Sudan University of Science and Technology
College of Graduate Studies

Measurement of Spleen to Left Kidney Ratio among Saudi School Age Children Using Ultrasonography

قياس معدل الطحال الى الكليه اليسرى لدي الاطفال السعوديين فى سن المدارس باستخدام التصويربالموجات فوق الصوتية

A Thesis Submitted for Partial Fulfillment for the Requirements of M.sc Degree in Medical Diagnostic Ultrasound

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2020

الآية

قال تعالي: -

(قَالَ رَبِّ اشْرَحْ لِي صَدْرِي (25) وَيَسِّرْ لِي أَمْرِي (26) وَاحْلُلْ عُقْدَةً مِنْ لِسَانِي (27) يَفْقَهُوا قَوْلِي (28)

صدق الله العظيم
سورة طه

Dedication

This research dedicated

To

The candle that is burring for me to my parents

To

My extraordinary supporter to my family

To

All my readers

Acknowledgement

I would like to express my special thanks of gratitude to God. My deepest appreciation and sincerest gratitude to thank my supervisor Dr. Ahmad Abukonna, for continuous guidance, assistance, endless advice during and throughout this study. Thanks too for many people who have supported me during this study.

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List of Abbreviation

Abbreviation	Meaning
U/S	Ultrasound
S/K ratio	Spleen length to left kidney length ratio
Lt kidney	Left kidney

Abstract

Clinical determination of mild splenomegaly is extremely in accurate as the spleen length varying according to many factors such as individual height, age and weight. The objective of this study was to determine sonographically the spleen to left kidney ratio according to age among school age children in Saudi Arabia.

A cross sectional study and convenience sampling were done on 50 apparently healthy subjects (22 boys and 28 girls) aged 7 - 17 years at the Taawon clinic in Kharj city, Saudi Arabia. The sonographic examination was performed on Siemens (Acuson X300) machine with 3.5 and 5 MHz convex transducers. Spleen and left kidney lengths were obtained using appropriate techniques. The weight and height of the subjects were obtained with the participants wearing light weight clothes without shoes.

The result of the study showed that the spleen and left kidney lengths were not statistically different in boys and girls ($p > 0.05$). The spleen to left kidney ratio according to age and hight is constant at about 1.1 with 1.3 as the upper limit of normal in the studied population.

Spleen to left kidney length ratio becomes a promising method to detect non palpable splenic enlargement. Mild splenomegaly is considered if the spleen to left kidney ratio is greater than 1.3 in the absence of renal disease among school age children

المستخلص

التحديد السريري لتضخم الطحال الخفيف غير دقيق للغاية حيث يختلف طول الطحال وفقًا لعدة عوامل مثل الطول الفرد والعمر والوزن. الهدف من هذه الدراسة هو تحديد نسبة الطحال إلى الكلية اليسرى بالموجات فوق الصوتية حسب العمر بين الأطفال في سن المدرسة في المملكة العربية السعودية.

تم إجراء دراسة مقطعية مستعرضة وأخذ عينات من 50 شخصًا أصحاء (22 فتى و 28 فتاة) تتراوح أعمارهم بين 7 و 17 عامًا في عيادة التعاون في مدينة الخرج بالمملكة العربية السعودية. تم إجراء الفحص بالموجات فوق الصوتية على جهاز سيمنز (Acuson X300) بمسبار 3.5 و 5 ميجاهرتز. تم الحصول على أطوال الطحال والكلى باستخدام التقنيات المناسبة. كما تم الحصول على وزن وطول الاطفال المشاركين و هم يرتدون ملابس خفيفة الوزن بدون حذاء.

أظهرت نتائج الدراسة أن أطوال الكلى اليسرى و الطحال لم تكن مختلفة إحصائيا في الأولاد والبنات ($p > 0.05$). نسبة الطحال إلى الكلية اليسرى حسب العمر وهي ثابتة عند حوالي 1.1 مع 1.3 كحد أعلى طبيعي في عينة الدراسة.

تصبح نسبة الطحال الي الكليه اليسرى طريقة واعدة للكشف عن تضخم الطحال غير الواضح. يعتبر تضخم الطحال خفيفاً إذا كانت نسبة الطحال إلى الكلية اليسرى أكبر من 1.3 في حالة عدم وجود أمراض الكلى بين الأطفال في سن المدرسة.

