



Sudan University of Science and Technology
College of Graduate Studies



**Measurement of Normal Spleen in Sudanese Adult using
Ultrasonography**

قياس الطحال الطبيعي لدى السودانين البالغين باستخدام الموجات فوق الصوتية

*A thesis Submitted for Partial Fulfillment for the Requirement of
(M.Sc.) Degree in Medical Diagnostic Ultrasound*

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الاية

قال تعالى :

(قُلْ لَوْ كَانَ الْبَحْرُ مِدَادًا لِكَلِمَاتِ رَبِّي لَنَفِدَ الْبَحْرُ قَبْلَ أَنْ تَنْفَدَ كَلِمَاتُ رَبِّي

وَلَوْ جِئْنَا بِمِثْلِهِ مَدَدًا)

صدق الله العظيم

سورة الكهف الآية (109)

Dedication

To:

My family

My husband

My friends

My colleagues

Acknowledgment

First of all, I Thank Allah the almighty for helping me to complete this project. I Thank Dr .Ikhlas my supervisor for her help and guidance, my great fullness for my all teachers in different educational levels, specially thanks for Dr. Mohammed Abdulla who helped in the collection data of this research. Finally I would like to thank everybody who helped me in this project.

Abstract

This is experimental study was done in Clinic of ultrasound, Alfao, Algardarif state, Sudan, during the period from June to October 2018, using **Sonoscape A6machine** with Curvilinear transducer 3.5MHZ to measure the normal spleen dimensions in adult Sudanese, and to correlate these dimensions with the variables of age, gender, height, weight and body mass index, the study was done with the subjects lying in right lateral decubits in deep breath the spleen dimensions were measured by centimeter. A number of 50 subjects age(20-70years).male 20 (40%)and female30 (60%) were examined using ultrasound ,the mean values for body characteristic age, height ,weight and BMI are 37.80 ± 14.8 , 168.2 ± 8.8 , 60.8 ± 11.04 , 21.3 ± 2.6 respectively the study found The mean value of spleen Length ,spleen width, spleen Thickness and Splenic volume were $8.976 \pm 1.1\text{cm}$, $3.9 \pm 0.6\text{cm}$, $3.73 \pm 0.7\text{cm}$, $71.38 \pm 31.04\text{cm}^3$ respectively, and there was significant correlation between spleen length with height and weight and non-significant correlation with body mass index, and there was non- significant correlation between spleen width and spleen depth with height, weight and BMI, furthermore there were significant correlation between spleen volume and height and non-significant correlation with weight and BMI and there were statistically significant differences between males and females in (length) and non-significant differences between male and female in (depth,, width and volume) the means of (length, depth, width and volume) are, (9.565,8.583), (3.8750, 3.6333), (3.9750, 3.6333), (79.805,65.777) for Male and Female respectively , the men had larger spleen than female in relation of spleen to gender, there is non-significant correlation between spleen dimension and age.

ملخص البحث

أجريت هذه الدراسة التجريبيه في عيادة الموجات فوق الصوتية، الفاو، ولاية القضارف السودان في الفترة ما بين شهر يونيو إلي أكتوبر 2018 باستعمال جهاز سونوسكوب للموجات فوق الصوتية . لقياس أبعاد الطحال للسودانيين البالغين و كان الغرض من هذه الدراسة هو ربط هذه الأبعاد بمتغيرات العمر و الجنس و طول و وزن و كتلة الجسم، تم قياس الطحال أثناء الاستلقاء الجانبي بالسنتمرات و كان المسح أثناء النفس العميق، تم فحص عدد 50 شخص يتراوح أعمارهم بين (20-70)سنة، (20ذكور 30،%40، 30 إناث 60%)0

أوضحت الدراسة إن القيم المتوسطة لطول و عرض و سمك و حجم الطحال كالتالي:

$$71.38 \pm 31.04 \text{cm}^3, 8.976 \pm 1.1 \text{cm}, 3.9 \pm 0.6 \text{cm}, 3.73 \pm 0.7 \text{cm}$$

وجد أن هناك علاقة ذات دلالة احصائية تربط بين طول الطحال و طول وزن الجسم و علاقة ذات دلالة غير احصائية مع كتلة الجسم، و علاقة ذات دلالة غير احصائية تربط بين عرض الطحال و إرتفاع و وزن و كتلة الجسم و علاقة ذات دلالة غير احصائية تربط بين سمك الطحال و إرتفاع و وزن و كتلة الجسم و أيضا هناك علاقة ذات دلالة احصائية تربط بين حجم الطحال و الإرتفاع و غير هامة مع وزن و كتلة الجسم، في هذه الدراسة اختلافات هامة ذات دلالات احصائية بين الذكور والإناث في طول الطحال و اختلافات غير هامة ذات دلالة غير احصائية بين الذكور والإناث في سمك و عرض و حجم الطحال، و القيم المتوسطة لطول و سمك عرض و حجم الطحال علي نحو الآتي (9.565,8.583), (3.8750, 3.6333), (3.9750, 3.6333), (79.805,65.777) للذكور والإناث علي التوالي ، للذكور طحال أكبر مقارنة بالاناث و هناك علاقة غير هامة بين أبعاد الطحال و العمر.

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List of Abbreviations

Abbreviation	Meaning
BMI	Body mass index
CEUS	Contrast Enhanced Ultrasound
ST	Spleen thickness
SV	Spleen volume
SL	Spleen length
SW	Spleen width

Chapter one

Introduction

1.1Introduction

The spleen is the largest lymphoid organ with a parenchymal structure in the reticuloendothelial system and it is situated in the left hypocondrium (Ehimwenma et al, 2011).

The spleen size shows variations according to people, depending on the individual's height, age and sex (Danila, 2010).

The spleen is normally measured along its long axis, the normal spleen measures 8 to 12 cm in length 7 to 8 cm in anteroposterior diameter, and less than 6cm in thickness.

Sonographically the spleen must be smooth in its outer contour, mid gray to low level echoes splenic parenchyma, and homogeneous texture with less or same liver texture echogenicity, spleen plays 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 a part of the mononuclear phagocyte system, it metabolizes hemoglobin removed from senescent erythrocytes. The globin portion of hemoglobin is degraded to its constitutive amino acids, and the heme portion is metabolized to bilirubin, which is removed in the liver (Curry and Tempkin, 1995).

Ultrasonography is commonly used to diagnose splenomegaly and to determine the spleen size and it is safe, quick and reliable method for the calculation of splenic dimensions (Dhingra *ET al.*2010).

Several studies have proved that the normal dimensions of the spleen vary according to age, weight, body surface area, height and sex, the size of the spleen undergoes changes in accordance with the nutritional status of the patient, as it exhibits a slight growth after meals. A splenomegaly is common to many

conditions, it is important to know in clinical practice when to consider that a spleen is enlarged.

In a study published in 2012 in which 111 human cadaveric spleens have been analyzed, the average length of the spleens examined was 9.66cm (ranging from 5 cm to 13 cm), the average width of 6.22 cm (values ranged between 3.5 cm and 9.5 cm) and the thickness varied between 1.5 cm and 5.5 cm, with an average of 3.06 cm. the weight also showed great variations, ranging between 80 and 300g, 145.76g being the average weight (muataz. 2006).

Another study indicates that normal average dimensions of the spleen in athletes taller than 2 m the average dimensions of the spleen were found to be approximately 11.2 cm, with the maximum value recorded of 14 cm. the current clinical practice guidelines accept 11-12 cm (less than 13 cm) as the normal length of the spleen in a healthy adult, 3-4 cm in breadth and a Weight of about 150g. The spleen shrinks proportional to the aging Process (John and Tempkin 1995).

Furthermore study in Turkish adults found that all dimensions were greater in males than females and spleen length decreased with increase in age in both genders. (celiktas. Et al.2015) , another study found that spleen length, Weight and thickness were decreased within increase in age with all parameters greater in males than in female and all dimension are greater in male than in female. (Narora et al.2010).more ever study was done in collegiate athletic population found that mean(SD) splenic length in men larger than women.(Mayahuza et al.2016).

1.2 Problem of the study:

The normal spleen size generally stated in a book or journal that carried out their study in different nation with different body characteristic therefore adoption of

their normal might not give a true result, therefore. there is no reference value for spleen measurements in Sudanese population.

1.3 Objective of the study:

1.3.1 General objective:

To measure the normal spleen in Sudanese population

1.3.2 Specific objectives:

- To establish the standard splenic measurements in normal Sudanese Adults using ultrasound
- To measure the length, width, thickness and volume of the spleen.
- To correlate these measurements to the height ,weight and body mass index of the body
- To identify the relation between spleen and age

1.4 Thesis outlines

The thesis is divided into the five chapters. Chapter one, which is an introduction, deals with theoretical frame work of the study. It presents the statement of the of the study problems, objectives of the study, it also provides an outlines of the thesis. Chapter two included theoretical background material for thesis, and literature review (previous studies). Chapter three deals with material and method used to measure the spleen. Chapter fours deal with (results) data presentation. Chapter five discusses the data (discussion), conclusion and recommendations for this thesis and suggestions for future work.

Chapter two

Theoretical Background and Literature review

Theoretical Background and Literature review

2.1 Theoretical Background

2.1.1 Anatomy of the Spleen:

The spleen is situated principally in the left hypochondriac region, but its superior extremity extends into the epigastric region; it lies between the fundus of the stomach and the diaphragm. It is the largest of the ductless glands, and is of an oblong, flattened form, soft, of very friable consistence, highly vascular, and of a dark purplish color. (Henry, 2000)

2.1.1.1 Development:

The spleen appears about the fifth week as a 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 the left kidney. The part of the dorsal mesogastrium which intervened between the spleen and the greater curvature of the stomach forms the gastrosplenic ligament. .

(Henry, 2000)

2.1.1.2 Relations:

The diaphragmatic surface (faces diaphragmatic; external or phrenic surface) is convex, smooth, and is directed upward, backward, and to the left, except at its upper end, where it is directed slightly medial ward. It is in relation with the under surface of the diaphragm, which separates it from the ninth, tenth, and eleventh ribs of the left side (Fig 2.1), and the intervening lower border of the left lung and pleura. (Henry, 2000).

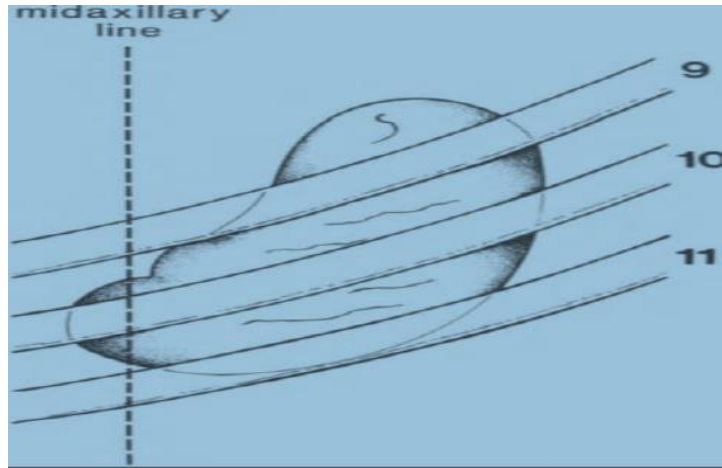


Fig 2.1. The diaphragmatic surface of the normal spleen, showing its relationship to the ninth, tenth, and eleventh ribs (Anthony J, 2002)

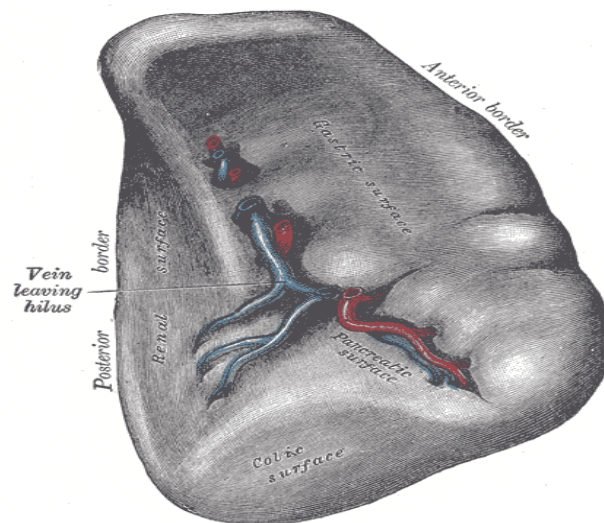


Figure 2.2 The visceral surface is divided by a ridge into an anterior gastric and a posterior or renal portion. (Henry, 2000).

The gastric surface (*facies gastrica*), which is directed forward, upward, and medial ward, is broad and concave, and is in contact with the posterior wall of the stomach; and below this with the tail of the pancreas. It presents near its medial border a long fissure, termed the hilum. This is pierced by several

irregular apertures, for the entrance and exit of vessels and nerves. (Henry,2000).

The renal surface (*faciesrenalis*) (Fig. 2.2) is directed medial ward and downward. It is somewhat flattened, is considerably narrower than the gastric surface, and is in relation with the upper part of the anterior surface of the left kidney and occasionally with the left suprarenal gland. (Henry, 2000).

