Chapter One

Introduction

1.1 Introduction

Spleen the spleen is the largest organ in reticulo endothelial system , the spleen is situated for the most part in the left hypochondrial region of the abdomen. the postereior edge of extended in to the epigasteric region .it lies between the fudus of the stomach and the diaphragm in the the line of the tenth rib.

Splenic artery is large branch of celiac trunk.its tortuous vessel that passes to the the left horizontally behind the stomach and the lasser sac along the superior border of the pancreas it crosses anterior to the left suprarenal gland and upper part of the left kidneys near the spleen it divided to five or more branches which inter the hilum of the spleen .the splenic vein is less tortuous than the splenic artery which begin as served tributaries from the the hilum of spleen .(Ashwin -2011)

US give good information on the shape and size of the spleen and on any pathological changes that may be present either hypo or hyper echogenicity .

The best images of the spleen are obtained by CT ,which also give information on any calcification present e.g.in granulomas or cyst walls and allowed precise measurement of splenic size . Pathological changes are seen as on US but often with greater clarity ,especially after IV contrast infusion.

On MRI diffuse infiltrated such as occur ,for instance , in lymphoma ,may be seen more cleary than US and CT ,but essentially MRI and CT have equal value .

Localized changes, such as tumors can be shown by radionuclide imaging ,though the specificity and spatial resolution of the technique are inferior to US and CT.Images of the splenic functions may obtain with autologous radio labelled blood cells.

Angiography is not used for diagnostic purposes (except on acute bleeding)but may be used as a step in embolising the spleen or spleen artery in the treatment of hypersplenism ,trauma or aneurysm .(David Standerskjold –Nordenstam 2008) .

1-2 problem

The variation in the anthropometric feature of various population races and regions of the zone and socioeconomic status of the sudan make the population of this region was ignored (there is no previous studies) . so there is no comprehensive anthropometric

study on normal measurement of spleen and there fore it was thought pertinent to under take present study to evaluate the spleen measurements in different Sudanese tribes .

The size of spleen in Sudanese population compared to international index and since the organ measurement usually affected by the body characteristic this might lead to wrong diagnosis therefore is need to compare this measurement to the body characteristic and hence we can have our own index.

1.3Objectives

General objective of this study is to evaluate normal spleen measurement in different Sudanese tribes using CT in order to find new index for Sudanese

Specific objectives are

- To measure spleen (length, width and CT number).
- To correlate spleen measurement (age, weight).
- To compare the spleen measurement in different Sudanese tribes.
- To study the variable between normal and diseased subjects.

1.4 Significance of study

This study provides good information about Sudanese tribes splenic measurement and hence it can be used as a guide line to proper Sudanese index

1.5 Overview of study

This study will consist of five chapters chapter one deal with the introduction chapter two include literatures review chapter three detailed the materials and methods then chapter four presents the results and chapter five presents the discussion conclusion and recommendations.

Chapter Two

Literatures review

2.1 Anatomy

The spleen has 2 ends, 3 borders, and 2 surfaces, as follows:

The 2 ends: The anterior end of the spleen is expanded and more like a border: it is directed forward and downward to reach the maxillary line. The posterior end is rounded: it is directed upward and backward and rests on the upper pole of the left kidney, {Ashwin pai 2011}

The 2 surfaces: diaphragmatic and visceral.

The diaphragmatic surface (facies diaphragmatica : external or phrenic surface) which is convex , smooth , and is directed slightly medialward . It is in relation with the under surface of the diaphragm, which separates it from the ninth, and eleventh ribs of the left side, and the intervening lower border of the left lung and pleura . {Ashwin pai 2011}

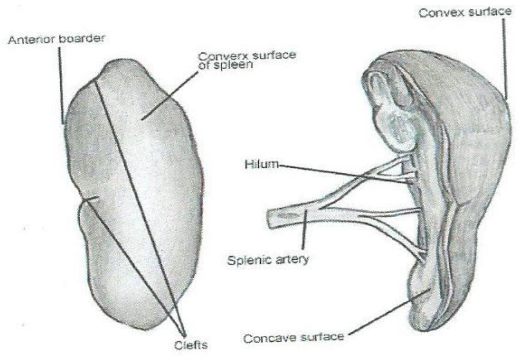


Figure 2.1 the surfaces and the splenic notches. [Ashwin pai 2011]

is divided by a ridge into an anterior or gastric and posterior renal or renal portion

Figure 2.2 The visceral surface of the spleen [Ashwin pai 2011]

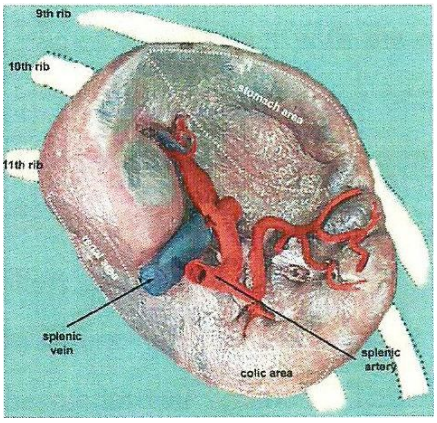


Figure 2.3 the garstric surface of the spleen . { Ashwin pai 2011}

The gastric surface (facies gastrica) , which is directed forward , upward , and medialward , is broad this with the posterior wall of the stomach : and below the tail of the pancreas . Near its medial border presented a long fissure termed the hilum . This is pierced by several irregular apertures for the entrance and exit of vessels and nerves [Lewis 1918]

The renal surface (facies renalis) is directed medialward and It is somewhat flattened , is considerably narrower then gastric surface , and is in relation with the upper of the anterior surface of the left kidney and occasionally with the left suprarenal gland , { gery,s anatomy – yahoo Education } .

The 3 borders : The anterior border (margo anterior) is free , sharp, and thin , and is often notched, especially below ; it separates the diaphragmatic form the gastric surface .

The posterior border (margo posterior), more rounded and blunter than the anterior , separates the renal form the diaphragmatic surface ; it corresponds to the lower border of eleventh rib and lies between the diaphragm and left kidney .

The inferior border (internal border) separates the diaphragmatic from the colic surface {Lewis 1918 }

2.1.1 The Peritoneal relations

The spleen is almost entirely surrounded by peritoneum , which is firmly adherent to its capsule . It is position by two folds of membrane . One, the phrenicolienal lidament , is derived from the peritoneum, where the wall of general peritoneal cavity comes into contact with the omental bursa between the left kidney and the spleen ; the lineal vessels pass between the other fold , the gastrolienal ligament, is also formed of two layers , derived form the general cavity and the omental respectively , where they meet between the spleen and stomach the short gastric and left gastroepiploic branches of the lineal artery run between its two layers. The lower end of the spleen is supported by the phrenicocolicligament . Thesplenornal ligament extent : this ligament extends from the the hilum of the spleen to the anterior surface of the left kidney ; it contains the tail of the pancreas and splenic vessels {Ashwin 2011}

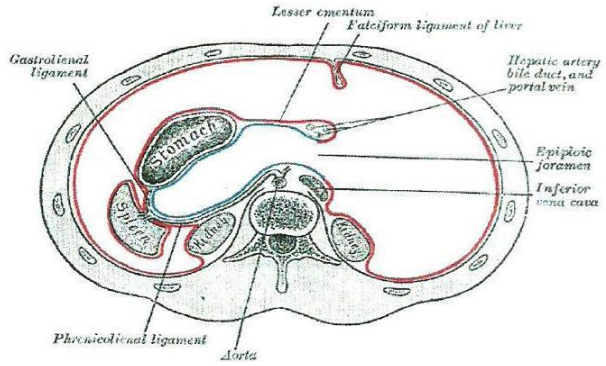


Figure 2.4 Adult spleen and ligamentous attachmentus. { Lewis 1918}

2.1.2 Hilum of the spleen

The hilum lies on the inferomedial part the gastric impression It transmits the splenic vessels and nerves and provides attachment to the gastrosplenic and splenorenoreal (lien renal) ligaments { Ashwin 2011}

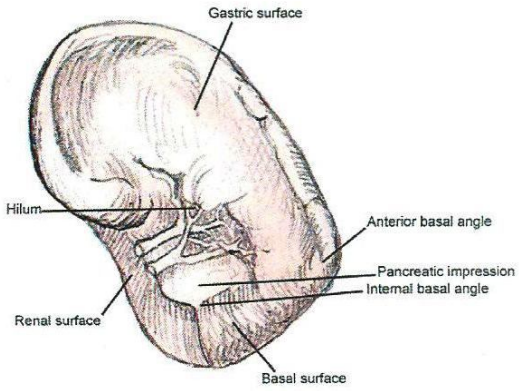


Figure 2.5 spleen showing the different surfaces and impressions caused by different organs withrelation to the hilum of the spleen {Ashwin 2011}

2.1.3 Development of the spleen

The spleen develops in the cephalic part of the dorsal mesogastrium , from its left layer ; during the sixth week of intrauterine life , into a number of nodules that soon fuse to form a lobulated spleen . Notching of the superior border of the adult spleen is the evidence of its multiple origins . {www.Meds cape .com }

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 lift , and comes to lie behind the stomach and in contact with the left kidney .

The part of the dorsal mesogastrium which intervend between the spleen the and the greater curvature of the stomach forms the gastrosplenic ligament . {Lewis 1918}.

