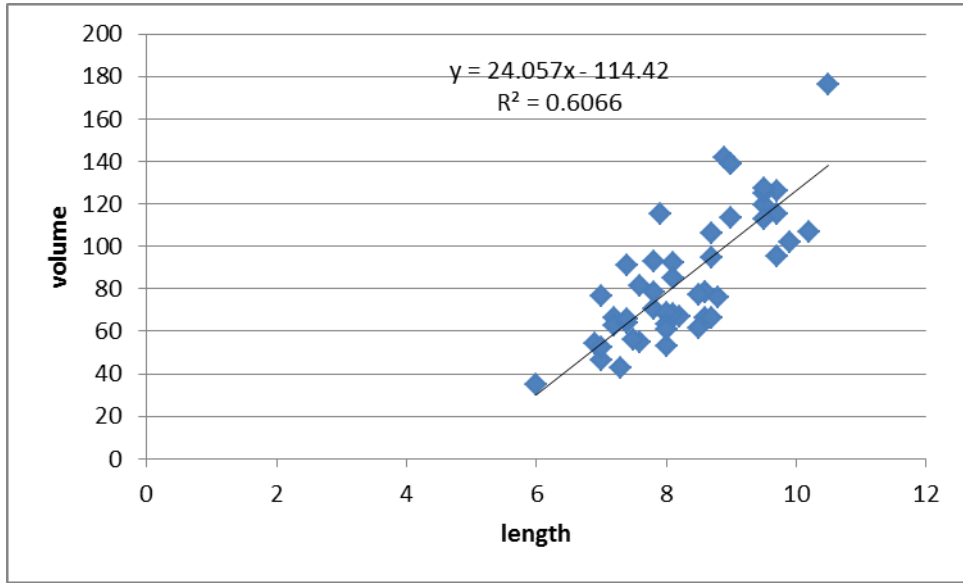


Figure (4.6) scatter plot shows relationship between volume of spleen and length

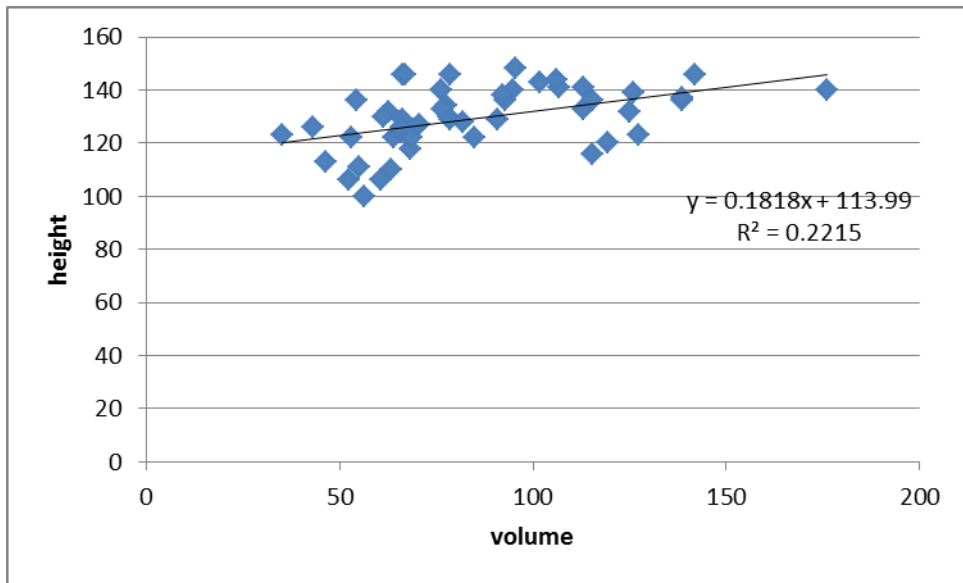


Figure (4.7) scatter plot shows relationship between volume heights

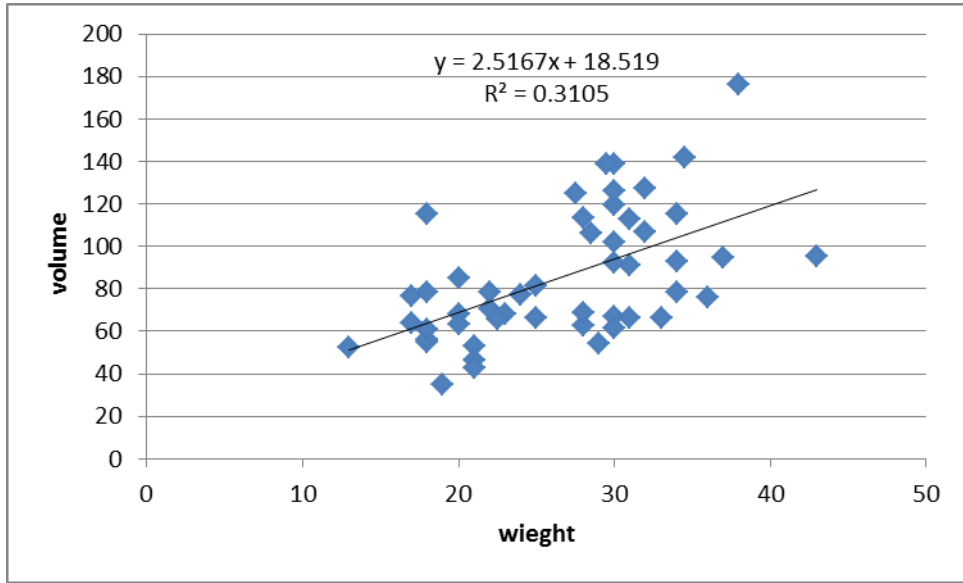


Figure (4.8) scatter plot shows relationship between volume and weights

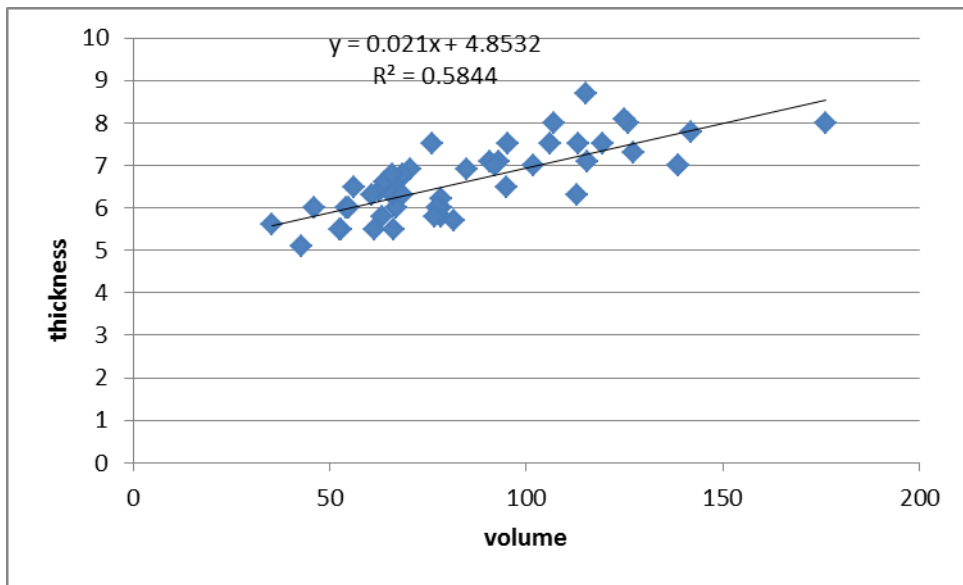


Figure (4.9) scatter plot shows relationship between volume and thickness

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

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	25	5.00	14.00	9.4400	2.54673
Height	25	106.00	148.00	129.322	11.71793
Weight	25	13.00	43.00	26.1800	6.92652
Length	25	6.00	10.20	8.0320	.92813
Width	25	2.00	4.20	2.6960	.51839
Thickness	25	5.50	8.00	6.3680	.71863
Volume	25	35.21	141.87	73.7081	25.05858
Valid N (listwise)	25				

Table (4.5) Shows minimum, maximum, mean, Std. deviation for age , height and weight of child and length , width and thickness of spleen for female

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	25	4.00	13.00	9.6000	2.58199
Height	25	100.00	144.00	129.762	11.85074
Weight	25	17.00	38.00	27.0800	6.54739
Length	25	7.00	10.50	8.5920	.96260
Width	25	2.20	4.20	3.0560	.54702
Thickness	25	5.10	8.70	6.9280	.85025
Volume	25	42.84	175.73	97.1843	30.63877
Valid N (listwise)	25				

Chapter five

Discussion, Conclusion and Recommendation

Chapter five

5.1 .Discussion

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

This study was done on 50 healthy school age children . age group between 4-14 years .the male sex represent 50% of the sample and the female also

The mean ages group is 9.5 years with st error 2.5 years , the mean of body height is 129.5 cm with st error 11.6 cm and the mean of the body weight is 26.6 k with st error 6.7 k (table 4.1) .

In this study the splenic length compared with body height and weight ,it showed high significant correlation. 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 .