The superior extremity (*extremitas superior*) is directed toward the vertebral column, where it lies on a level with the eleventh thoracic vertebra. The lower extremity or colic surface (*extremitas inferior*) is flat, triangular in shape, and rests upon the left flexure of the colon and the phrenicocolic ligament, and is generally in contact with the tail of the pancreas. The anterior border (*margo anterior*) is free, sharp, and thin, and is often notched, especially below; it separates the diaphragmatic from the gastric surface. The posterior border (*margo posterior*), more rounded and blunter than the anterior, separates the renal from the diaphragmatic surface; it corresponds to the lower border of the eleventh rib and lies between the diaphragm and left kidney. The intermediate margin is the ridge which separates the renal and gastric surfaces. The inferior border (*internal border*) separates the diaphragmatic from the colic surface; the spleen is almost entirely surrounded by peritoneum, which is firmly adherent to its capsule. It is held in position by two folds of this membrane. One, the phrenicolienal ligament, is derived from the peritoneum, where the wall of the general peritoneal cavity comes into contact with the omental bursa between the left kidney and the spleen; the lienal vessels pass between its two layers (Fig.2.3). The other fold, the gastrolienal ligament, is also formed of two layers, derived from the general cavity and the omental respectively, where they meet between the spleen and stomach (Fig. 2.3); the short gastric and left gastroepiploic branches of the lienal artery run between its two layers. The

lower end of the spleen is supported by the phrenicocolic ligament. (Henry, 2000).

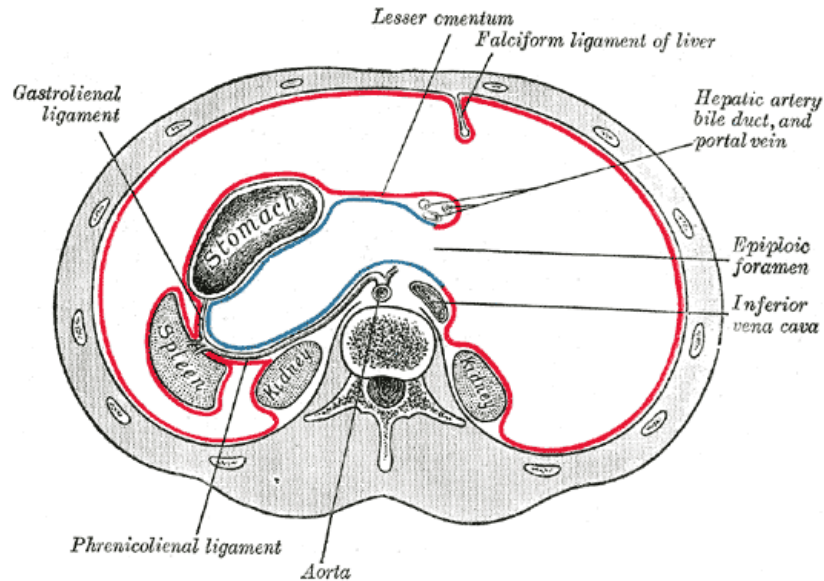


Fig 2.3 Horizontal disposition of the peritoneum in the upper part of the abdomen.

The size and weight of the spleen are liable to very extreme variations at different periods of life, in different individuals, and in the same individual under different conditions. In the adult it is usually about 12 cm. in length, 7 cm. in breadth, and 3 or 4 cm. in thickness, and weighs about 200 grams. At birth its weight, in proportion to the entire body, is almost equal to what is observed in the adult, being as 1 to 350; while in the adult it varies from 1 to 320 and 400. In old age the organ not only diminishes in weight, but decreases considerably in proportion to the entire body, being as 1 to 700. The size of the spleen is increased during and after digestion, and varies according to the state of nutrition of the body, being large in highly fed, and small in starved animals. In malaria fever it becomes much enlarged, weighing occasionally as much as 9 kilos, Frequently in the neighborhood of the spleen, and especially in the

gastrosplenic ligament and greater omentum, small nodules of splenic tissue may be found, either isolated or connected to the spleen by thin bands of splenic tissue. They are known as accessory spleens (lien accessories; supernumerary spleen). They vary in size from that of a pea to that of a plum. (Henry, 2000).

2.1.1.3 Structure:

The spleen is invested by two coats:

An external serous and an internal fibro elastic coat.

The external or serous coat (tunica serosa) is derived from the peritoneum; it is thin, smooth, and in the human subject intimately adherent to the fibroelastic Coat ,it invests the entire organ, except at the hilum and along the lines of reflection of the phrenicosplenic and gastrosplenic ligaments, The fibroelastic 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 fibroelastic coat, numerous small fibrous bands, trabeculae (Fig.2.4), are given off in all directions; these uniting, constitute the frame-work of the spleen. The spleen therefore consists of a number of small spaces or areolae, formed by the trabeculae, in these areolae is contained the splenic pulp The fibroelastic 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 variations in size that it presents under certain circumstances. In addition to these constituents of this tunic, there is found in man a small amount of non-striated muscular fiber; and in some Mammalia, e. g., dog, pig, and cat, a large amount, so that the trabeculae appear to consist chiefly of muscular tissue. (Henry, 2000).

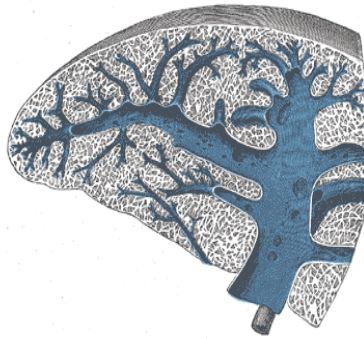


Fig 2.4 Transverse section of the spleen, showing the trabecular tissue and the splenic vein and its tributaries (Henry, 2000).

The splenic pulp (pulpalienis) is a soft mass of a dark reddish-brown color, resembling grumous blood; it consists of a fine reticulum of fibers, continuous with those of the trabeculae, to which are applied flat, branching cells. The meshes of the reticulum are filled with blood, in which, however, the white corpuscles are found to be in larger proportion than they are in ordinary blood. 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 interior. The cells of the reticulum each possess a round or oval nucleus, and like the splenic cells, they may contain pigment granules in their cytoplasm. (Henry,2000)



Fig 2.5 Transverse section of the human spleen, showing the distribution of the splenic artery and its branches (Henry , 2000).

2.1.1.4 Blood vessels of the 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 (Fig. 2.5), receiving sheaths from an involution of the external fibrous tissue. Similar sheaths also invest the nerves and veins, 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, 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 larger branches of the artery supplies chiefly that region of the organ in which the branch ramifies, having no anastomosis with the majority of the other branches, The arterioles, supported by the minute trabeculae, traverse the pulp in all directions in bundles (pencilli) of straight vessels. Their trabecular sheaths gradually undergo a transformation, become much thickened, and converted into adenoid tissue; the bundles of connective tissue becoming looser and their fibrils more delicate, and containing in their interstices an abundance of lymph corpuscles, The nerves are derived from the celiac plexus and are chiefly non-medullated. They are distributed to the blood vessels and to the smooth muscle of the capsule and trabeculae. (Henry, 2000).

2.1.2 Functions of the Spleen:

As the largest secondary lymphoid organ, the spleen has a number of important roles in the immune response, including the clearance of effete or damaged cells from the bloodstream and host resistance to infection. Other organs serve some functions similar to those of the spleen. The widely dispersed system of lymph

nodes situated throughout the host responds vigorously with antibodies and T - cells to foreign antigens that gain access to peripheral tissues. Again, like the spleen, the liver, with its large mass of phagocytic Kupffer cells lining vascular sinusoids, is an important site of clearance of particulate antigens from the bloodstream and a major contributor to resistance to infection. The spleen, however, has a unique place in host defense, because it combines all of these functions in one organ. Thus, because of its anatomic location directly connected to the circulation, it responds promptly to blood borne antigens with antigen-specific immune responses, much more effectively than can lymph nodes or other lymphoid tissues (Rowley, 1950).

2.1.3 Pathology of The Spleen:

2.1.3.1 Anatomic variation

2.1.3.1.1 Accessory spleen

Accessory spleen refers to one or more small foci of splenic tissue in the presence of an otherwise normal-sized spleen. (Anthony, 2002).

2.1.3.1.2 polysplenia

Poly splenia is a condition in which multiple spleens are present. As with the accessory spleen, these splenunculi are functional. (Anthony, 2002).

2.1.3.1.3 Splenosis

A second form of ectopic splenic tissue results from the regeneration of splenic fragments implanted at suitably supportive sites for growth, usually following traumatic rupture of the organ, but also, less commonly, following splenic surgery. (Anthony, 2002).

2.1.3.2 Splenomegaly

Splenomegaly is defined by increased splenic dimensions and volume.

Spleen longitudinal and transverse diameters averaged over 13 cm, 5 cm respectively are considered splenomegaly. Besides measuring the spleen diameters, there have been studies that used the calculus of the maximum area of the spleen in order to classify the splenomegaly using ultrasound. In a study describing portal hypertension in cirrhotic patients Gaiani defined a normal sized spleen by an area of $<45 \text{ cm}^2$, a moderately enlarged spleen by $45\text{-}65 \text{ cm}^2$, and a marked splenomegaly by an area of $>65 \text{ cm}^2$. Splenomegaly usually occurs associated with other organs pathology and sometimes it can be the debut sign of a disease onset. Mild to moderate splenomegaly (weight $< 1000\text{g}$) are usually correlated with portal hypertension or with infections, while severe splenomegaly (weight $>1000 \text{ g}$) are common in hematological diseases, especially chronic leukemia and myelofibrosis.



Figure 2.6 massive splenomegaly

2.1.3.3 Splenic abscesses

It is important to know that in the course of infectious pathology of the spleen, we can meet both types of spleen injury, focal and diffuse. Usually a homogenous, mild to moderate splenomegaly is found. In case of severe infections of other organs that disseminate in the spleen (endocarditis, acute supra-infected pancreatitis, postoperative infection complications) occurring

mainly in immune suppressed patients, splenic abscesses can be found. The frequency of splenic abscesses is low, cited in literature as 0.14-0.17% cases discovered at autopsy. A splenic abscess has a variable ultrasound appearance, hypo or hyperechoic nodule. Large abscesses, usually unique, rarely multiple, are characteristic for microbial infection, and a wedge shaped abscess may typically be seen in patients with infective endocarditis and associated septic embolism. Usually they appear with well-defined contour but with an irregular wall, multilocular, with inhomogeneous, complex echo structure, most often hypoechoic. It may present debris, septa or gas (characteristic for anaerobic infections) and posterior enhancement, and usually are avascular on colour Doppler ultrasound. Splenic phlegmons differentiate by abscesses with a poorly defined border compared with the rest of the splenic parenchyma. Fungal abscesses, which are present in HIV and other immunosuppressive disorders are caused by *Mycobacterium tuberculosis*, atypical mycobacteria, *Pneumocystis carinii* and candidiasis and shows a characteristic appearance of multiple small lesions with hyperechoic center and hypoechoic rim, the typical “bull’s eye” appearance.

The use of a high-frequency linear probe will enhance the detection of micro-abscesses. Sometimes the ultrasound cannot distinguish between splenic abscesses and tumours only using standard and Doppler examination.



Figure 2.7 splenic abscess

2.1.3.4 Splenic hydatid cyst

The frequency of splenic hydatid cyst is very rare (less than 2% of all hidatydosis localizations) and generally appears by haematogenous dissemination of a hepatic hydatid cyst and not as a primary localization of the disease. Therefore, when a splenic hydatid cyst is suspected, also another possible localization should be sought (peritoneal, hepatic).



Figure 2.8 splenic hydatidcyst

2.1.3.4 Focal splenic lesions

It is a known fact that the focal splenic pathology is rare. The most recently published study, June 2010 by Neesse et al., extended over 6 years (between

2004 and 2009), with a total of 50,000 abdominal ultrasounds, only 279 (less than 0.6%) focal splenic lesions were reported. The 279 patients (\approx 0.6%) with focal splenic lesions were diagnosed on B-mode ultrasound as follows:

72 cases (25.8%) splenic infarction, 57 cases (20%) Non-Hodgkin's Lymphoma, 51 cases (18.4%) splenic incidentaloma (incidentaloma defined as incidentally detected focal splenic lesion, without patient's history of tumour, infection or trauma, lesion stable on follow-up examination), 35 cases (12.6%) splenic rupture, 7 cases (2.5%) splenic abscess, 25 cases (9.1%) miscellaneous splenic lesions (i.e., hemangioma, hamartoma), and 32 cases (11.5%) splenic metastases of solid tumours. Focal splenic lesions can be single or multiple, benign or malignant, and can occur on normal or enlarged spleen. Ultrasound is a proven procedure for detecting focal splenic lesions, but their characterization is difficult, the ultrasound pattern often being uncharacteristic for different pathologies. The low lesions number and the difficulty to obtaining a histological document, makes their analysis harder. Their diagnosis is often based only on CE-CT and/or CE-MRI and clinical follow-up, the spleen biopsy not being an option due to the increased bleeding risk.

2.1.3.5 Benign splenic lesions

2.1.3.5.1 Splenic cystic lesions

Splenic cystic lesions can be congenital (true epidermoid or false posttraumatic cysts) – characterized by the presence of an inner endothelial lining or posttraumatic cysts (pseudocysts) which do not have cellular lining.