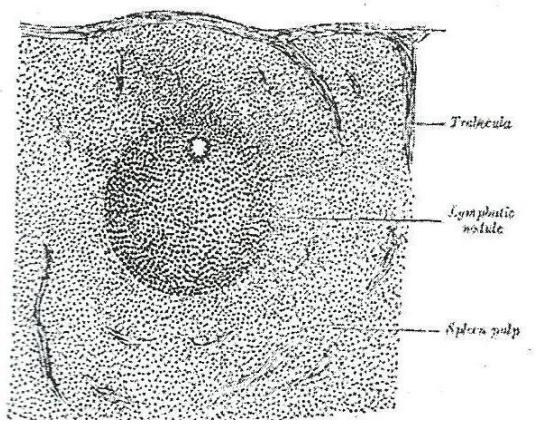


Figure 2.6 shows Transverse section of a portion of the spleen{ Lewis 1918}

The size and weight of the spleen are liable to very extreme variations at different individual, and in the same individual condition. In the adult it is usually about 12 cm. in length, 7cm . in breadth, and 3 or 4 cm . in thickness, and weighs abut 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 much enlarged, weighing occasionally as much as 9 kilos .

Frequently in the neighborhood of the spleen , and especially in the gastrolienal ligament and grater 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 . { Lewis 1918}

2.1.4 Structure of the spleen

The spleen is invaested by two coats : anexternal serus 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 refection of the phrenicolienal and gastrolienal ligaments.

The fibro elastic coat (tunica albuginea) invests the organ, and at the hilum is reflected inward upon the vessels in the form of sheaths , as well as form the inner surface of the fibro elastic coat, numerous amall fibrous bands, trabeculae , are given off in all directions; these uniting , constitute the frame – work of the spleen , The spleen therefore consistits of a number of small spaces or areola , formed by the trabeculae ; in these areola is contained the dplenic pulp…{Lewis 1918}

The fibro elastic 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-striped 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. { Lewis 1918}.

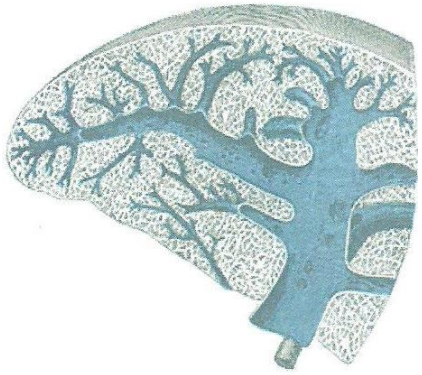


Figure 2.7 Transverse section of the spleen, showing the trabecular tissue and the splenic and its tributarises { Lewis1918} .

The splenic pulp (pulpa liens) 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 to be in larger peoportion than they are capable of ameboid movement, and often contain pigment and red-blood

corpuscles in their interior . the cells of the reticulum each possess around or oval nucleus, and like the splenic cells, they may contaion pigment granules in their cytoplasm; they do not stain deeply with carmine, and in this respect differ from the cells of the Malpighian bodies . In the young dpleen, giant cells may a;so be found, each containing numerous nuclei or one compound nucleus { Lewis 1918}

2.1.5 Microscopic Anatomy of the spleen

The spleen is made up of 3 components, white pulp, and vascular system. The white pulp consists of lymphatic nodules arranged around an eccentric arteriole called the interstices of the reticulum, in between the sinusoids . The cell population includes all types are freely transformed into plasma cells, whch can produce large amounts of antibodies and immunoglobulin {Ashwin pai 20131}

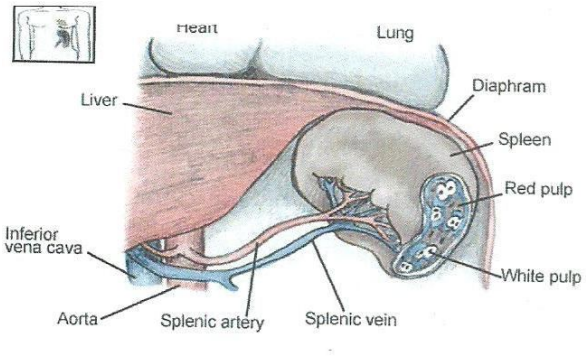


Figure 2.8 gross cut section showing the red pulp the white pulp of the spleen [Ashwin 2011].

2.1.6 Vascular system

The lineal 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 sheathes from an involution of the external fibrous tissue . Similar sheaths also invest the nerves and veins. .{ Lewis 1918 } .

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 . .{Lewis 1918}.

The arterioles, supported by the minute trabeculae, traverse the pulp in all directions in bundles (pencilli) of straight vessels, Their trabecular sheaths gradually undero a transformation, become much thickened ,and converted ininto adenoid tissue ; the bundles of containing in their interstices an abundance of lymbh corpuscls {W.Muller 2010} .

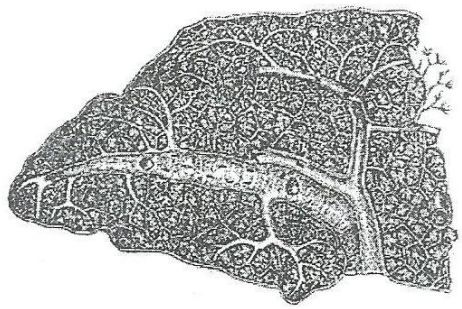


Figure 2.9 Transverse Section of the human spleen , the distribution of the splenic artery and its branches [W. Muller 2010]

The altered coat of the arterioles, consisting of adenoid tissue, presents here and there thickenings of a spheroidal shape .

The lymphatic nodules (Malpighian bodied of the spleen)

These bodies vary bodies vary in size from about 0.25 mm. in diameter . They are merely local expansions or hyperplasia of the adenoid tissue , which the external coat of the smaller arteries of the spleen is formed . They are most frequently found surrounding the arteriole, which thus seems to tunnel them , but occasionally thy grow from one side of the vessel only, and present the appearance of a sessile bud growing form the arterial wall. In transverse sections, the majority of cases, is found in an eccentric position. These bodies are visible to the naked eye on the surface of a fresh section of the organ,

appearing as minute dots of a semi opaque whitish color in the dark substance of the pulp. . {Lewis1918}

In minute structure they resemble the adenoid tissue of lymph glands, consisting of a delicate reticulum, in the meshes of which lie ordinary lymphoid cells the reticulum is made up of extremely fine fibrils, and is comparatively open in the center of the corpuscle, becoming closer at its periphery . The cells which it encloses are possessed of ameboid movement. when treated with carmine they become deeply stained, and can be easily distinguished from those of the pulp the arterioles and by opening freely into the splenic pulp; their walls walls become much attenuated, they lose their tubular character, and the endothelial cells become altered, presenting a branched appearance, and acquiring processes which are directly connected with the processes of the reticular cells of the pulp . In this manner the vessels end, and the blood flowing through them finds its way into the interstices of the reticulated tissue of the splenic pulp. Thus the blood passing through the spleen is brought into intimate relation with the elements of the pulp, and no doubt undergoes important changes . After these changes have taken place the blood is collected from the interstices of the tissue by the rootles of the veins, which begin much in the same way as the arteries end . The connective-tissue corpuscles of the pulp arrange themselves in rows, in such a way as to form an elongated space or sinus. .[Lewis 1918] .

They become elongated and spindle-shaped, and overlap each other at their extremities, and thus form a sort of endothelial lining of the path or sinus, which is the radical of a vein . On the outer surfaces of these cells are seen delicate transverse lines or markings, which are due to minute elastic elastic fibrillae arranged in a circular manner around the sinus. Thus the channel obtains an external investment, and gradually becomes covered into a small vein, which after a short course acquires a coat of ordinary connective tissue, lined by a layer of flattened epithelial cells which are continuous with the supporting cells of the pulp. The smaller veins unite to form larger ones ; these do not accompany the arteries, but soon enter the trabecular sheath of the capsule, and by their junction form six or more branches, which emerge from the hilum, and, uniting, constitute the lienal vein, the largest radical of the portal vein . . [Lewis 1918]

2.1.7 Venous drainage

The principal venous drainage of the spleen is through the splenic vein. It is formed at the hilum and runs behind then joins the superior mesenteric vein the neck of the pancreas to form the portal vein . Its tributaries are the short gastric, left gastro-omental, pancreatic, and inferior mesenteric vein .

2.2 Physiology of the Spleen

Human spleen is an important constituent of the lymphatic system. It is concerned with producing lymphocytes, which is a type of white blood cells. So, spleen is an integral part of the human immune system, as the lymphocytes are responsible for producing antibodies to fight against the foreign invaders . Antibodies are mainly associated with the destruction of the bacteria, virus or any other microorganisms or germs that can cause several diseases. This immune function of the spleen is the subject matter of the white pulp of organ. [Ashwin 2011]

The red pulp of the spleen on the other hand, is concerned with looking after the filtration activities, i.e. removing the or damaged red blood to damaged red blood cells from the body .

In is also responsible for acting as a reservoir of blood to be supplied in time of emergencies like hemorrhagic shock or excess loss of blood due to cuts or injury.