Chapter One

Introduction

1-1 Introduction:

The spleen is an important organ in the immune system. It is a bean shaped structure, located in the left upper portion of the abdominal cavity, under the diaphragm, protected by the 9th through 11th ribs, in the mid-back. The spleen typically weighs 150 grams in a typical adult and spans about 11 cm vertically in its longest dimension. The spleen is a reticuloendothelial organ involved in defense against infection and infestation and thus it is expected that the spleen may be slightly comparatively larger in exposed subjects than to what is obtained in non-exposed subjects (Chadburn, 2000).

The morphological characterization of the spleen is one of the many parameters that assist in detecting splenic disorders and systemic infections, inflammatory and malignant pathologies (Porzionato et al., 2019). Invariably the complete characterization of the disease process may need morphological assessment of anatomical structures and laboratory reports. However, there are many conditions where organomegaly may be the only feature on ultrasonography like splenomegaly in malaria. On the contrary, clinically palpable spleen may not be pathological. Pushed down spleen due to subdiaphragmatic pathology, visceroptosis and palpable spleen in 10% to 15% of normal children are a few examples of palpable spleen without any clinical significance (Menezes et al., 2014). Clinical assessment of changes in visceral organ size is difficult and unreliable. Ultrasonography is a non-invasive, established, safe, quick and accurate method for measurement of spleen and kidney sizes (Paraskevas et al., 2016).

It is important to compare the length of the spleen to the length of the left kidney in order to establish an internal reference standard against which the spleen size can be calibrated. Loftus and Metreweli as well as Al Imam et al found that the spleen to left kidney ratio

among children was constant for all age groups with a mean value of 1 and proposed a ratio of 1.25 as the up-per limit of normal (Al-Imam et al., 2000, Loftus and Metreweli, 1998). In a similar study in adult population, spleen length was correlated with left kidney length in women, but not in men and they found the spleen to left kidney ratio to be an unreliable index for spleen size in adults (Spielmann et al., 2005). Racial differences in the normal length and width of the spleen have been shown to exist (Hosey et al., 2006). There is paucity of data in the tropics on the spleen to left kidney ratio with reference to age and somatometric parameters among school age children which will serve as an internal reference standard against which the spleen size can be calibrated (Eze et al., 2014a).

This research could be related and introduced into a more diverse population by ensuring population specific charts to compensate for demographic variations in spleen dimensions.

1-2 Problem of the study:

Main research problem is that spleen length varying depends on age, gender and length when measured by ultrasound, so we tried here to find other method to measure it by ultrasound to compare its length to left kidney length which gives constant ratio that can be used to detect mild splenomegaly.

1-3 Objectives of the study:

1-3-1 General objective:

The general objective of this study was to measure sonographically the spleen to left kidney ratio according to age among school age children in Saudi Arabia.

1-3-2 Specific objectives:

- To measure the spleen and left kidney length and estimate the ratio.
- To correlate spleen to left kidney ratio to age.
- To find accurate method of measurement to detect mild splenomegaly

1-4 Thesis overview:

Chapter one: introduction ,objective and problem.

Chapter two: literature review.

Chapter three: material and methods.

Chapter four: results.

Chapter five: discussion ,conclusion and recommendation.

Chapter Two

Theoretical Background and Literature Review

2.1 Anatomy of the spleen:

The spleen is an intra-peritoneal organ located in posterior portion of left upper quadrant of the abdomen It lies parallel to the diaphragm, medially and anteriorly to the kidney, inferiorly and medially to the tail of pancreas and splenic flexure medially. It is convex along it is superior lateral border and concave medially. The contour is generally smooth but contour lobulation can be seen as normal variant. The splenic artery enters and splenic vein leaves medially at the hilum with the artery being the most posterior vessel (Zheng et al., 2015).

The spleen is organ of the lymphatic system located in the left side of the abdominal cavity under the diaphragm, the muscular portion between the abdomen and the chest in humans it is the size of a fist and is well supplied with blood, as the lymphatic circulation, the spleen is primary filtering element for the blood. In humans, spleen is brownish in color and located in the left upper quadrant of the abdomen (Dong et al., 2015).