Congenital cysts include lymphangiomas and, very rarely, cystic hemangiomas. Ultrasound cannot make reliable differentiation between trueCysts and pseudocysts. The cysts usually appear as transonic areas, well delineated, with sharp contour and posterior enhancement. They can have calcified walls and

may contain cholesterol crystals or debris that appears as low-level echoes inside. When they bleed, the cysts appear partially or totally filled with fine, mobile echoes when the patient's position is changed, or their content appears highly inhomogeneous, difficult to be differentiated from a tumour lesion. In addition to splenic cysts there is a spectrum of lesions that have a predominantly cystic appearance at imaging. Cystic splenic masses may be inflammatory (abscesses, hydatid cyst), vascular (infarction, peliosis), posttraumatic (hematoma, false cyst), or tumoral (benign: hemangioma, lymphangioma, or malignant: lymphoma, metastasis), Parenchymal calcifications are quite common, non-specific, incidental findings, of different sizes

They could be secondary to splenic infarction, granulomas, tuberculosis or metastases



Figure 2.9 simple splenic cyst

2.1.3.5.2 Solid splenic lesions

The solid splenic lesions have a different pattern in B-mode ultrasound, hyper-, iso- or hypo-echoic than the surrounding normal tissue. Benign primary tumours of spleen are rare and include hamartoma, hemangioma and cystic lymphangioma Splenic hemangiomas have been reported in up to 14% of autopsy studies.

They can be found isolated or may occur in the Klippel-Trenaunay-Weber syndrome. There is no ultrasound specific pattern for hemangiomas. The majority is hyperechoic homogeneous lesions, with precise contour, measuring less than 2 cm. Larger; cavernous hemangiomas (> 3 cm) may appear iso- to hypoechoic with cystic changes or calcifications. They show a greater enhancement degree, with rapid or slow opacification. Filling-in can be centripetal or diffuse. Contrast enhancement is very pronounced and prolonged, with a possible shadowing in larger hemangiomas. In a minority of cases hemangiomas are quickly enhanced with a centripetal direction of enhancement. On ultrasound examination, hamartoma has both solid and cystic components, and generally appears hyperechoic.

Ultrasonographic appearance of lymphangioma is as a multicystic mass replacing splenic parenchyma. Usually, benign splenic lesions are mostly hyperechoic. Lesions that do not wash out or only a little can be regarded as benign. The most common causes are previous granulomatous infections, as histoplasmosis, tuberculosis or sarcoidosis and we encountered similar aspects in LES cases, much less studied or quoted in the literature. Usually multiple hyperechoic small lesions can be seen diffusely throughout the spleen and can be associated with calcifications in the splenic artery. But in active, miliary tuberculosis multiple small hypoechoic splenic lesions or small cystic lesions can be seen, representing tuberculous abscesses. On CEUS examination, the lesions appear hypoechoic, with progressive hypo enhancement in parenchymal phase.

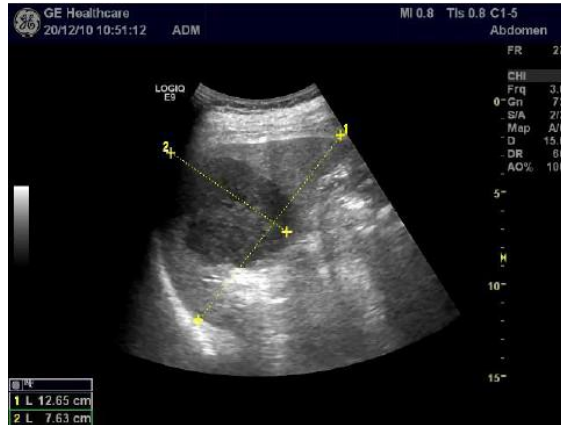


Figure 2.10 splenic granuloma

2.1.3.6 Malignant splenic lesions

2.1.3.6.1 Lymphomas

Splenic involvement in Hodgkin or Non-Hodgkin disease is the most common cause of focal splenic lesions. The detection of splenic involvement is very important for clinicians, as it might change the therapeutic approach.

Different studies show that the spleen is involved in less than 25% of the cases. Therefore, Gorg published a retrospective study in 2009 and found that in 41 out of 250 cases with a variety of lymphatic diseases had involvement of the spleen, and another study shows the spleen involvement in 101 cases out of 680. The data on CEUS contribution improving the splenic lesions detection in lymphomas is contradictory, Gorg showing in a 250 patients study that CEUS examination is not superior to B-mode imaging in splenic focal lesions detection, while Picardi found in a study with 100 patients with Hodgkin disease that CEUS was the most sensitive imaging modality to detect splenic involvement and was superior to CT and FDG PET. On ultrasound, there are 4 types of splenic involvement in lymphomas: diffuse, with small focal lesions below 1cm in size, with large focal lesions and bulky disease. The diffuse involvement and the small focal lesions are frequently in LH and in low-

differentiated lymphomas. This is why the tiny lesions can be best detected by using high frequency linear probes. The focal splenic lesions are described as hypoechoic and mostly hypo enhancing on CEUS, a small number being iso-enhancing during the arterial phase, but washing out in parenchymal phase. The small lesions in NHL might be overlooked even on CEUS as its microvasculature does not differ from the non-infiltrated tissue. In other cases the lesions are hypo vascularized even during the wash in phase and may completely wash out over time.



Figure 2.11 Infiltrated spleen in Non-Hodgkin's Lymphoma

2.1.3.6.2 Leukemias

The splenic involvement in leukemias can be homogeneous diffuse or focal



Figure 2.12 Diffuse homogeneous splenomegaly in patient with acute Leukemia

2.1.3.6.3 Metastases

Splenic metastases are mostly seen in far advanced malignant diseases ,except in patients with testicular germ cell tumors, and small cell lung cancer in which the spleen might be the only abdominal organ showing a metastatic spread.

Mostly splenic metastases have a hypoechoic appearance .But echogenicity alone is not a reliable sign for the lesion's character Patients with testicular germ cell tumours (4 from 9 patients had splenic metastasis), malignant melanoma (9 from 27 had spleen metastasis), and small cell lung cancer (8 out of 106 had spleen metastasis) have the highest frequency of splenic involvement. In the majority of cases a biopsy is not needed, clinical context being clear, its proof or non-proof will not change the clinical management of these patients. Metastases are mostly hypoechoic with no or only little tumour vasculature on colour Doppler imaging



Figure 2.13 Splenic metastases in known hepatocellular carcinoma

2.1.3.7 Vascular disease

2.1.3.7 .1 Infarction of the spleen

Considered the most common cause of focal splenic lesions. The study

Published by Neisse et al. reported a frequency of 25.8% splenic infarctions detected from all focal splenic lesions. They are caused by the embolic occlusion of the branches of the splenic artery or even of the splenic arterial

trunk (thromboembolic diseases, septic distance embolism) or local thrombosis in cases of acute pancreatitis, hematological disorders (sickle cell anemia, leukemia, lymphomatous disorders) or other diseases (sarcoidosis), systemic lupus erythematosus ,polyarteritis nodosa The ultrasound aspect different according to the time elapsed from the initial moment (the occurrence of the infarction) and the sizes of the infarction area. Often, in the first 24 hours the splenic infarction, especially the small sized one, can escape the ultrasound examination, appearing only as an inhomogeneous area, ill-defined in the splenic parenchyma. After 24 hours the splenic infarction appears hypo echoic, with borders not always well delineated, and dimensions generally underestimated

In time, due to fibrosis, splenic infarction appears hyperechoic, triangular shaped (wedge-shape) with the base always orientated to the splenic capsule and with capsular retraction. Sometimes the appearance can be nodular. Due to fibrosis, their dimensions decrease over time. They can keep the triangular aspect or they can produce linear scars, form calcifications or they can turn into pseudocysts. Sometimes they can mimic a tumoral mass. On colour Doppler examination infarction areas do not present vascular signals.



Figure 2.14 splenic infarction

2.1.3.7.2 Splenic vein thrombosis

Is a common complication seen in patients with acute pancreatitis or sepsis.

We also found splenic vein thrombosis in patients with hematologic malignancies. Recent partial or total thrombosis, in the first days appears

Hypo echoic and is quite difficult to diagnose it on 2D or colour Doppler Ultrasound examination.



Figure 2.15 splenic vein thrombosis

2.1.3.7 Traumatic spleen

The spleen is often affected in abdominal trauma, due to its fragility. In major trauma ultrasound has a major role in detecting life threatening complications due to the FAST protocol (Focused Assessment of sonography in Trauma) commonly used today to detect or exclude the presence of free fluid in the pericardium or in the abdomen in cases of Trauma.

Ultrasound is a fast technique, portable and proved that it can easily be integrated into the resuscitation of the patients with trauma without delay of the therapeutic measures. Routine abdominal ultrasound can be also performed at the bedside in trauma centers. Studies show that the use of screening ultrasound in the follow-up of traumatic patients can improve clinical decision making for the use of the emergency laparotomy. On the other side, in major trauma with

clinically stable patients, contrast enhanced CT remains the method of choice, with the advantage of the entire examination of the abdominal cavity and the possibility of standardization. But its efficiency decreases in minor trauma, contusions, lacerations or edemas, which can be ignored or overestimated on CT scan. But B-mode ultrasound has a poor detection rate in blunt splenic injury, especially in imaging minor tissue damage, therefore is not recommended in the assessment of stable trauma patients. In these situations CEUS examination allows a better evaluation of the blunt abdominal trauma, especially in children and has the advantage that it is not irradiant or toxic, and it may be used for cases treated conservatively to avoid unnecessary CE-CT Examinations. The ultrasound exam can diagnose a series of traumatic lesions as hematomas, contusions, lacerations or capsular infraction .Frequently these lesions are combined, often associating traumatic lesions of other organs. We must note the traumatic context of these lesions, but the rare possibility of the spontaneous spleen rupture should not be neglected, usually arising on a pathological spleen. The sonographic appearance of hematoma depends on the amount of splenic tissue damaged and the delay time between the trauma and the first US examination. Immediately post traumatic, the hematoma has a hypoechoic appearance and can be easily differentiated from splenic parenchyma. But, within the first few hours, hematoma develops a nearly Isoechoic appearance with inhomogeneous areas inside and an intra-splenic hemorrhage might not be visible at all, depending on the volume of hemorrhage the spleen may be enlarged causing local pain. Over the following days, Hematoma becomes slightly hypo-echoic, due to re-liquefaction. Finally, a hematoma can be differentiated as clearly hypo echoic areas. Because the splenic capsule is very thin, we can receive important information about the integrity of the capsule analyzing the shape of the fluid collection. If the

collection is crescent and conforms to the contour of the spleen, we can presume that hematoma is subscapular. If the collection is irregularly shaped, perisplenic hematoma is suggested during the recovery process, hematoma sizes gradually decrease and its echo structure may become hyperechoic due to the fibrosis process, when the spleen recovers, it may contain small irregular foci or the parenchyma may have a homogeneous B-mode appearance again. Sometimes at a later scan, pseudocysts can be seen at the site of the hematoma. CEUS is the most sensitive US technique to prove minor defects during the follow up after splenic trauma Blunt parenchymal trauma may cause other various injuries, such as lacerations, contusions, capsule rupture and vessel tears of different severities. B-mode ultrasound shows minimal or absent modifications of the splenic parenchyma. Most often an Inhomogeneous area in the parenchyma is seen or a hypo echoic area with ill-defined irregular borders; this, in time, can evolve to resolution or it can form a collection (hematoma).



Figure 2.16 Posttraumatic follow-up. Inhomogeneous “wedge-shaped”, ill-defined subscapular area with small cysts inside

2.2 Previous Studies:

This study in north Indian adults established normal splenic measurement in 150 adult subjects (78 males and 72 females, ages 18 to 76 years) using ultrasonography. The mean values of the age, height, weight and body mass index (BMI) of subjects, spleen width (SW), spleen length (SL), spleen thickness (ST) and spleen volume. These measurements were found to be 36.37 ± 10.83 years, 164.22 ± 4.72 cm, 60.26 ± 7.11 kg, 22.30 ± 2.09 kg/m², 7.58 ± 1.56 cm, 9.87 ± 1.28 cm, and 3.34 ± 0.79 cm and 136.05 ± 61.14 cm³ in females respectively. Additionally, in males same dimensions were 40.50 ± 12.77 years, 174.41 ± 6.57 cm, 76.33 ± 8.54 kg, 25.06 ± 2.10 kg/m², 8.75 ± 1.84 cm, 11.01 ± 1.186 cm, 4.12 ± 1.09 cm and 220.70 ± 115.35 cm³ respectively (Narora et al.2010).

Another study in Turkish adults established normal splenic measurement in 160 subjects (80 males & 80 females) in age between 20 and 60 years. They found that spleen length, weight and thickness were decreased in increase in age with all parameters greater in males than in female and all dimension are greater in male than in female. (Celiktas.m et al.2015).

Another study established normal splenic dimensions using ultrasound in 400 Nigerian adults, there were 212 males and 188 females, their age ranged between 20 and 70 years. The mean age of the subjects and (\pm standard deviation) were 33.0 years (± 12.0), mean height was 1.64 m (± 0.1) and mean weight was 61.4 kg (± 11.0). The mean splenic length, width and depth for the subjects studied were 101.6 mm (± 13.7), 46.8 mm (± 8.2), and 86.8 mm (± 12.7), respectively, There was positive correlation between subjects height and weight with splenic length ($P < 0.001$ and $P < 0.001$), depth ($P < 0.01$ and $P < 0.001$) and width ($P < 0.01$ and $P < 0.001$). (MAYahuza et al.2016).