By acting as a filter, spleen recognizes as well as removes the old, damaged and malformed red blood cells from the body . The old red blood cells are then broken down by the macrophages, which are a type of phagocytes. . [Ashwin 2011]

Macrophages not only engulf and digest the red blood cells, but other invading microorganisms and debris as well.

Filtering the blood is one of the functions of the spleen, while destroying the old red blood cells; it saves some important components like iron from them . Iron is stored in the spleen as bilirubin and ferreting

Iron preserved in this way id then transported to the bone marrow, which is the main site for synthesizing hemoglobin is a type of protein consisting of hem and

globins and it transports, also stores coenocytes, which is a type of leukocytes the help engulfing and digesting bacteria and other harmful microorganisms . [Ashwin 2011] .

2.3 Pathology of spleen

Accessory spleens or splenonucli are natural anatomic variants formed from nodules that fail to fuse during development . these are found in various locations such as the gastrosplenic ligament ,splenorenal ligament , gastrosplenic ligament and gastrocolic ligament. They have also been reportedly found in broad ligament of the uterus and in the spermatic cord

2.3.1 Splenomegaly

A variety of disorders can cause the spleen to enlarge ,sometimes to 2kgs or more .Any conditions that cause arapid breakdown of blood cells ,such as heamolytic anemia,can place great strain on the spleen and make it large .other causes of includes infections such as glandular fever ,liver disease and some cancer(leukemia and lymphoma { mayr kur 2009]

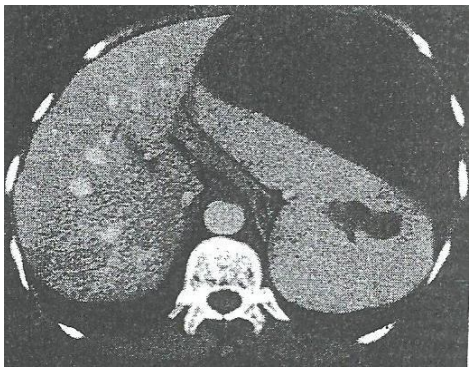


Figure 2.10 axial Ct showing splenomegaly

2.3.2 Splenic rupture

Certain disorders, including glandular fever ,can occasionally make the enlarged spleen delicate enough to spontously rupture .A sudden blow of the abdomen can split the outer capsule of the spleen and cause bleeding into the abdominal cavity .There are various degrees of splenic rupture . when bleeding is life threatening ,surgery to remove spleen is need.

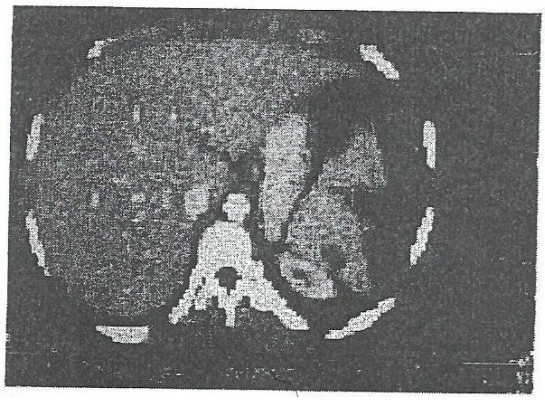


Figure 2.10 axial Ct showing Splenic rupture

2.3.3 Hypersplenism

The two characteristic features of hypersplenism are splenomegaly and a deficiency of one or more blood components .it seems that an enlarged is sometimes overactive and will destroy more blood cell s thant necessary. Symptoms depend on which blood component is lacking .for example ,if RBCs are deficient ,anemia will be the result with symptoms including fatigue and pallor.Most cases of hypersplenism are caused by disorders somewhere else in the body such as liver cirrhosis.

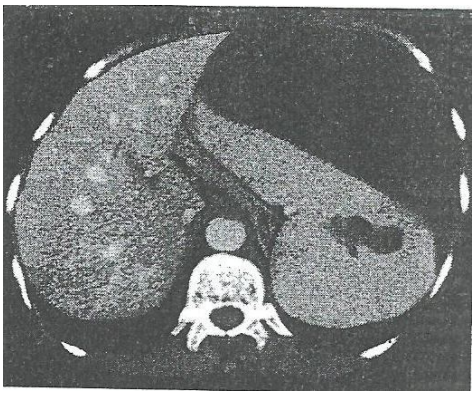


Figure 2.11 axial Ct showing Hypersplenism

2.3.4 Asplenia

Is rare case in which there is a congenital absence of the spleen or that functions.

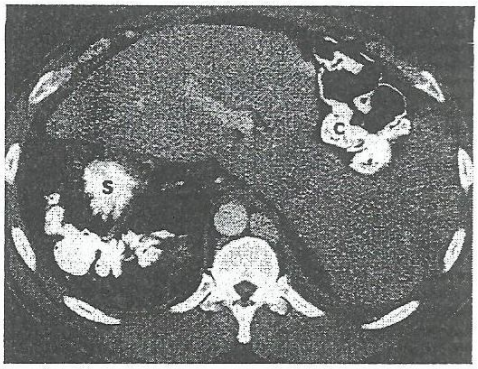


Figure 2.12 Axial CT image shows Asplenia [Mayr kur 2009]

2.3.5 Thrombocytopenia

Low platelet count) anenlarge spleen sometimes store few platelets circulating in the bloodstream where they belong.

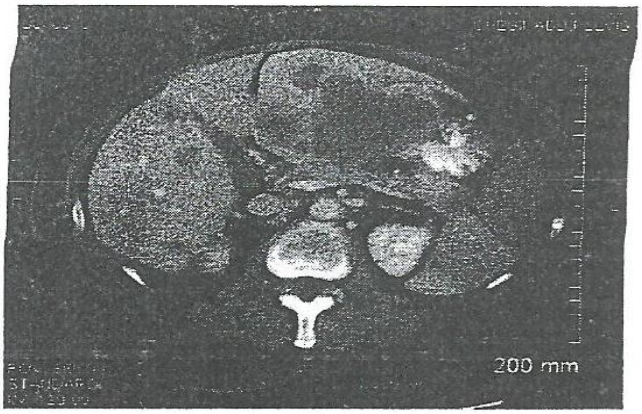


Figure 2.13 Axial CT image shows Thrombocytopenia [Mayr kur 2009]

2.3.6 Sickle cell anemia

In this inherited form form of anemia, abnormal RBCS block the flow of blood through vessels and can lead to organ damage, including damage to spleen. People with sickle cell disease need immunizations to prevent illnesses their spleen help fight

2.3.7 Methods of spleen investigations

Physical examination: by pressing on the bell under the left ribcage, adoctor can feel an enlarged spleen .he or she can also look for other signs of illnesses that cause splenomegaly.

Liver and spleen scan: asmall amount of radioactive de is injected into the arm .the dye moves throughout the body and is collected in both of these organs.

2.3.8 Spleen treatments

Splenectomy: the spleen is removed by surgery, either through laparoscopy or laparotomy .vaccinations: after spleen removal it's important to get vaccinations against certain bacteria such as H.influenza and S. Pneumonia .an absent spleen increase vulnerability to these infections .

Usually, treatments for spleen conditions focus not on the spleen, but

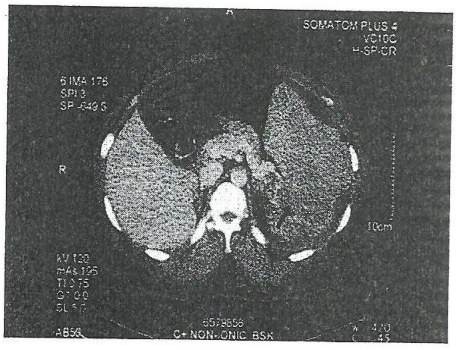


Figure Axial CT image shows Sickle cell disease [Mayr kur 2009]

on treating the underlying condition.

2-4 previous study

Dr Adil Asghar,2011 had done amorphometeric study of spleen in north Indian adult population ,the mean length ,width of spleen were 10,67+1.26cm ,6.26+1.66 respectively.All linear splenic dimensions have significant positive correlation with height of patients and normative data can be produced with the help of regession formula developed with the help of statistics which can be used as research tool where objective determination of splenomegaly is required.

(Journal of Clinical and Diagnostic Research.2011 October)

Dr .I.J.Okoye had done a study that aimed to establish ultrasonic splenic dimensions which can be used as tomogram for adult Nigerians . the normal splenic sizes obtains from 9.9-11.5 cm(length L) ,6- 7.5 cm(width W) . the splenic dimensions for males were 11.1 +0.7 cm (L) ,7.3 +0.2 cm (W) ,the corresponding values for females were 10.6+0.7 cm (L) 6.8+0.5 cm(W) ,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 Caucasian population compared with them (P>0.05).

This finding appears to bear credence to existing opinion by chauhan et al that splenic recession rather splenomegally is prevalent in adults living in endemic falciparum zones .statistically significant differences between splenic length and weights of the sexs have been establish by the study .(African journal of radiology)

Mittal R ,Chowdhary D,2010,study the normal standards of liver and spleen by ultra sound in Rajasthan population .the average length of the spleen was 9.4+0.91 cm(males) and 9.34 +0.95cm(females). the average width of the spleen in males as well as in females was 3.45+0 .59 cm . the normal values of the dimensions of the liver and spleen are important parameters during a sonographical exams .this study

provides valuable data from the Rajasthan population .so, this study will be importance in the dialy practice in radiology clinics.