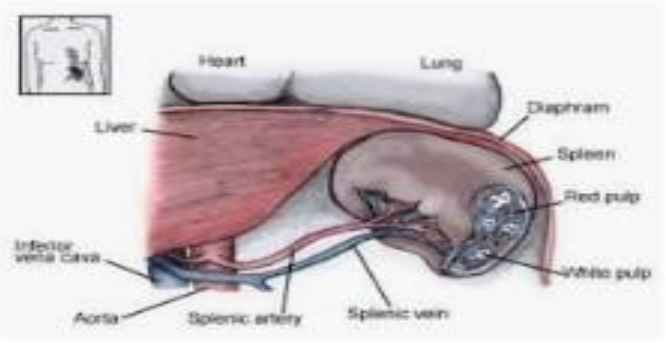

Figure (2-1) spleen Anatomy (Snell, 2012)

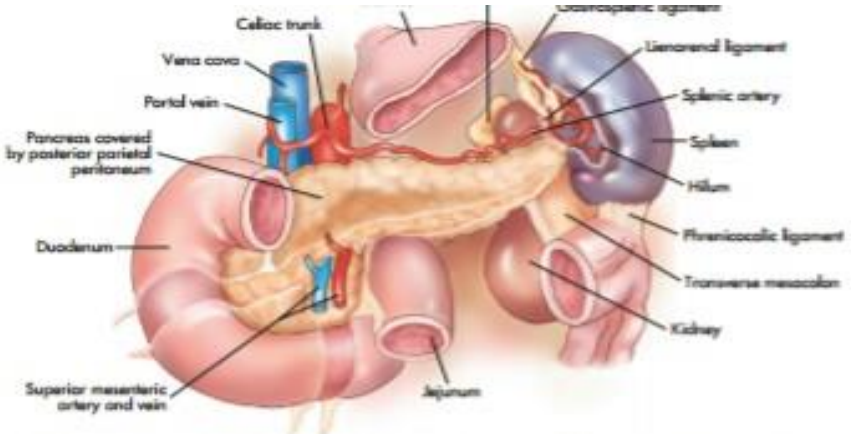

Figure (2-2) shows anatomy of spleen (Zheng et al., 2015)

Figure (2-3) show structures of the spleen (Paraskevas et al., 2016)

2-1-1Development:

The spleen appears about the fifth week as localized thickening of the mesoderm in the dorsal mesogastrium above the tail of the pancreas with the change in position of the stomach and in contact with left kidney. The part of the dorsal mesogastrium which

intervened between the spleen and the greater curvature of the stomach form the gastrosplenic ligament (Ignjatovic et al., 2002).

2-1-2 Structure of the spleen:

The external coat or serous coat (tunica serosa) is derived from the peritoneum, it is thin, smooth and in the human subject intimately adherent to the fibroblastic coat, it is invests the entire organ, except at the hilum and along the lines of reflection of the phrenic lineal and gastrolienal ligament (Chadburn, 2000).

The fibroblastic coat (tunica albuginea) invests the organ, and at the hilum is reflection inward upon the vessels in the form of sheaths. From these sheaths, as well as from the inner surface of the fibroblastic coat, numerous small fibrous bands, trabeculae (figure 2-2) are given in all direction; these uniting constitute the frame of the spleen. The spleen than for consists of a number of small spaces or areolae, formed by trabeculae in these areolae contained the splenic pulp (Bajwa and Kasi, 2018).

The fibroblastic coat, the sheaths of the vessels and the trabeculae, are composed of white and yellow elastic fibrous tissues. The later predominating is owing to the presence of the elastic tissue that the spleen possesses considerable amount of elasticity, which allows of the very great variation in size that is present under certain circumstances (Bajwa and Kasi, 2018).

In addition to these constituent this tunic ,these is found in man , in 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 . The spleen is encased in thick connective tissue capsule, inside the mass of splenic tissue of two types; Red pulp and white pulp (which do not separate into regions but intermingle distributed throughout the spleen (Ignjatovic et al., 2002).