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. This findings supports the historical assessment of splenomegaly based on splenic length.

This study showed the mean of splenic measurements were (length 8.2cm with st error 1.43cm, width 2.9cm with st error .66 cm and thickness 6.6 cm with st error .83 cm). These measurements are consistent with previous normal values reported for the general pediatric population (Andrews E et, 2010).

The study revealed high correlation between splenic dimensions(length, width and thickness) 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 4-14 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.

5.2 conclusion:

This study define normative values for spleen size for Sudanese pediatric population. The variation in normal splenic dimensions in this study group underlies the diversity of body types observed. The normal limit of spleen measurements are important during a sonographic examination. The best correlation was between the child weight and splenic dimension, followed by child height and the weaker correlation between the age and splenic dimensions. But there are no significant different between splenic dimensions and sexes.

5.3 Recommendations:

The operator should update their knowledge about technique used and any information regarding ultrasound measurements.

Assessment of splenic size by physical 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 series of measurements in healthy individuals, taking into consideration sex and race.

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Appendices

This image for female patient(the weight was 32 kg,height 128cm,age 10years.The spleen measurements were (length=8.8cm, width=3.6 Th



This image for male patient(the weight was 19 kg ,,height 110cm,age 5years.The spleen measurements were (length=6.9cm, width=4.3 Th



This image for male patient(the weight was 29 kg,height 135cm,age 10years.The spleen measurements were (length=8.9cm, width=3.4 Th



This image for female patient(the weight was 53 kg ,height 140cm,age 12years.The spleen measurements were (length=9.0cm, width=3.5