Zeinab Mustafa provided this study to determine the normal range of the spleen size in an adult African population ,the mean of spleen volume was 120 cm3 . spleen volume correlated with spleen width (r=0.85),thickness(r=0.83)and length(r=0.80). men had larger mean of +spleen volume than women . no correlation was found between spleen volume and age , weight, height or body mass index. Mean spleen volume in African adults is smaller than western sources , and cannot be explained by difference in body habits .{European journal of tadiology}

Chapter three

Material and methods

3.1 Materials

3.1.1 Study sample:-

110 sudanese adult patients (male- female) ,patient age range between (_80 years) ,underwent computed tomography examination for KUB and abdomen . in this range of age the spleen completed the process of development ,the researcher included the patients with diseases that may affect the spleen(malaria-sickle cell anemia- schistozoma)

3.1.2 Area ,duration and data analysis

This is community based descriptive study .It took place in Khartoum state with permission from different hospitals and centers,Alnelien Medical Diagnostic Center, Ibn Alhaytham medical center and Soba University Hospital. The study was conducted during the period from April to October . The data were analyzed using excel program and simple frequency tables.

3.1.3 CT machine characteristics

This study used phlips and dual general CT scanner . the gantry and table allows for a120 cm scan range . It is also equipped with positioning lights and breathing lights. This scanner allows acquiring two thin slices simultaneously in the same amount of time and would take for single slice scanner

3.2 Methods

The patients were prepared for exam by fasting 4 -6 hours before the exam and asked to remove any jewelry and wear a hospital gown during the study.

3.2.1 Methods of scanning

The technologist had positioned the patient on the CT examination table , usually lied flat on their back or less commonly , on their side or prone with their hand over the head .Straps and pillows may be used to help patient maintain the correct position and hold still during the exam . this requires contrast media (a special dye) to delivered into the body through the venous system. Due to contrast reactions, the technologist should ask the patient about his history of allergies and their current health issues . the contrast that was given through a vein before the exam starts , the patient would be asked to drink diluted contrast orally(pure water with contrast media) .CT scan were performed using protocol of axial images from the xiphoid process to symphisis pubis .For better imaging ,reconstruction is used with thin slice thickness(3 mm) to obtain coronal sections .In addition , the technical parameters that were used in this study were 120 kv ,100 mA ,10 mm increments, 10 mm slice thickness with identical reconstruction index and a rotation time of 1.5 sec

3.2.2 Methods of measurements

Splenic length ,width were calculated around 10 rib from CT scans image . the splenic length was measured from sigittal reconstruction image , the width was measured from two higher points across the spleen . the unit of measurements used was metric . the patients were also measured for weight using weight scale .the researcher used the methods that used in below figure

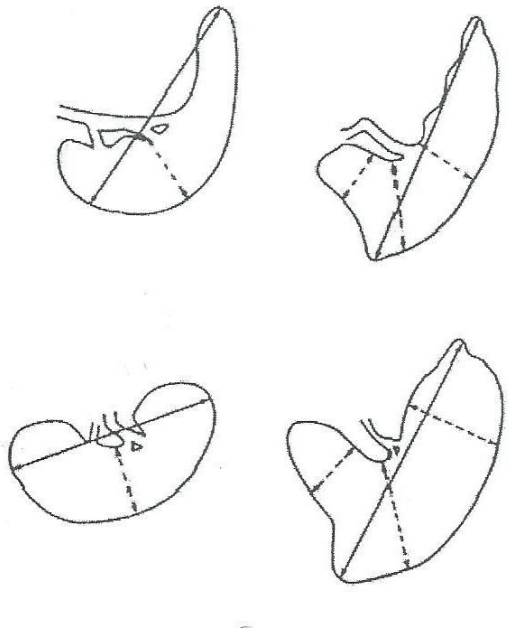


Figure 3.15 Methods of measurements

Width= solid arrow thickness= dashed arrow splenic index = (Iength x width x width x thickness)

Length = was measured along axis, is the sagittal plane .

Width = is the a longest splenic diameter that can be drawn on any transverse image .

Chapter Four

Results

The following tables and figures presented the data obtained from 80 normal subjects and 30patients affected with shistosomiases, malaria, sickle cell anemia that may affected the spleen in both genders.

Table4- 1 the distribution of sample (normal) according to gender in frequency and percentages

Gender	Frequency	Percentages
Male	36	45%
Female	44	55%
Total	80	100%

Table4-2 The distribution of the Diseased Sample according to gender

Gender	Frequency	Percentages
Male	16	53.3%
Female	14	46.7%
Total	30	100%

Table4-3Demographic Data of Diseased &Normal including Mean &STDV

Demographic Data	Normal	Diseases
Mean Age	44.81124	38.2
STDV	16.08191	18.13056
Mean Weight	64.38861	58.16667
STDV	14.16642	10.97358

Table4-4The Diseased Sample according to the type of disease

Disease	Frequency	Percentage
Shistosomiases	10	33.3%
Malaria	10	33.3%

Sickle Cell anemia	10	33.3%
Total	30	100%

Table4-5The Measurements Of The spleen (mean and standard deviation) in the normal and diseases samples

Mean and Standard Deviation	Spleen Length	Spleen Width	Spleen CT number	Left Kidney Length	Left Kidney Width
Normal Sample(means)	8.75	4.29	48.69	4.91	3.72
STDV	±1.59	±0.89	±8.39	±1.26	±1.02
Diseased Sample(means)	12.59	4.93	44.3	4.71	3.91
STDV	±0.63	±0.44	±2.92	±0.81	±0.62

Table4-6.The Measurements Of The spleen (mean and standard deviation) in the normal classes according to the residence.

Mean and STDV	Spleen Length	Spleen Width	Spleen CT number	Left Kidney Length	Left Kidney Width
North	8.39	4.22	49.25	4.91	3.69
	±1.38	±0.80	±7.77	±1.56	±1.08
Middle	9.61	4.77	50.7	5.08	4.16
	±1.57	±0.90	±8.22	±1.37	±1.11
East	9.02	4.48	50.6	4.53	3.58
	±1.59	±0.89	±8.39	±1.26	±1.02
West	9.07	4.20	50.5	5.63	3.81
	±0.49	±0.53	±0.68	±1.46	±0.97

Table4-7the measurements done for the samples affected with different diseases.

	Spleen Length	Spleen Width	Spleen CT number	Left Kidney Length	Left Kidney Width
Malaria	12.3	4.76	43.3	4.61	3.81
	±0.40	±0.51	±2.75	±0.73	±0.65
Schistosomiases	12.17	4.85	47.3	4.30	3.70
	±0.59	±0.48	±1.15	±0.54	±0.52
Sickle cell anemia	13.25	5.17	42.3	5.2	4.21
	±0.21	±0.20	±1.76	±0.90	±0.62

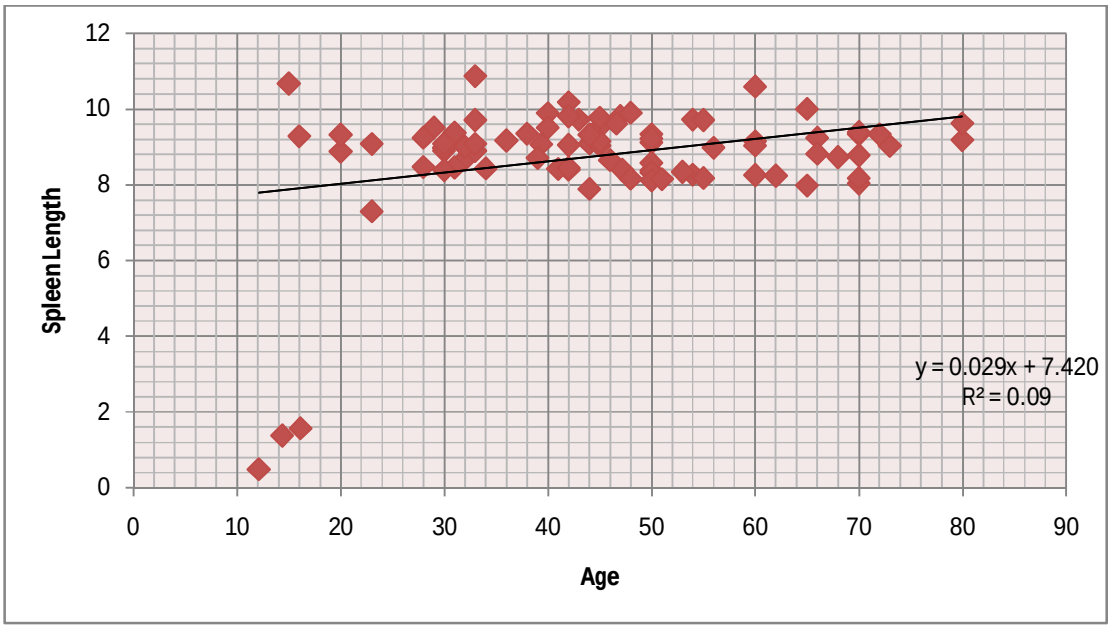


Figure4.16 a scatter plot shows the relation between the Normal Subjects age and Spleen Length, The relation showed a linear relation between the age and spleen length, as the age increases the spleen length is also increased by 0.029starting from 7.