Furthermore study in a healthy collegiate athletic in Americans found that the Mean splenic length was 10.65 (1.55) cm and width, 5.16 (1.21) cm. Men had larger spleens than women ($p < 0.001$). (Hosey, 2006).

Okoye, (2005) study aimed to establish ultrasonic splenic dimensions which can be used as normogram for adult Nigerians. Their study include 250 adult subjects were scanned prospectively using a 3.5MHZ ultrasound sector probe. The splenic length, width and thickness were obtained in the supine position and the weight calculated using Downey's formula. Differences in splenic dimensions were determined using Z test, while the relationship between the splenic dimension and the subjects' age, BMI, and height were analyzed using Pearson Moment Correlation. The normal splenic sizes obtained ranged from 9.9 -11.5cm (length — L), 6.0-7.5cm (Width W) and 4.0- 4.5cm (thickness -T). The splenic dimensions for males were 11.1+0.7cm (L), 7.3 + 0.2cm (w) and 4.2+ 0.2cm (T). The corresponding values for females were 10.6 + 0.7cm, 6.8 + 0.5cm and 4.2 + 0.2cm respectively; thus showing a statistically significant difference between the males and females ($P < 0.05$). A poor correlation was shown to exist between splenic dimensions and age but splenic weight increased with body weight ($r=0.75$).

Even though value of the splenic sizes were similar to those of a Caucasian population compared with them ($P < 0.05$), the maximum splenic weights occurred in the 4 decade in Nigerians and in the 2 decade in Caucasians .this finding appear to bear credence to existing opinion by Chauhan et al that splenic recession rather than Splenomegaly is prevalent in adults living in endemic falciparum zones.

study done by Marwa Aggbash to measure the normal spleen dimensions in adult Sudanese, and to correlate these dimensions with the variables of age, gender, height, weight and body mass index,. The spleen dimensions were

measured by centimeter. A number of 60 subjects were scanned (29 male, 31female)The findings included that the mean value of Spleen length, width, Thickness were 10.3 ± 1.2 , 3.3 ± 0.4 , 3.9 ± 0.6 for male and 9.2 ± 0.9 , 3.1 ± 0.3 , 3.6 ± 0.6 for female, the spleen volume 73.3 ± 23.1 for male and $56.5\pm 18.0\text{cm}^3$ for female. There were statistically significant differences between male and female in length, width and volume, and non-significant differences between male and female in depth .The means of length, depth, width and volume were, 10.2955, 9.2194, 3.8793, 3.5755, 3.28, 3.06, 7.32573, 5.65242 respectively for Male and Female, with corresponding significance values of t-tests 0.000 , 0.053 , 0.022 , 0.003.It was found that there is significant correlation between spleen length, height, weight and non-significant correlation with body mass index ,sig values were 0.003 ,025 and 0.418 respectively, there was non-significant correlation between spleen width and height ,weight and BMI. Also there was significant correlation between spleen depth and height and non-significant correlation with weight and BMI, Furthermore there were significant correlation between spleen volume and height and non-significant correlation with weight and BMI, the sig values were 0.001and 0.141, 0.653 respectively. (Marwa, 2016)

Another analytical study aimed to assess the spleen volume in western region of UAE using ultrasound measurement in order to provide the reference marker of its volume. A 50 patients (50 men; mean age, 35years [range, 20-57years]; mean body-surface area, 1.8 m² [range 1.27-2.25m²], and patient demographic data was measured for all study population which include (Height, Weight, BAS, and BMI) having mean 169.5 ± 7.6 , 73.1 ± 11.4 , 1.8 ± 0.196 and 25.39 ± 3.036 , respectively, the result showed that the mean \pm SD of the spleen volume equal to 162.2 ± 30.5 . Directly proportional to the BSA, BMI, and patient weight. (yousef,2017)

Chapter three
Material and Method

Chapter three

Material and Method

3.1 Materials

3.1.1 Subjects: This study was conducted at clinic of ultrasound, Alfao, Algardarif state during the period from June to October 2018 Fifty adult patients (20) male and (30) female age range (20-70) years were enrolled in the study; healthy volunteer persons who referred to ultrasound department for abdomen ultrasound were included. Any person suspected with abnormal splenic measurement by ultrasound examination were excluded

3.1.2 Machine used

Sonoscape A6 with curvilinear transducer 3.5MHZ

3.2 Method

3.2.1 Technique used:

The measurement of the spleen made during deep inspiration with patient in right lateral decubitus, scanning obtained in the left coronal plane for long axis scan and by turning the transducer ninety degrees for a short axis scan.

The measurement is length: by measuring the longest dimension in a sagittal, parasagittal or coronal plane. Thickness, on a transverse scan the hilar thickness is measured from the hilum perpendicular to the medial concave surface and the lateral convex surface, width: on a transverse scan the width is measured as the greatest dimension perpendicular to the thickness, The splenic volume (SV) was calculated manually by using the standard clinical prolate ellipsoid equation for spleen [$0.524 \times \text{splenic index (length} \times \text{width} \times \text{thickness)}$].

3.2.2 Data collection

Data were collected with special data collection sheet encompass patient demographic data and ultrasound findings.

3.2.3 Data analysis

Data were analyzed using SPSS statistical program for significance of tests.

3.2.4 Ethical issue

- Permission from ultrasound department was obtained.
- No patient identification data or detail published.
- Safe uses of ultrasound.

Chapter Four

Results

Chapter Four

Results

The following tables presented the data obtained from 50 patients who were examined using ultrasonography. The spleen length, width , thickness and volume were measured. Patient's age, weight, height and body mass index (BMI) were also measured.

Table (4.1) frequency distribution of gender

Gender	Frequency	Percent	Valid Percent
Female	30	60.0	60.0
Male	20	40.0	40.0
Total	50	100.0	100.0

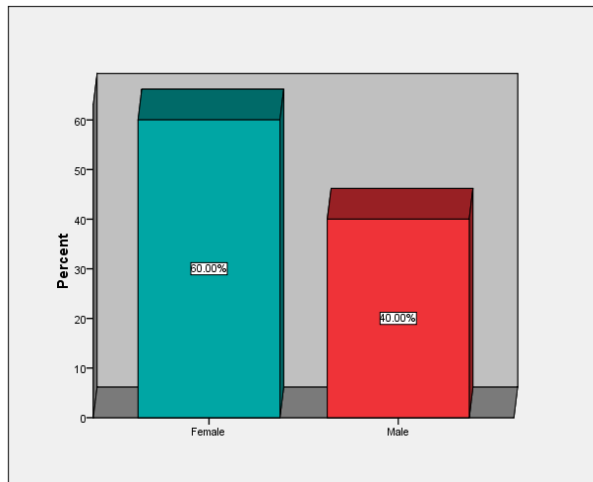


Figure (4.1) frequency distribution of gender

Table (4.2) frequency distribution of age \years

Age\years	Frequency	Percent	Valid Percent
20-30	25	50.0	50.0
31-41	6	12.0	12.0
42-52	12	24.0	24.0
53-63	1	2.0	2.0
64-70	6	12.0	12.0
Total	50	100.0	100.0

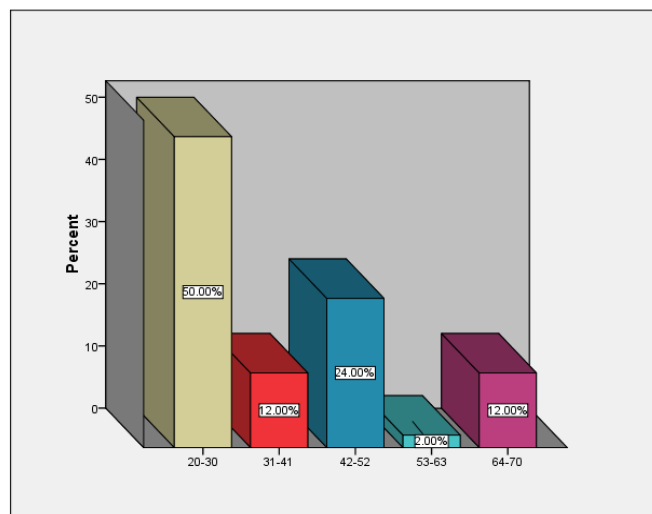


Figure (4.2) frequency distribution of age \years

Table (4.3) Descriptive statistic age, height, weight, BMI and splenic measurements

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	20	70	37.80	14.898
Height	50	154	190	168.24	8.828
Weight	50	45	85	60.88	11.048
BMI	50	16.0	27.8	21.352	2.6414
Spleen length	50	6.9	12.5	8.976	1.1422
Spleen width	50	3.00	5.50	3.9140	.65652
Spleen thickness	50	2.30	5.40	3.7300	.76030
Spleen volume	50	30.80	173.50	71.3880	31.04591
Valid N (listwise)	50				