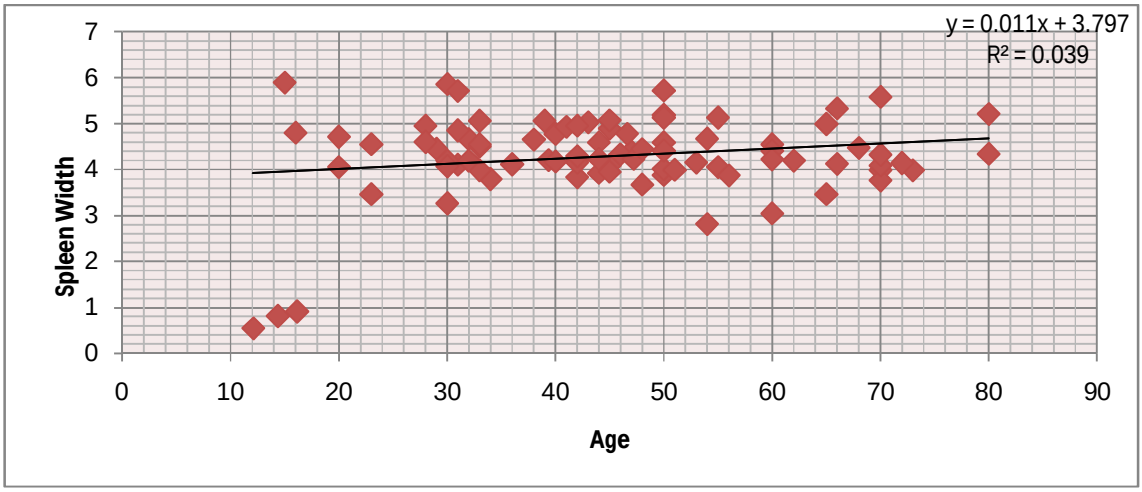


Figure4.17 a scatter plot shows the relation between the Normal Subjects age and Spleen width, the relation showed a linear relation between the age and spleen width, as the age increases the spleen width is also increased by 0.011starting from 3.7

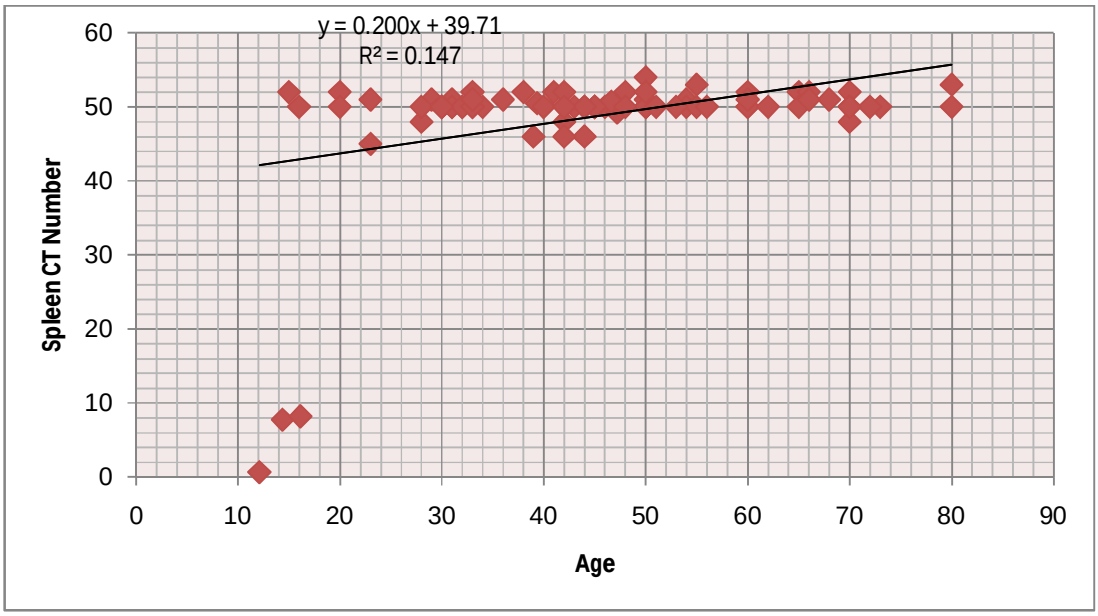


Figure4.18 a scatter plot shows the relation between the Normal Subjects age and Spleen CT number, the relation showed a linear relation between the age and spleen CT number, as the age increases the spleen CT number is also increased by 0.20 starting from 39.7

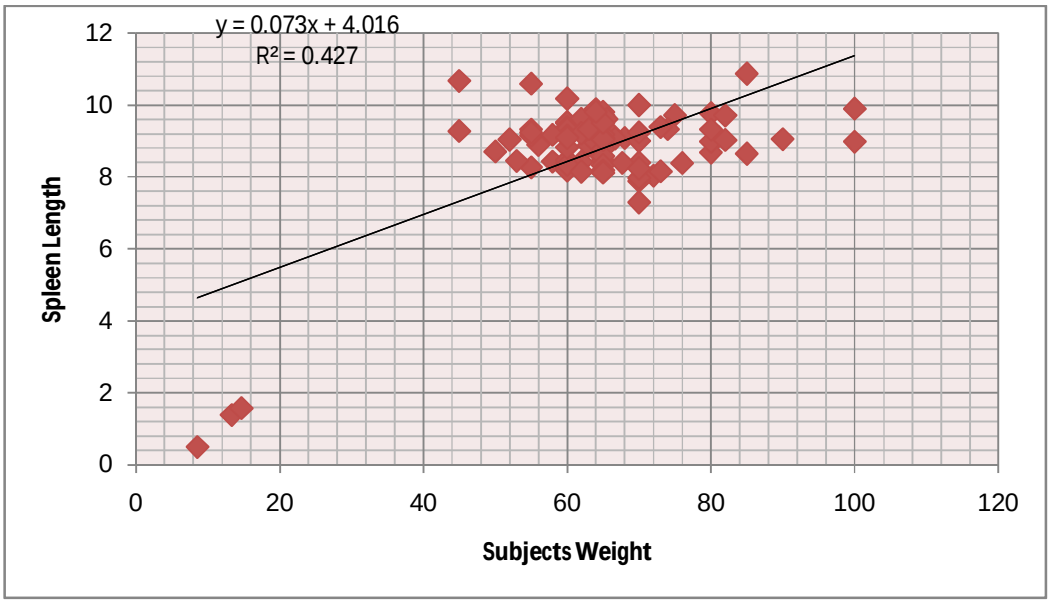


Figure4.19 a scatter plot shows the relation between the Normal Subjects weight and Spleen length, the relation showed a linear relation between the weight and spleen length, as the weight increases the spleen length is also increased by 0.073 starting from 4.01

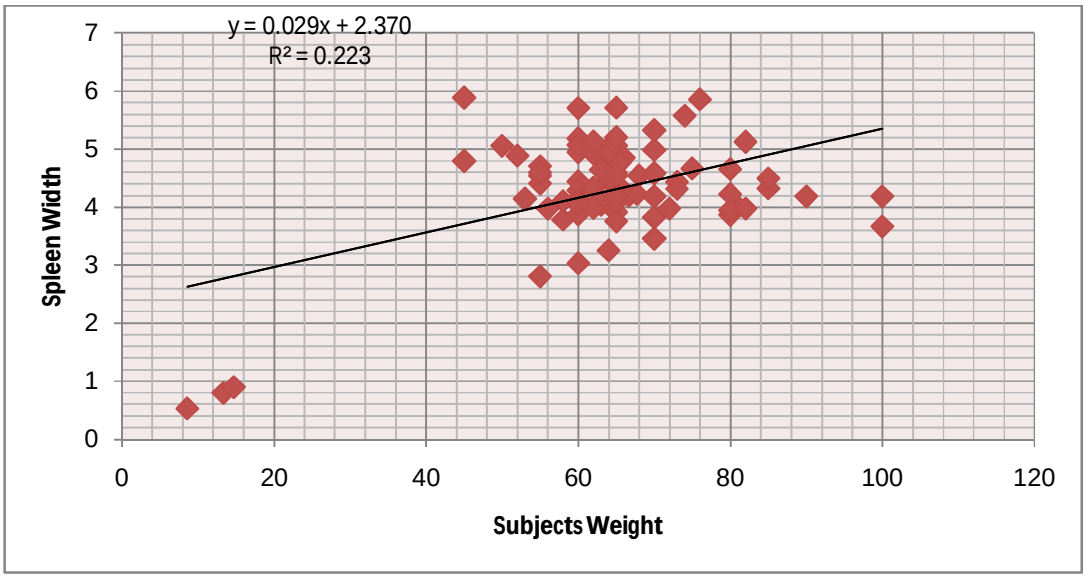


Figure4.20 a scatter plot shows the relation between the Normal Subjects weight and Spleen width, the relation showed a linear relation between the weight and spleen width, as the weight increases the spleen length is also increased by 0.029 starting from 2.37