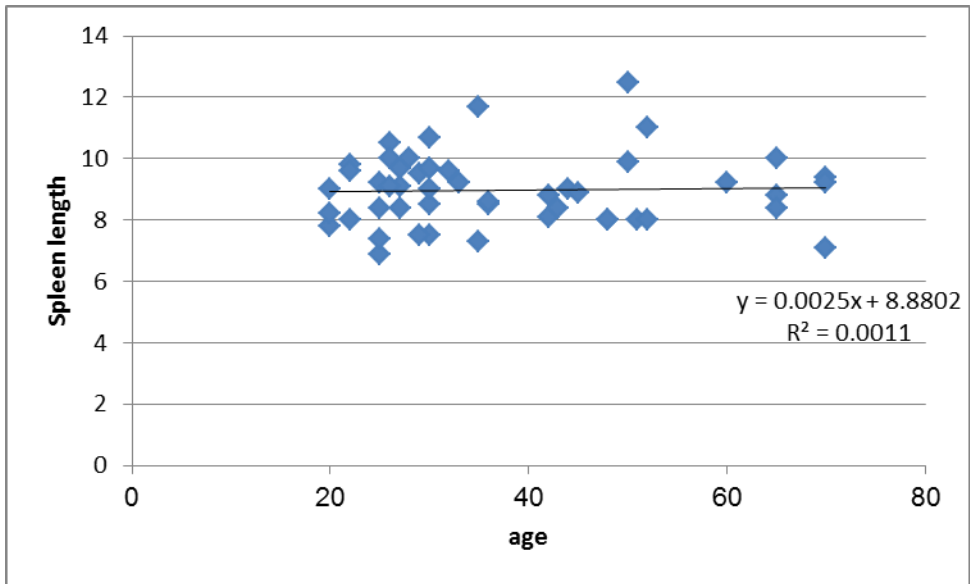


Figure (4.3) scatterplot shows relationship between spleen length and age

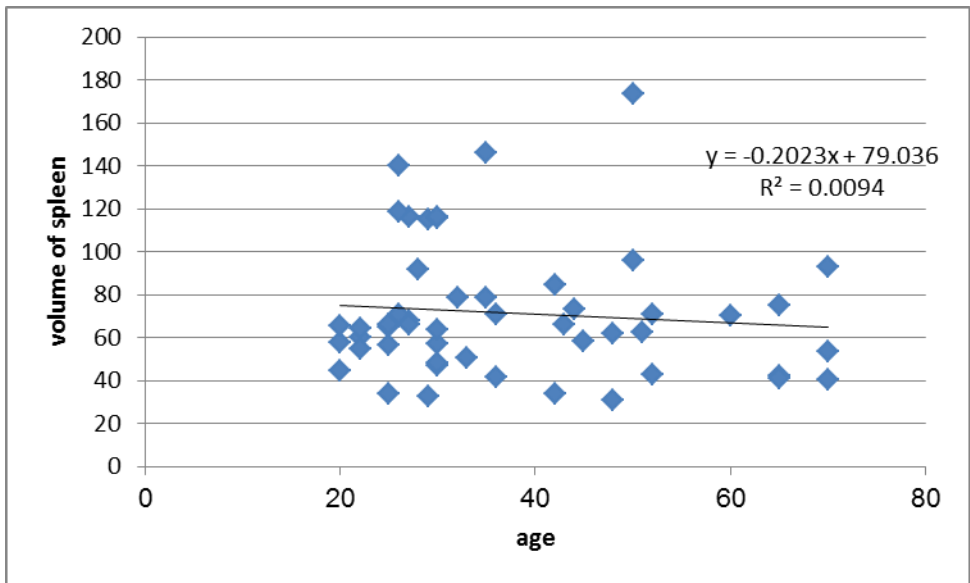


Figure (4.4) scatter plot shows relationship between spleen volume and age

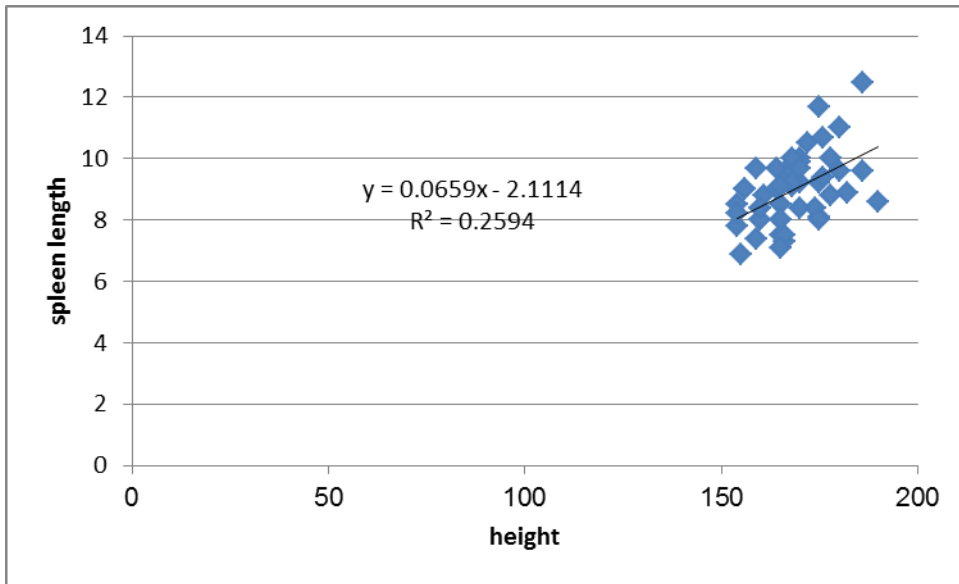


Figure (4.5) scatterplot shows relationship between spleen length and height

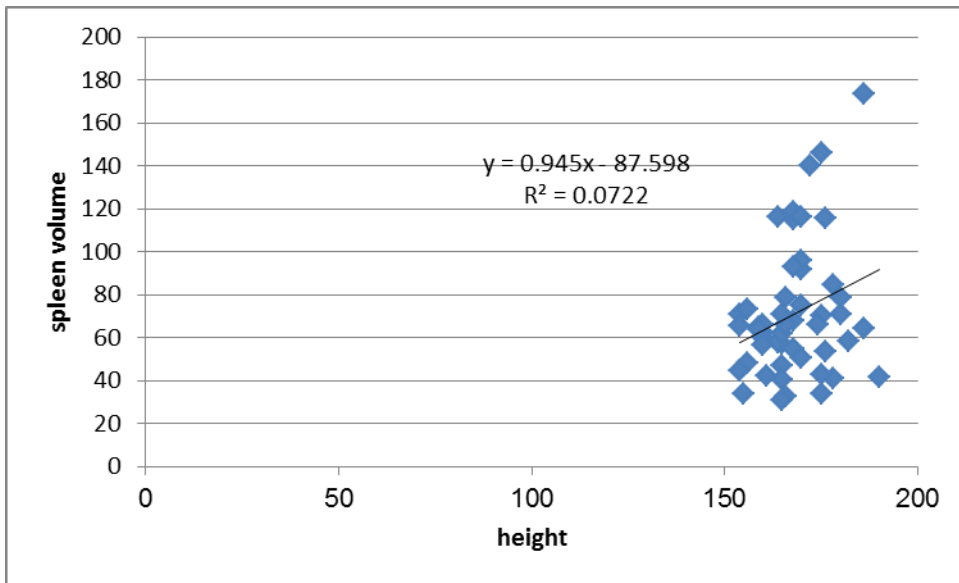


Figure (4.6) scatterplot shows relationship between spleen volume and height

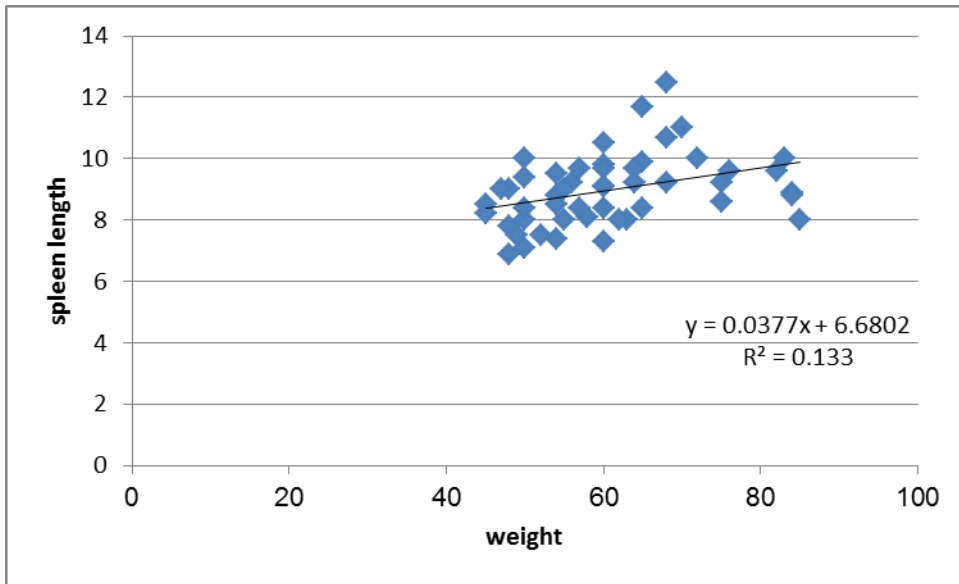


Figure (4.7) scatterplot shows relationship between spleen length and weight

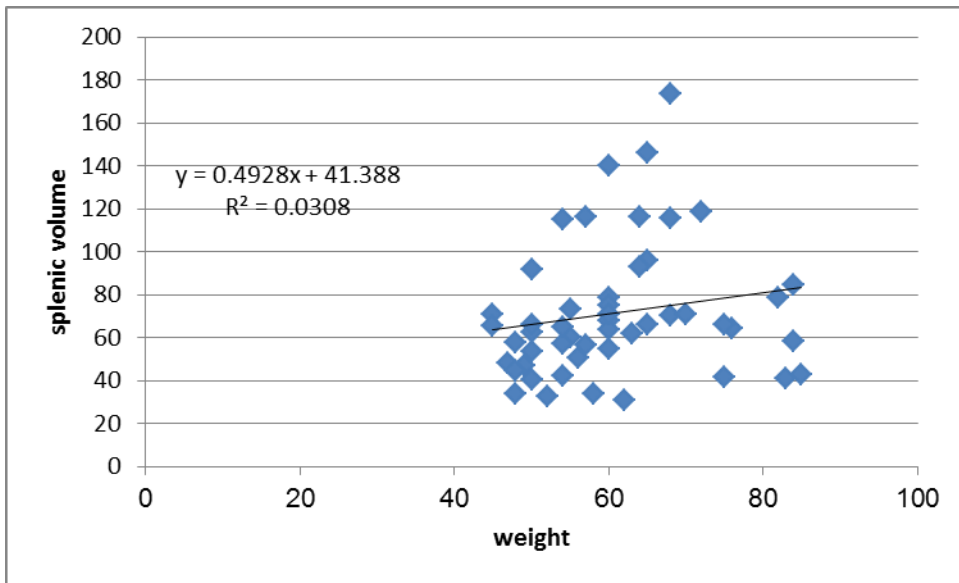


Figure (4.8) scatterplot shows relationship between spleen volume and weight

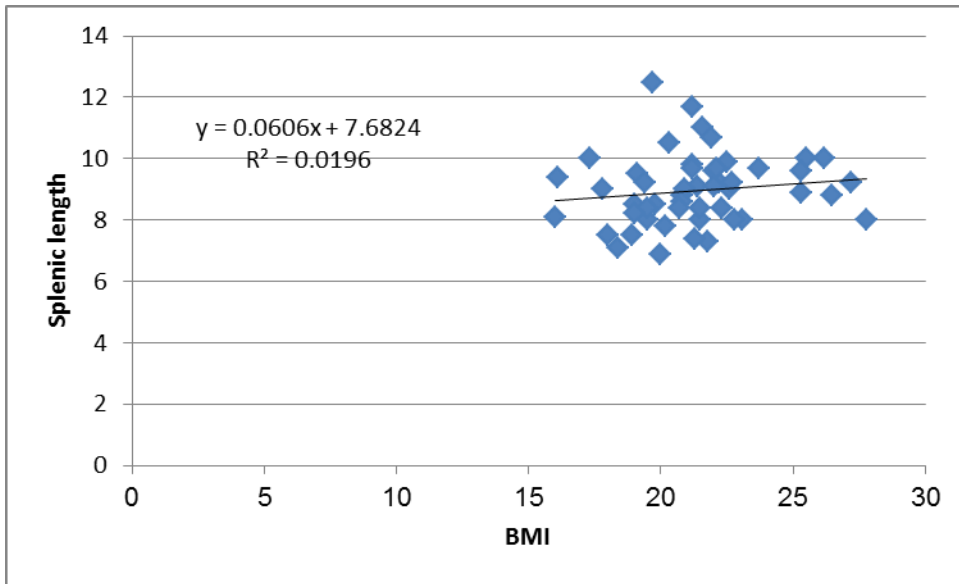


Figure (4.9) scatterplot shows relationship between spleen length and BMI

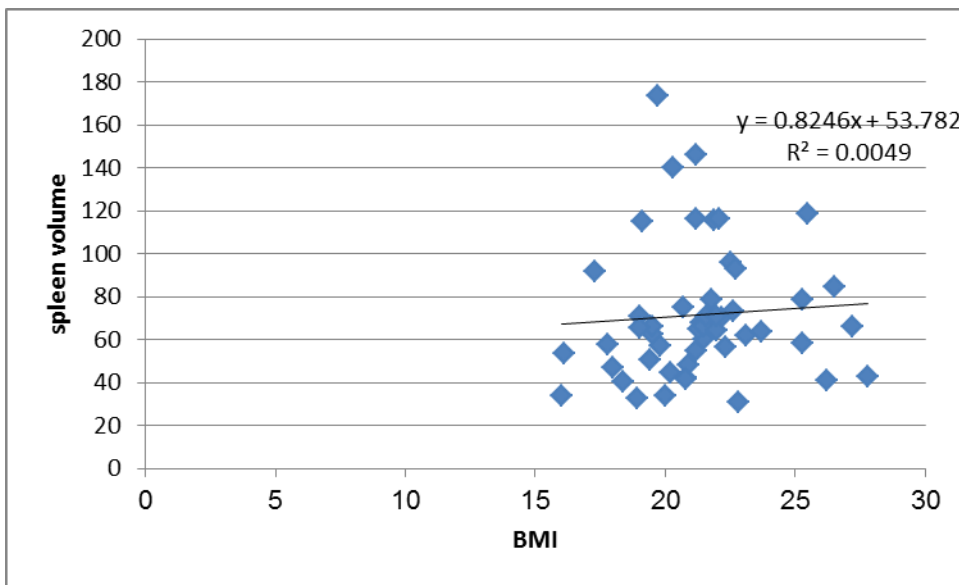


Figure (4.10) scatterplot shows relationship between spleen volume and BMI

Table (4.4) correlation between age, height, weight, BMI and splenic measurements

		Spleen length	Spleen width	Spleen thickness	Spleen volume
Age \years	Pearson Correlation	.033	-.082	-.174	-.097
	Sig. (2-tailed)	.820	.571	.226	.502
	N	50	50	50	50
Height \cm	Pearson Correlation	.509**	.131	.060	.269
	Sig. (2-tailed)	.000	.365	.677	.059
	N	50	50	50	50
Weight\ kg	Pearson Correlation	.365**	.088	.063	.175
	Sig. (2-tailed)	.009	.542	.664	.223
	N	50	50	50	50
BMI	Pearson Correlation	.140	.051	.081	.070
	Sig. (2-tailed)	.332	.724	.578	.628
	N	50	50	50	50
** correlation is significant at the 0.01 (two –tailed)					

Table (4.5) Compare mean age group and splenic measurements

Age \years		Spleen length	Spleen width	Spleen thickness	Spleen volume
20-30	Mean	8.928	3.9280	3.8520	73.372
	Std. Deviation	1.0269	.67424	.72118	29.6970
31-41	Mean	9.150	4.1500	3.7667	77.683
	Std. Deviation	1.4734	.62530	.92232	36.7183
42-52	Mean	9.050	3.8667	3.6750	71.192
	Std. Deviation	1.4222	.73896	.77826	37.4616
53-63	Mean	9.200	4.4000	3.3000	70.000
64-70	Mean	8.817	3.6333	3.3667	57.450
	Std. Deviation	1.0008	.48442	.84063	21.8190
Total	Mean	8.976	3.9140	3.7300	71.388
	Std. Deviation	1.1422	.65652	.76030	31.0459
p value >0.05					

Table (4.6) Independent sample t- test to compare means of splenic measurement with different gender

a. Means

	Gender	Mean	Std. Deviation	Std. Error Mean
Spleen length	Female	8.583	1.0713	.1956
	Male	9.565	1.0022	.2241
Spleen width	Female	3.8733	.66433	.12129
	Male	3.9750	.65685	.14688
Spleen thickness	Female	3.6333	.76759	.14014
	Male	3.8750	.74472	.16652
Spleen volume	Female	65.777	29.4142	5.3703
	Male	79.805	32.2625	7.2141

b. t-test

	t-test for Equality of Means				
	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Spleen length	-3.256	48	.002	-.9817	.3015
	-3.300	42.726	.002	-.9817	.2975
Spleen width	-.533	48	.597	-.10167	.19092
	-.534	41.197	.596	-.10167	.19048
Spleen thickness	-1.104	48	.275	-.24167	.21899
	-1.110	41.730	.273	-.24167	.21765
Spleen volume	-1.589	48	.119	-14.0283	8.8258
	-1.560	38.206	.127	-14.0283	8.9935