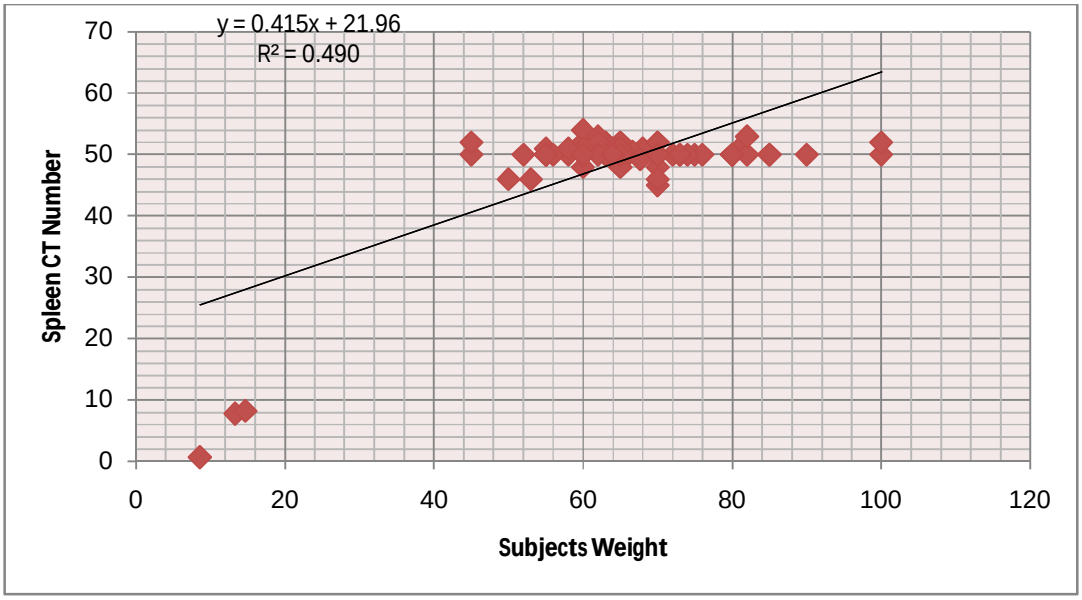


Figure4.21 a scatter plot shows the relation between the Normal Subjects weight and Spleen CT number, the relation showed a linear relation between the weight and spleen CT number, as the weight increases the spleen length is also increased by 0.415starting from 21.9

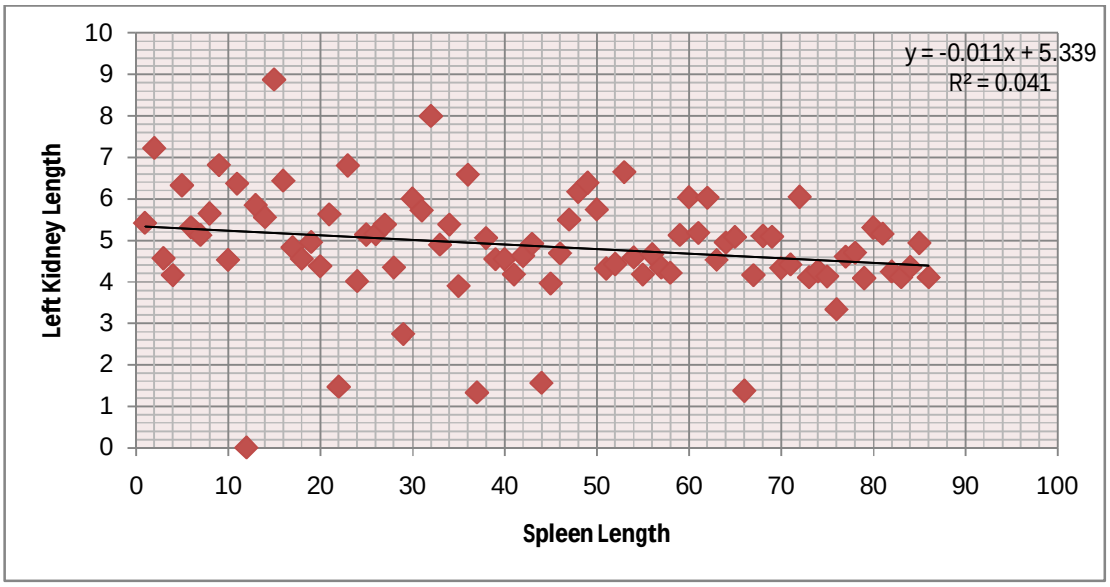


Figure4.22 a scatter plot shows the relation between the Normal spleen length and Left kidney length, the relation showed a linear relation between spleen length and Left kidney length, as the spleen length increases the Left kidney length is also decreased by 0.011 starting from 5.33

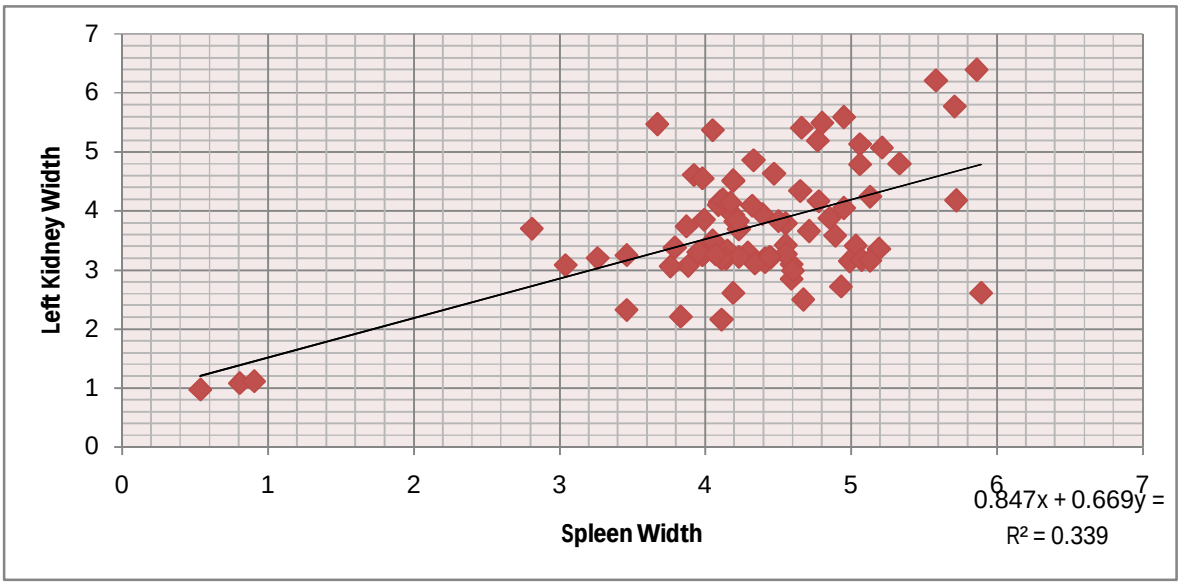


Figure4.23 a scatter plot shows the relation between the Normal spleen width and Left kidney width, the relation showed a linear relation between spleen width and Left kidney width, as spleen width increases the Left kidney width is also increased by 0.66 starting from 0.84

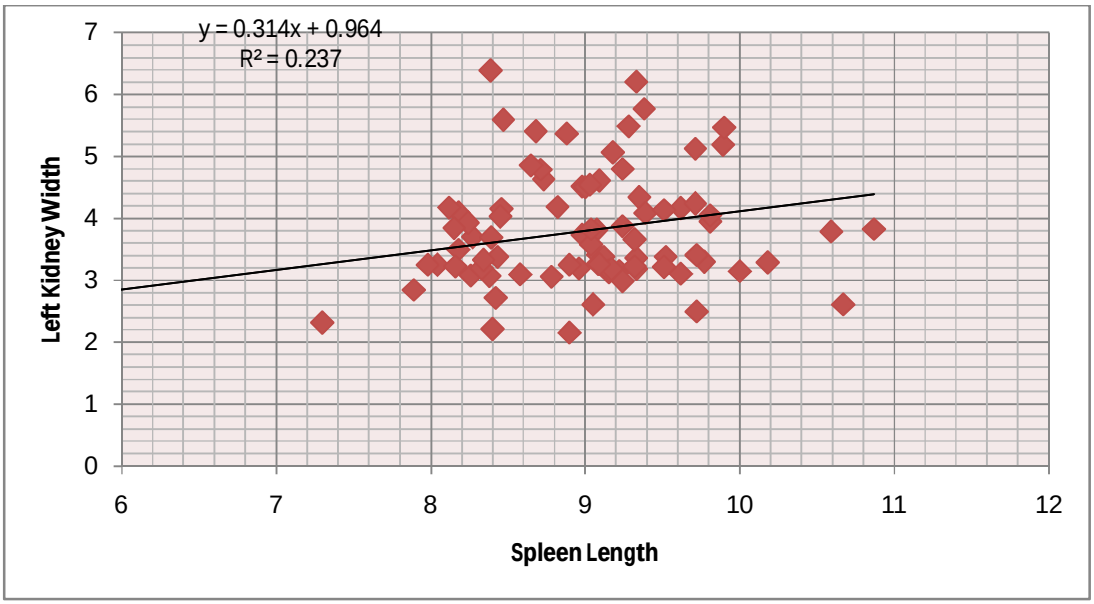


Figure4.24 a scatter plot shows the relation between the Normal spleen length and Left kidney width, the relation showed a linear relation between the spleen length and Left kidney width, as spleen length increases the Left kidney width is also increased by 0.31 starting from 0.96

Chapter Five

{discussion, conclusions and recommendations}

5-1 discussion

This study is an attempt to find out an index for spleen measurements(length, width and spleen CT number) for different Sudanese areas using CT scan as well as to find out the relation of certain diseases and spleen enlargement

The data were collected for patients age (15-80)years old .The results showed that the length, width and spleen CT number were correlated with patients age and weight.