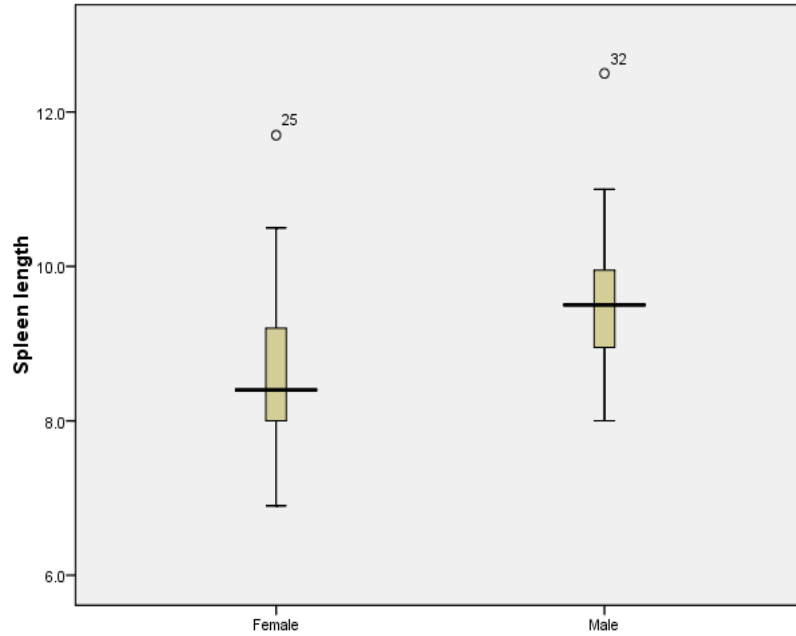


Figure (4.11) plot box shows mean spleen length in different gender

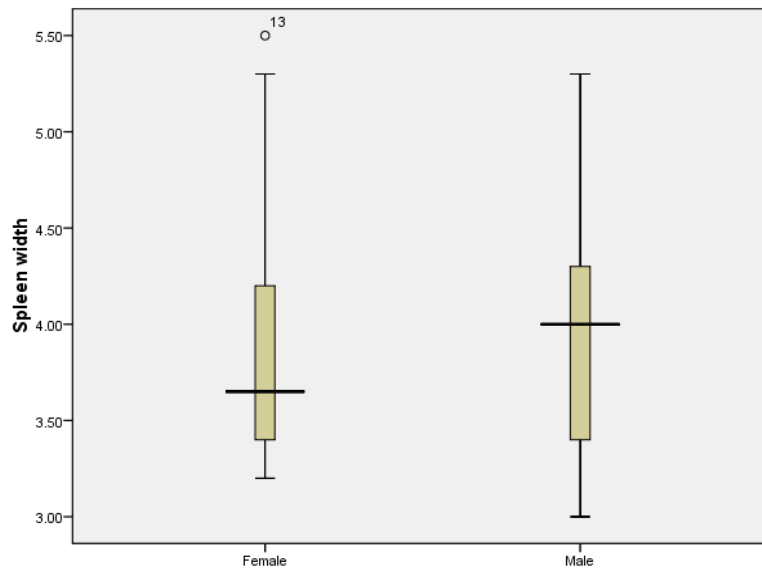


Figure (4.12) plot box shows mean spleen width in different gender

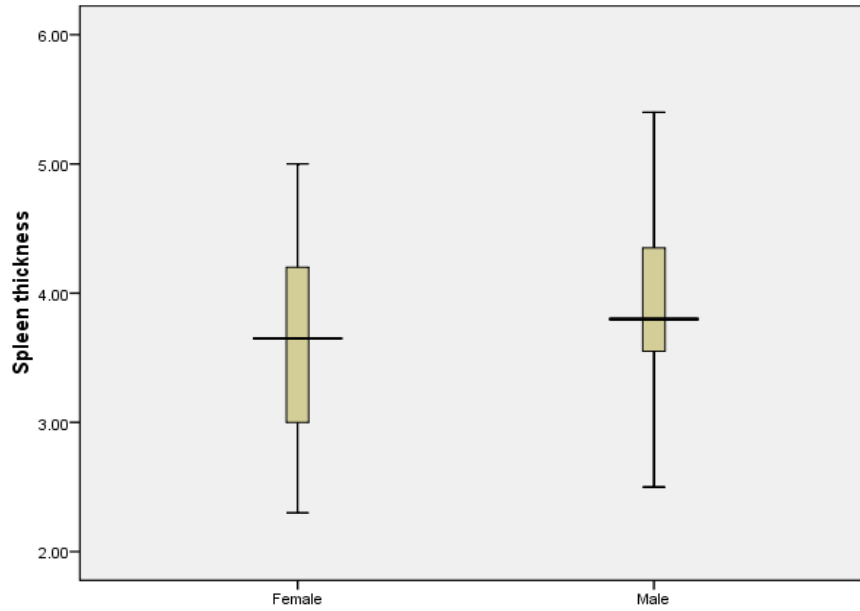


Figure (4.13) plot box shows mean spleen thickness in different gender

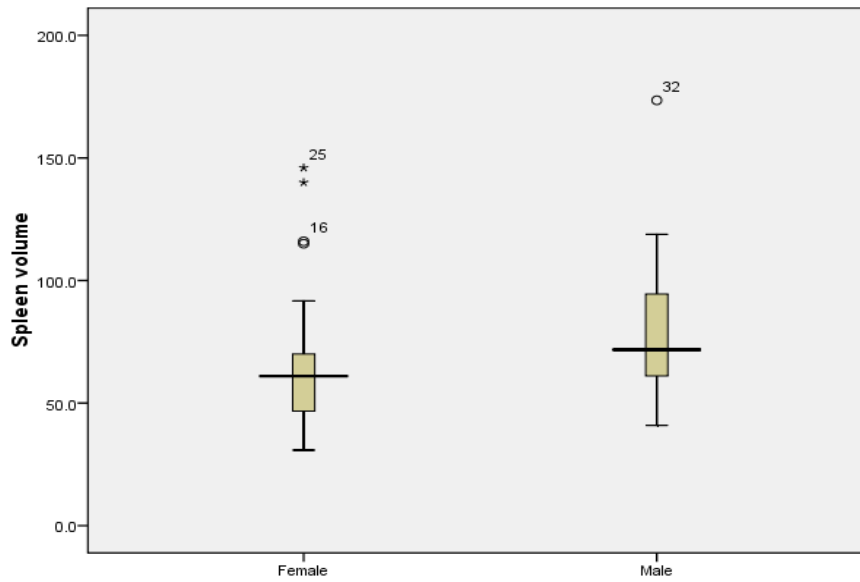


Figure (4.14) plot box shows mean spleen volume in different gender

Chapter five

Discussion, conclusion and Recommendations

Chapter Five

Discussion, conclusion and Recommendation

5.1. Discussion:

In this study 50 subjects from (20-70 years). male 20 (40%) and female 30 (60%) were examined using ultrasound, the mean values for body characteristics age, height, weight and BMI are 37.80 ± 14.8 years, 168.2 ± 8.8 cm, 60.8 ± 11.04 kg, 21.3 ± 2.6 kg/m². I found that the mean values of SL, SW, ST are 8.976 ± 1.1 cm, 3.9 ± 0.6 cm, 3.73 ± 0.7 cm. Splenic volume is 71.38 ± 31.04 cm³ table (4-3). This dimension is smaller than previous studies (Narora et al. 2010, Mayahuza et al. 2016, Hosey, 2006) these discrepancies could be a result of such factors like race, genetic variables, nutritional status, and demographic variables.

The study found that there is a positive significant correlation between spleen length with height and weight and non-significant correlation with body mass index, sig values were 0.000, 0.009 and 0.332 respectively table (4-4). Agreement with (Mayahuza et al. 2016)

This study showed that there was non-significant correlation between spleen width with height, weight and BMI the sig values were 0.365, 0.542 and 0.724 respectively table (4-4) Agreement with study done by (Marwa Aggbash. 2016).

The study showed that there was non-significant correlation between spleen depth with height, weight and BMI, the significant values were 0.677, 0.664 and 0.578 respectively table (4-4). Miss match with Marwa Aggbash (2016) due to different body habitus.

Furthermore there were significant correlation between spleen volume and height and non-significant correlation with weight and BMI, the sig values were

0.059 and 0.223, 0.628 respectively table (4-4) match with study done by (Marwa Aggbash. 2016, yousef .2017)

The study showed moderate positive relation between spleen length and height ($R=0.25$) Figure (4.5) follow by weight ($R=0.133$) Figure (4.7) and poor relation with BMI and age.

The study found that there were statistically significant differences between males and females in (length) and non-significant differences between male and female in (depth, width and volume) the means of (length, depth, width and volume) are, (9.565, 8.583), (3.8750, 3.6333), (3.9750, 3.6333), (79.805, 65.777) for Male and Female respectively, with corresponding significance values of t-tests (0.002, 0.273, 0.596, .127) table (4-6) which implies that the men had larger spleen than female in relation of spleen to gender, this match with (Narora et al.2010, Mayahuza et al.2016, Hosey, 2006 Marwa Aggbash 2016)

The study showed that in relation of spleen to age, the age groups were relatively the same in (length, depth, width and volume), The Sig. values are 0.820, 0.226, 0.571 and 0.502 for (length, depth, width and volume) table (4.4). which indicates there is no differences in means this mismatch the previous study (Celiktas.m et al.2015, Narora et al.2010), due to small sample size in this study

5.2. Conclusion:

The study concluded that The Sudanese spleen dimensions are greater in male than female its same as Turkish, north Indian and Americans adults but they were different in correlation to age, they were decreased with increase in age and no significant correlation in Sudanese with age The spleen dimensions were significantly correlates with subject height and weight, BMI. Spleen Length significantly correlates with subject height and weight and non-significant correlation with body mass index, while the Volume just significantly correlates with subject height and non-significant correlation with weight and BMI.

5.3. Recommendations:

- The operator should update their knowledge about technique used and any information regarding ultrasound measurements.
- Using of other imaging modalities like computed tomography and magnetic resonance imaging is recommended to confirm the results.
- More study and researches are needed with spleen texture, position in consideration for more reliable result.
- More study and researches are needed using Doppler for blood perfusion and its relation with spleen size to obtain accurate results.
- In the Sudan there are different types of races, and this may affect different organs measurements, there for further studies should be done for these variables including different areas and tribes in the Sudan,
- Further study in measurement of spleen dimension and spleen volume with larger sample of Sudanese population for more accurate results is needed.

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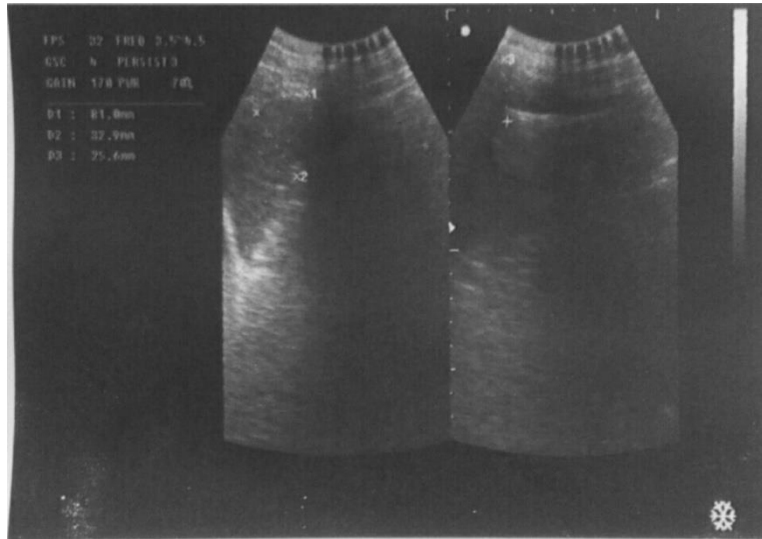
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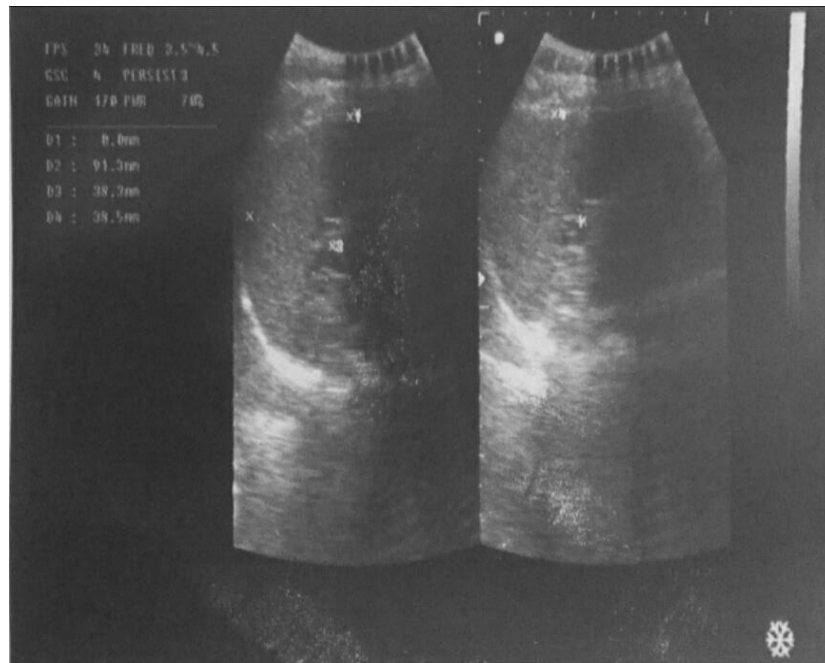
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Appendices

Appendix B:



Image(1) sagital and transvers u/s image of spleen for female the weight was58 kg,height 175cm,age 42years.The spleen measurements were (length=8.1cm,width=3.2cm Thickness=2.5cm,volume=33.9cm³



Image(2) sagital and transvers u/s image of spleen for female the weight was60 kg,height 168cm,age 27years.The spleen measurements were (length=9.1cm,width=3.8cm Thickness=3.8cm,volume=68cm³

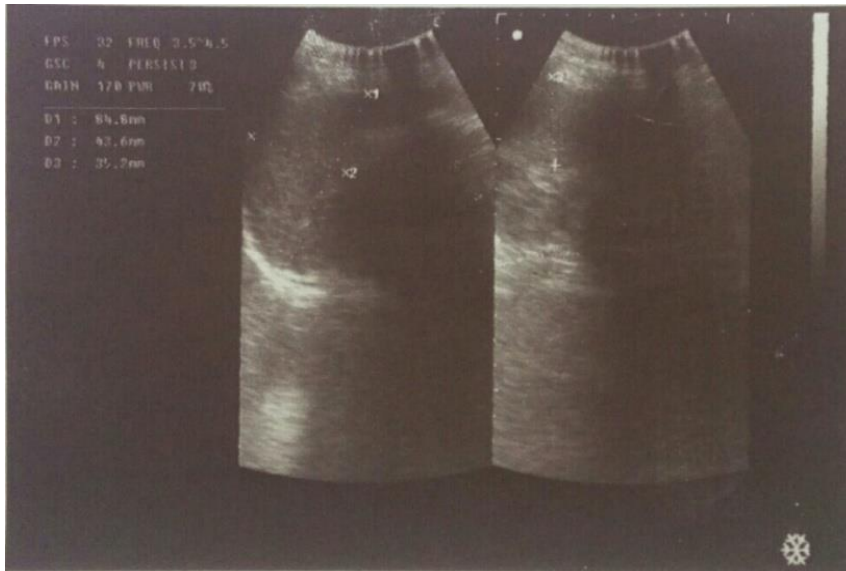


Image (3) sagittal and transvers u/s image of spleen for female the weight was 65 kg ,height 174cm,age 27years .The spleen measurements were (length=8.4cm,width=4.3cmThikness=3.5cm,volume=66.2cm³)

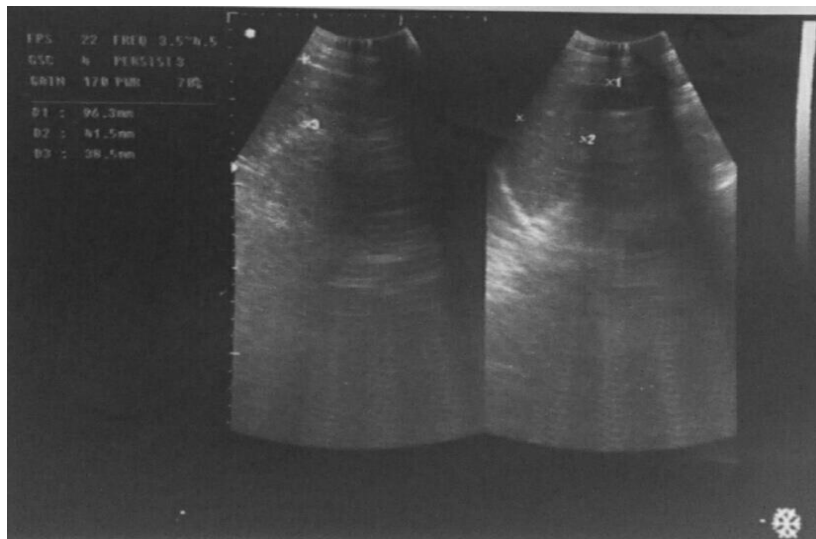
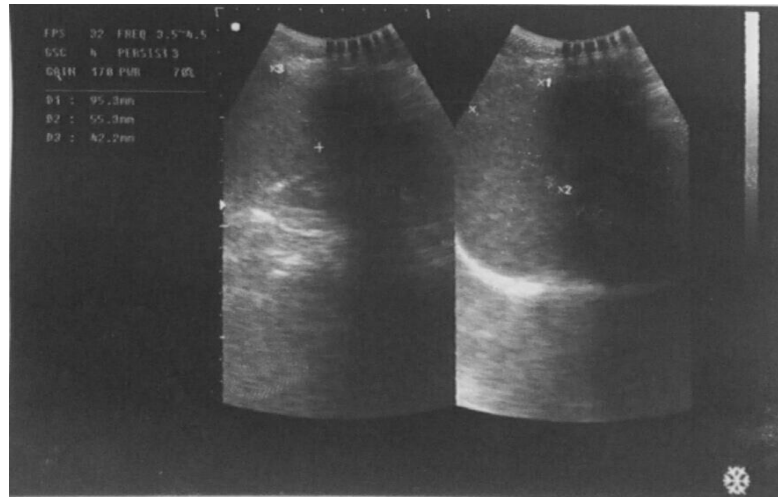
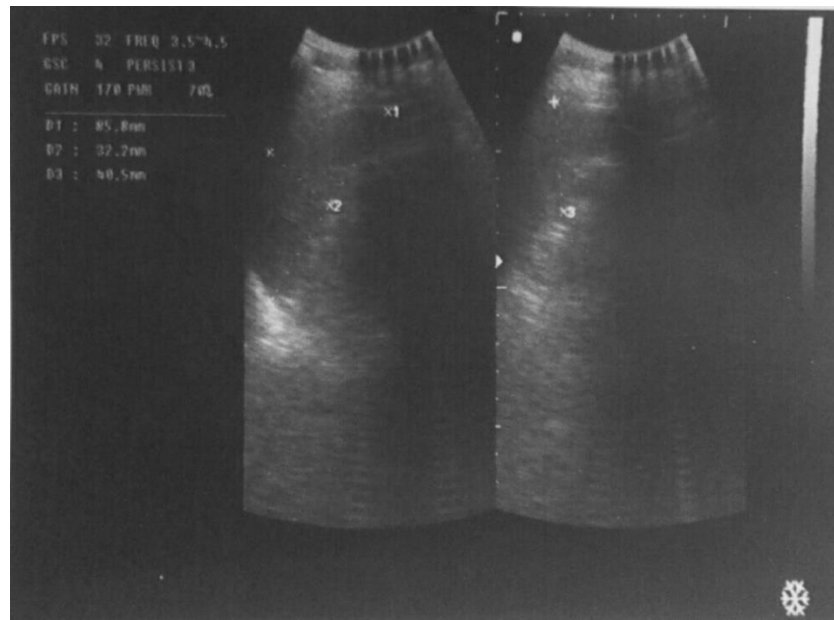


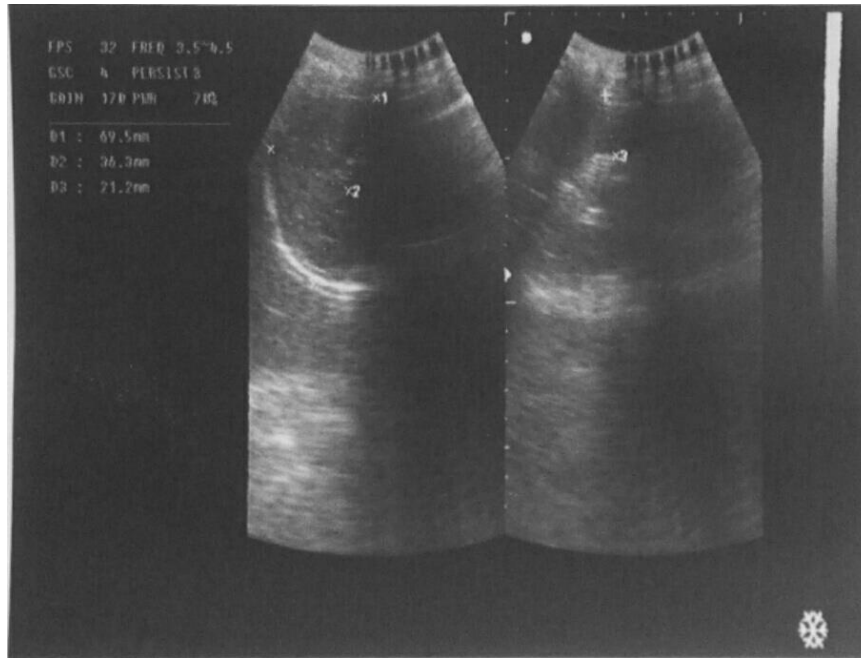
Image (4) sagittal and transvers u/s image of spleen for male the weight was 82kg,height180cm,age 32years.The spleen measurements were (length=9.6cm,width=4.1Thikness=3.8,volume=78.4cm³)



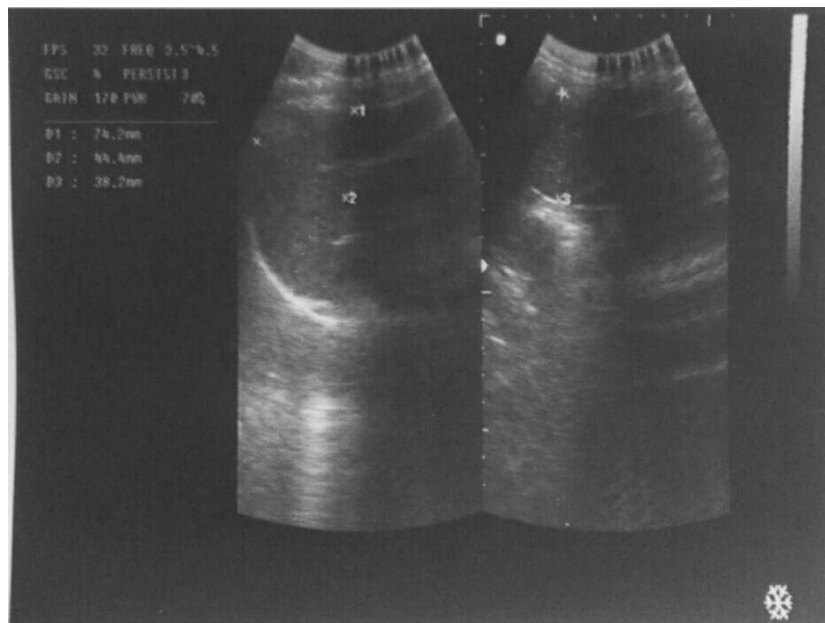
Image(5) sagittal and transvers u/s image of spleen for female the weight was54 kg,height 168cm,age 29years.The spleen measurements were (length=9.5cm,width=5.5cm Thickness=4.2cm,volume=115cm³



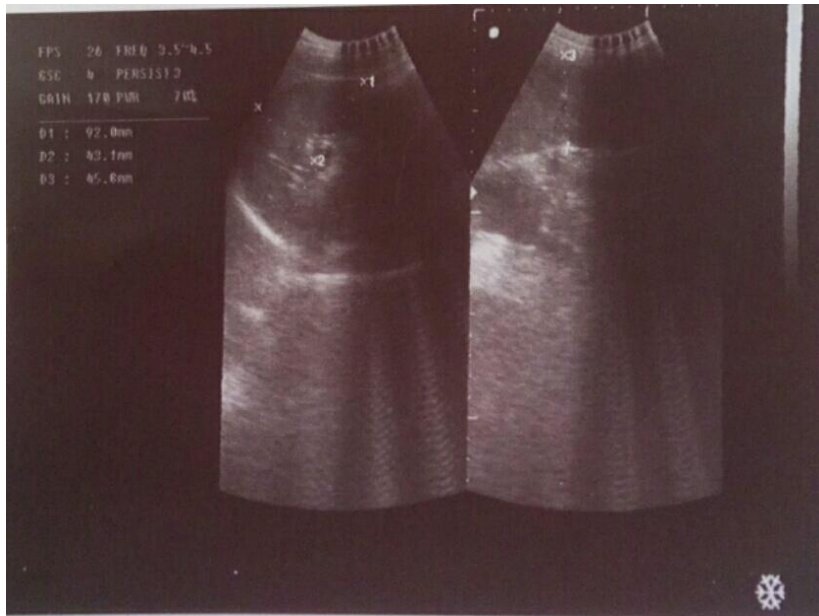
Image(6) sagittal and transvers u/s image of spleen for female the weight was54 kg,height 165cm,age30years.The spleen measurements were (length=8.5cm,width=3.2cmThickness=4cm,volume=57cm³