The study showed that females (44) were more frequent than males (36) in normal subjects but males(16) were more frequent than females (14) in diseased subjects that means the males were affected by diseases exactly shistosomiases due to their habits as presented in table 4-1/4-2.

The demographic data showed that the mean ages of normal sample were 44.81±16.08 and 38.20 ± 18.13 for diseased one ,also showed that the mean weight of normal sample were 64.38±14.16 and 58.18 ±10.97 as presented in table 4-3 , the researcher noticed the mean age and weight of normal patients were higher than diseased patients .

The study showed that the mean length of spleen was 8.75 ±1.59 cm for the normal sample and 12.59 ±0.63 cm for the diseased sample as presented in table 4-5 ,these measurement compared to study done by Adil Ashghar ,2011 found that the spleen length was 10.67±1.26 cm which was higher than our study by 1.92 cm (normal sample) and was lower this study by 1.92 cm also (diseased sample) .Another study done by Okoye, 2009 using ultrasonic measurement for adult Nigerians ,found that the splenic length was 10.85 cm which is higher by 2.1 for the normal sample and lower by 1.74 for the diseased sample.That means the spleen length increased under effect of diseases. In another study done by Mittal R and Chowdhary D ,2010 using ultrasonic measurements found that the mean of spleen length was 9.37 cm which was higher by 0.62 for the normal sample and lower by 3.22 for the diseased sample). The linear relation between the patients ages and spleen length were found to be increased by 0.029 for each year starting from 7 as in figure 4-16. Also the linear relation between patients weight and spleen length were increased by 0.073 starting from 4.01 as in figure 4.19.

The study showed that the mean width of spleen was 4.29±0.89 cm for the normal sample and4.93±0.44 cm for the diseased sample) as presented in table 4-5 ,these measurement compared to study done by Adil Ashghar ,2011 found that the spleen length was 6.26±1.66 cm which was higher than this study by 1.97cm for the normal sample) and also higher by 1.33 cm for the diseased sample .Another study done by Okoye,2009 using ultrasonic measurement for adult Nigerians ,found that the splenic width was 7.05cm which was higher by 2.76 for the normal sample and also higher by 2.12 for diseased sample.That means the spleen width increased under effect of diseases. In another study done by Mittal R and Chowdhary D ,2010 using ultrasonic measurements found that the mean of spleen width was 3.45±0.59 cm which was lower by 1.48for the normal sample and lower by for the diseased sample. The linear relation between the patients ages and spleen width were found to be increased by 0.011 for each year starting from3.7 as in figure 4-17 . Also the linear relation between patients weight and spleen width were increased by 0.029 starting from 2.37 as in figure 4.20.

The study found that the mean CT number of spleen was 48.69 ±8.39 HU for the normal sample and44.3 ±2.92 for the diseased sample as presented in table 4-5 , no other studies done CT measurements ,but it was lower in diseased sample that mean the spleen CT number decreased under effect of diseases. The linear relation between the patients ages and spleen CT number were found to be increased by 0.20 for each year starting from39.7 as in figure 4-18 . Also the linear relation between patients weight and spleen CT number were increased by 0.41 starting from 21.9 as in figure 4.21.

The study also found the left kidney dimensions that may affected by spleen dimensions when enlarged as followed ,the mean length of LT kidney was 4.91 ±1.26 cm for the normal sample and 4.71±0.81 cm for the diseased sample, no significant difference between normal and diseased samples as presented in table 4-5 .the linear relation between spleen length and LT kidney length was found that the spleen length increased the left kidney length decreased by 0.011 starting from 0.48(reversal relation) that means when spleen length increased due to effect of diseases (Malaria ,Sickle cell anemia and Schistosomiases) the LT kidney length decreased, because sickle cell anemia the RBCs destroyed and the spleen increased the amount of cells to faces this problem that lead to enlargement of spleen , also schistosomaisis causes portal hyper tension ,that affect the spleen and became enlarge Malaria , type of tropical diseases that caused splenomegaly and hepatomegaly ,as in figure 4-22.

Also the study showed the mean width of LT kidney was 3.72±1.02 cm for the normal sample and 3.91±0.81 cm for the diseased sample, no significant difference between normal and diseased samples , as presented in table 4-5 .the linear relation between spleen length and LT kidney width was found that the spleen length increased the left kidney width also increased by 0.31 starting from 0.96 that means when spleen length increased due to effect of diseases (,Malaria ,Sickle cell anemia and Schistosomiases) the LT kidney width also increased (linearly relation) as in figure 4-24 ,also the study showed that the linear relation between the spleen width and LT kidney width were found to be increased by 0.66 starting from 0.84 .as in figure 4-23. that means when spleen length increased due to effect of diseases (Malaria ,Sickle cell anemia and Schistosomiases) the LT kidney width were also increased .

The study found that the mean of spleen length, width and CT number (9.61±1.57cm , 4.77±0.90 cm and 50.7 ±8.22 respectively) for middle residence was higher than others areas ,North, East and West , as presented in table 4-6 .that might be due to their environment (Gazira state) ,another study done by M.A.Mustafa ,2008 for Gazira state population using ultrasonic measurements showed that the mean of spleen length was 10.22±0.54 cm which was higher by 0.61 . The LT kidney dimensions showed a bit difference between these groups.

The study also showed that patients affected by different diseases e.g .Malaria ,Sickle cell anemia and Schistosomaisis were higher mean of spleen length(12.3±0.40 cm ,13.25 ±0.21 cm and 12.17±0.59 cm respectively) than normal subjects . also the mean of spleen CT number were lower { 43.3±2.75 (Malaria) ,47.3±1.15(Schistosomiasis) and 42.3±1.76(Sickle cell anemia) }, but the mean of spleen width was similar in the two samples , as presented in table4-6/ 4-7.

5-2Conclusion

The study conclude that the spleen measurements for the length ,width and spleen CT number was found to be 8.75 +1.95 cm ,4.29+0.89 cm and 48.69+8.39 (normal sample) and 12.59 +0.63 cm ,4.93 +0.44 cm and 44.30 +2.92 (diseased sample) respectively .

The relation between spleen measurements (length, width and spleen CT number with age was found to be length increased when the age increased ,the spleen width increased when the age increased and spleen CT number increased when the age increased ,and the relation between spleen measurements (length, width and spleen ct number with weight was found to be length increased when the weight increased the spleen width increased when the weight increased and spleen CT number increased when weight increased

This studies showed that the spleen measurements results either to be higher or lower than what mentioned mentioned in the discussion may be due to different race and geographic changes.

5-3Recommendations

- Further study in evaluation of spleen dimensions with larger sample of population for more accurate results are needed.
- Correlations between more body characteristics and spleen measurements in further study *9*
- Using of other imaging modalities like MRI and Ultrasound might give more accurate results.
- Follow up the measurement of the changes of spleen with childrencould be added.

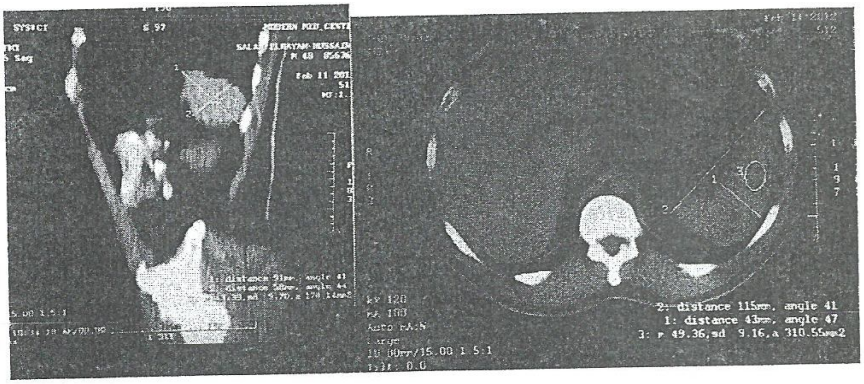
APPENDIX No (1)