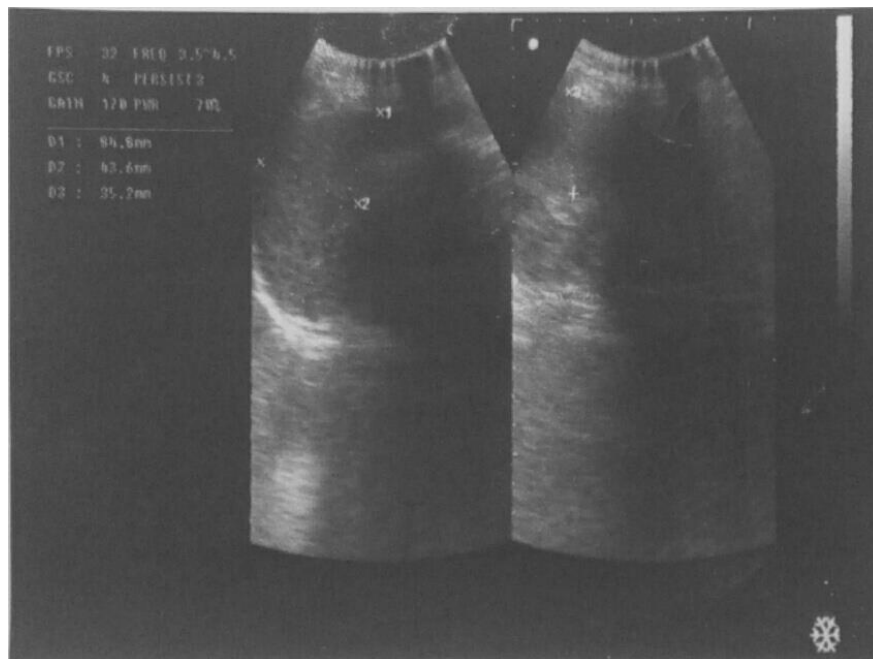
Image(7) sagital and transvers u/s image of spleen for female the weight was48 kg,height 155cm,age 25years.The spleen measurements were (length=6.9 cm,width=3.6cm Thickness=2.6cm,volume=33.8cm³



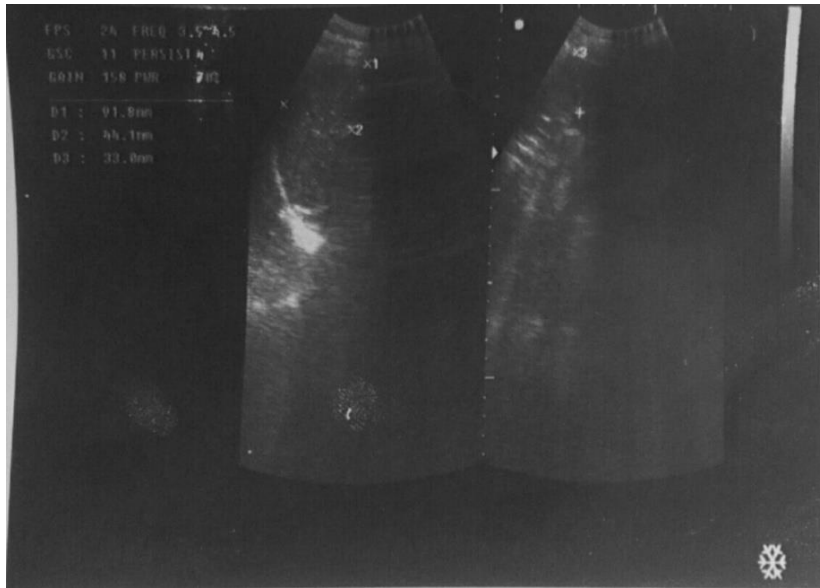
Image(8) sagital and transvers u/s image of spleen for female the weight was54 kg,height 159cm,age 25years.The spleen measurements were (length=7.4 cm,width=4.4cm Thickness=3.8cm,volume=64.8cm³



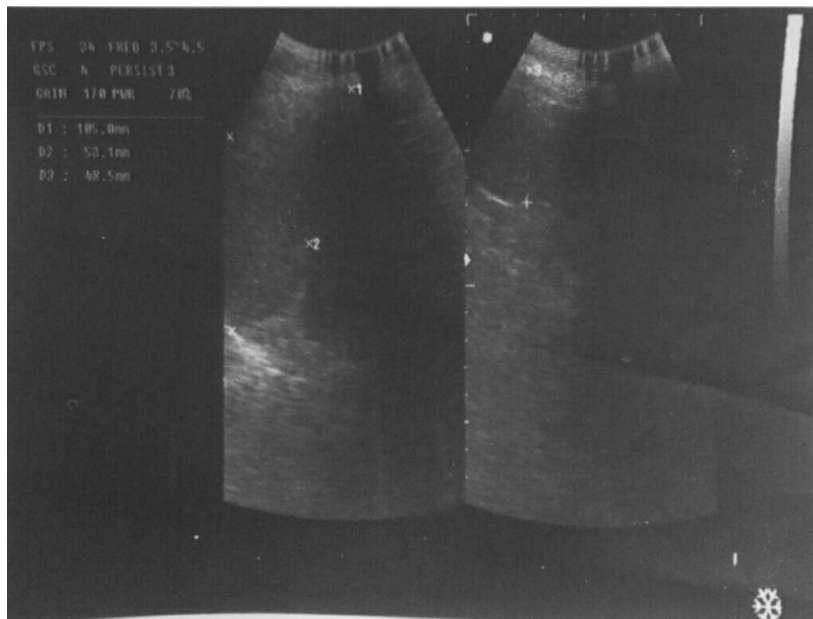
Image(9) sagittal and transvers u/s image of spleen for male the weight was64 kg,height 168cm,age 70years.The spleen measurements were (length=9.2 cm,width=4.3cm Thickness=4.5cm,volume=93cm³)



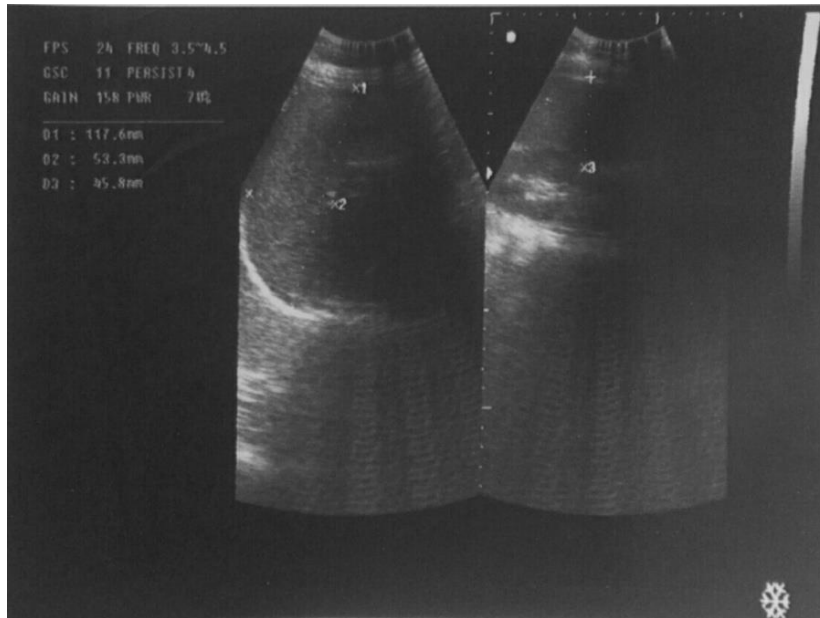
Image(10) sagittal and transvers u/s image of spleen formale the weight was65 kg,height 174cm,age 27years.The spleen measurements were (length=8.4 cm,width=4.3cm Thickness=3.5cm,volume=66.2cm³)



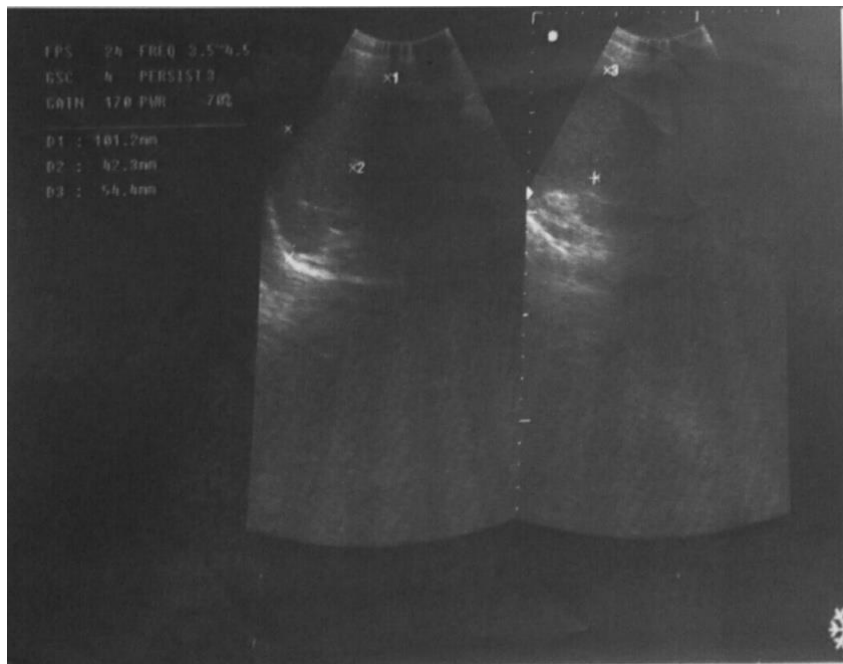
Image(11) sagittal and transvers u/s image of spleen for female the weight was68kg,height 175cm,age 60years.The spleen measurements were (length=9.1 cm,width=4.4cm Thickness=3.3cm,volume=70cm³)



Image(12) sagittal and transvers u/s image of spleen for female the weight was60kg,height162cm,age 26years.The spleen measurements were (length=10.5cm,width=5.3 cm Thickness=4.8cm,volume=140).



Image(13) sagital and transvers u/s image of spleen for female the weight was65kg,height 175cm,age 35years.The spleen measurements were (length=11.7cm,width=5.3cmThickness=4.5cm,volume=146cm³)



Image(14) sagital and transvers u/s image of spleen for male the weight was50kg,height 176cm,age 70years.The spleen measurements were (length=9.4cm,width=3.4 cm Thickness=3.2cm,volume=53.5cm³)

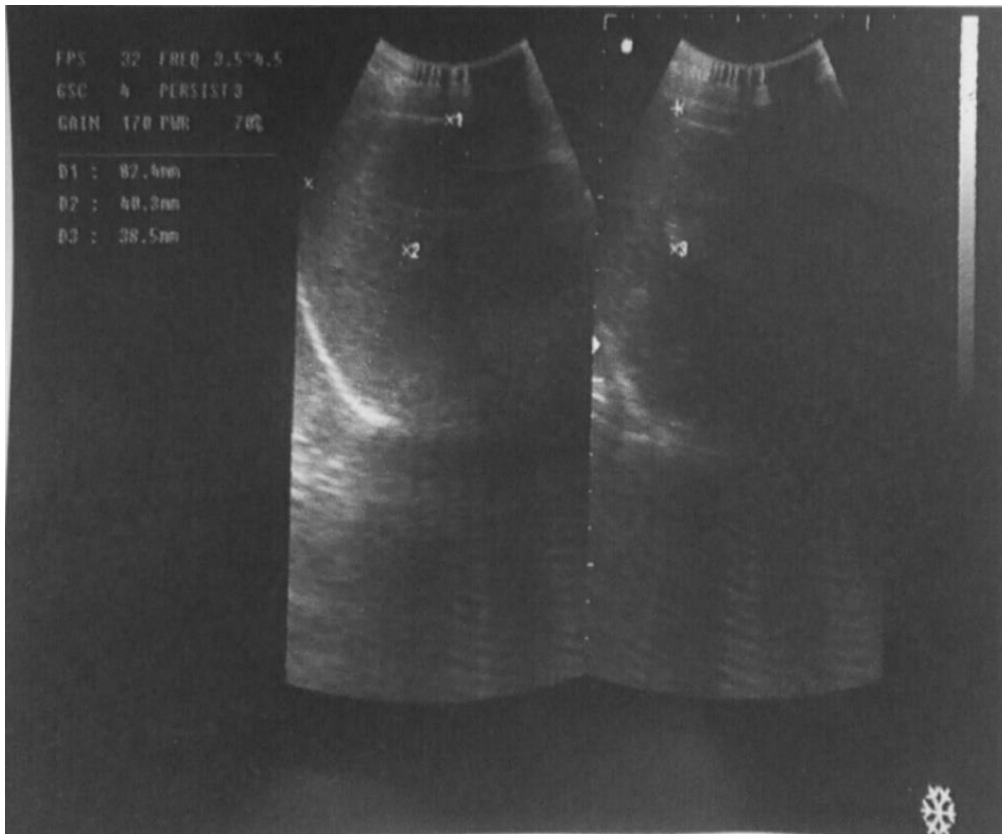


Image15) sagital and transvers u/s image of spleen for female the weight was45kg,height 154cm,age 20years.The spleen measurements were (length8.2cm,width=4cm Thickness=3.8cm,volume=65.3cm³