Patients Data				Spleen Data			Left Kidney Data	
Gender	Age	Weight	Tribe	Length	Width	CT NO	Length	Width
M	44	65	w	9.09	3.92	50	5.42	4.61
M	40	64	w	9.89	4.77	50	7.23	5.19
F	68	64	w	8.73	4.47	51	4.57	4.63
F	20	63	w	8.88	4.05	52	4.16	5.37
F	33	65	w	9.71	5.06	52	6.33	5.13
M	32	80	w	8.68	4.66	50	5.32	5.41
M	45	60	w	9.52	4.09	50	5.13	3.38
M	23	68	w	9.08	4.55	51	5.65	3.42
M	34	58	w	8.43	3.79	50	6.82	3.38
F	50	60	w	8.38	3.88	50	4.53	3.07
M	42	90	w	9.05	4.19	50	6.37	2.61
F	54	55	w	8.27	2.81	51	5,60	3.7
F	31	66	w	9.24	4.85	50	5.85	3.88
F	50	81	w	9.12	4.01	51	5.56	3.38
M	47	65	w	9.81	4.39	50	8.88	3.95
M	54	75	w	9.72	4.67	50	6.44	2.5
M	29	60	w	9.51	4.45	51	4.83	3.21
M	31	65	w	8.46	4.1	51	4.56	4.16
F	30	65	w	8.9	4.11	50	4.96	2.16
F	30	64	w	8.96	3.26	50	4.38	3.2
M	30	76	N	8.39	5.86	50	6.81	6.39
F	28	60	N	8.47	4.95	48	4.02	5.59
F	60	60	N	8.26	3.04	52	5.14	3.08
F	55	60	N	8.18	4.05	50	5.15	3.5
F	23	70	N	7.3	3.46	45	5.38	2.32
F	70	72	N	8.04	3.98	50	4.35	3.25
M	30	100	N	8.98	4.19	50	2.74	4.52
F	70	65	N	8.78	3.76	52	6.01	3.06
M	56	80	N	8.98	3.87	50	5.72	3.74
F	39	50	N	8.71	5.06	46	8	4.79
M	42	70	N	8.4	3.83	48	4.9	2.21
F	50	65	N	8.58	4.59	50	5.38	3.1
F	44	70	N	7.89	4.59	46	3.9	2.85
M	46	85	N	8.65	4.33	50	6.59	4.86
M	41	62	N	8.42	4.93	52	1.33	2.72
F	50	65	N	8.33	4.41	50	5.06	3.2
F	33	56	N	8.9	3.98	50	4.55	3.25
M	65	70	N	7.98	3.46	52	4.55	3.25
M	42	53	N	8.45	4.15	46	4.18	4.03
F	70	65	N	8.18	4.09	48	4.63	4.1
M	31	60	M	9.38	5.71	50	3.96	5.77
F	16	45	M	9.28	4.8	50	4.69	5.49
F	70	74	M	9.33	5.58	50	5.5	6.21

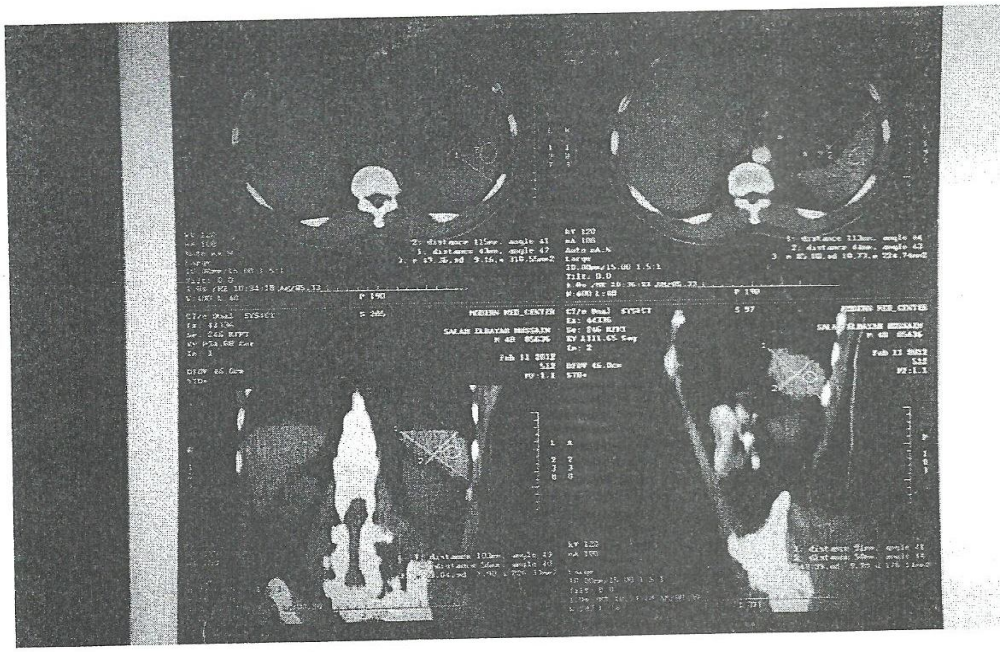
F	48	100	M	9.9	3.67	52	6.17	5.47
M	32	70	M	9	4.19	50	6.39	4.51
M	42	60	M	10.18	4.29	52	5.75	3.29
F	45	80	M	9.77	3.95	50	4.32	3.3
M	60	55	M	10.59	4.55	50	4.43	3.79
F	33	85	M	10.87	4.5	50	6.65	3.83
M	15	45	M	10.67	5.89	52	4.59	2.61
F	60	55	M	9.15	4.41	50	4.18	3.13
F	50	60	M	9.33	5.19	54	4.66	3.36
F	43	64	M	9.72	5.03	50	4.35	3.41
M	65	70	M	10	4.99	50	4.22	3.15
M	73	82	M	9.03	3.98	50	5.13	4.55
F	80	65	M	9.18	5.21	50	6.04	5.07
M	66	70	M	9.24	5.33	52	5.18	4.8
F	38	63	M	9.35	4.65	52	6.03	4.34
F	45	52	M	9.04	4.89	50	4.53	3.58
F	20	55	M	9.32	4.71	50	4.95	3.66
M	45	60	E	9.15	5.07	50	4.16	3.17
M	33	65	E	9.08	4.55	51	5.11	3.27
F	62	70	E	8.24	4.19	50	5.09	3.93
M	80	62	E	9.62	4.34	53	4.33	3.11
F	53	60	E	8.34	4.15	50	4.42	3.33
F	50	65	E	8.12	5.72	50	6.05	4.18
F	48	73	E	8.16	4.44	50	4.11	3.22
F	50	62	E	9.22	5.13	52	4.26	3.16
M	60	65	E	9.04	4.22	51	4.13	3.83
F	72	63	E	9.33	4.14	50	3.34	3.19
F	28	55	E	9.24	4.6	50	4.61	2.99
F	51	62	E	8.15	3.99	50	4.7	3.85
M	66	60	E	8.82	4.12	51	4.09	4.19
M	70	73	E	9.39	4.32	50	5.31	4.09
M	40	65	E	9.51	4.17	50	5.16	4.14
M	44	80	E	9.32	4.23	50	4.25	3.22
M	36	58	E	9.17	4.11	51	4.11	3.19
F	30	60	E	9.09	4.07	50	4.36	3.26
F	42	64	E	9.81	4.95	50	4.94	4.05
F	55	82	E	9.71	5.13	53	4.11	4.24

Patients Data				Spleen Data			Left Kidney Data		Diseases
Gender	Age	Weight	Tribe	Length	Width	CT NO	Length	Width	
F	51	80	M	12.54	4.67	45	4.23	3.35	malaria
F	60	59	M	12.43	4.19	46	4.42	3.95	malaria
F	16	48	W	13.33	4.9	43	5.1	4.46	sickle cell anemia
F	15	41	W	13.42	5.34	40	5.06	4.9	sickle cell anemia
F	20	44	W	13.6	5.41	44	5.36	3.98	sickle cell anemia
F	22	49	W	13.41	5.46	45	5.22	3.87	sickle cell anemia
F	24	48	W	13.14	5.16	43	4.15	3.18	sickle cell anemia
F	33	66	M	11.54	4.38	49	4.39	3.81	Shistozoma M
F	41	70	M	12.92	5.33	48	4.86	3.54	Shistozoma M
F	25	56	M	11.13	4.54	48	3.04	4.54	Shistozoma M
F	52	60	M	12.32	5.46	47	3.78	3.72	Shistozoma M
F	30	52	M	12.08	4.88	46	4.35	3.74	Shistozoma M
F	63	60	M	11.97	4.61	46	4.26	3.05	Shistozoma M
F	35	71	M	12.68	5.55	47	4.95	4.46	Shistozoma M
M	30	59	M	12.33	4.28	40	3.9	2.99	malaria
M	45	60	M	11.99	5.33	43	4.09	3.13	malaria
M	36	71	M	11.76	4.9	45	5.11	3.24	malaria
M	80	73	M	13	5.7	48	4.19	4.09	malaria
M	63	60	M	12.09	5.21	44	4.51	4.16	malaria
M	42	58	M	12.13	4.75	41	6.04	5.19	malaria
M	73	80	M	12.97	4.29	41	3.99	4.07	malaria
M	60	64	M	12.17	4.32	40	5.63	3.98	malaria
M	18	49	M	13.01	5.11	40	4.63	3.75	sickle cell anemia
M	28	52	M	12.89	5.32	40	4.24	3.89	sickle cell anemia
M	30	45	W	13.15	4.98	43	5.14	4.05	sickle cell anemia
M	15	45	W	13.26	4.9	42	6.35	5.18	sickle cell anemia
M	17	40	W	13.35	5.13	43	7.12	4.88	sickle cell anemia
M	45	63	M	11.79	4.05	49	4.38	3.9	Shistozoma M
M	48	67	M	12.99	4.89	47	4.45	2.99	Shistozoma M
M	29	55	M	12.37	4.89	46	4.59	3.3	Shistozoma M

Appendix no 2



Non contrast Axial and Sagittal CT image for female [25 years] show the measurements of spleen width and thickness in the level T12



Non contrast Axial, Coronal and Sagittal CT image for female[20 years] show the measurements of spleen in the level T12

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