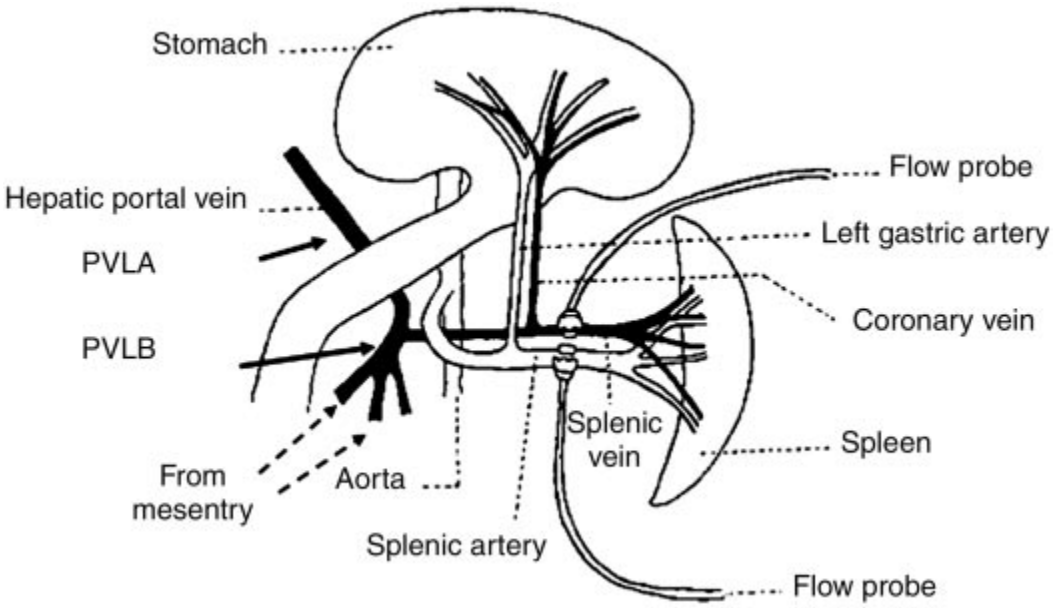

Figure (2-4) shows splenic circulation (Bajwa and Kasi, 2018)

The white pulp is lymphatic tissue that usually surrounds splenic vessels. The red pulp is network of cannels (sinuses) filled with blood and it is in the red pulp that most of the filtration occurs. The splenic pulp (pulpalienis) is a soft mass of a dark reddish – brown color, resembling grumous blood; it is consist of affine reticulum of fibers, continuous with those of trabeculae, to which are applied fat, branching cells. The meshes of the reticulum are filled with blood, in which however the whit corpuscles are found to be in large proportion than they are in ordinary blood.

The large rounded cells, termed splenic cells, are also seen; these are capable of amoeboid movement and often contain pigment and red blood corpuscles in their anterior. The cells of the reticulum each possess around or oval nucleus, and like the splenic cells they may contain pigment granules in their cytoplasm, they do not stain

deeply with carmine and in this respect differ the cell of the Malpighi and bodies (Bajwa and Kasi, 2018).

2-1-3Neurovascular supply:

Spleen is highly vascular organ that receives its arterial blood supply from the splenic artery. This vessel arises from the coeliac trunk, running laterally along the superior aspect of the pancreas, with in the splenorenal ligament. As the artery reaches the spleen, it branches in to five vessels, each supplying a different part of organ. These arterial branches do not anastomose with each other – giving rise to vascular segments without affecting the others (procedure known as a sub total splenectomy. Venous drainage occurs through the splenic vein. It combines with superior mesenteric vein. It combines with superior mesenteric vein to form the hepatic portal vein (Menezes et al., 2014).

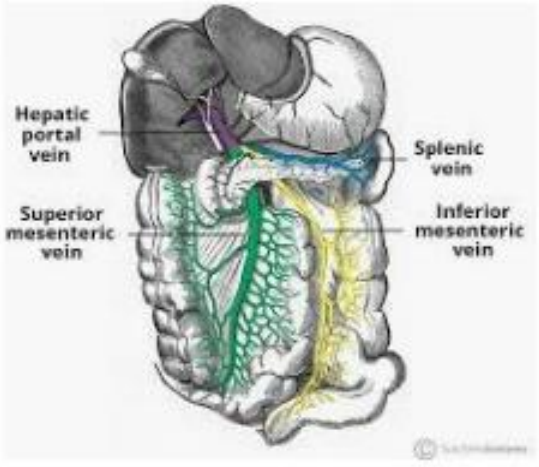

Figure (2-5) show venous portal system-draining into the hepatic portal vein (Menezes et al., 2014)

The lineal artery is remarkable for it is large size in proportion to the size of the organ, and also for it is tortuous course. It divides into six or more branches, which enter the hilum of the spleen and ramify throughout it is substance, receiving sheaths also invest the nerve and vein.

Each branches run in the transverse axis of the organ, from within out word, diminishing, in size during it is transit, and giving off in it is passage smaller branches – some of which pass to the anterior, and others to the posterior part. These ultimately leave the trabeculae sheaths and terminate in the proper substance of the spleen in small tufts or pencils of minute arterioles, which open in to the interstices of the reticulum formed by the branched sustent acular cells. Each of the large branches of the artery supplies chiefly that region of the organ in which the branch ramifies, having no anastomosis with majority of the other branches. The nerve supply to the spleen is from the celiac plexus. The nerves are chiefly non modulated. They distributed to the blood vessels and to smooth muscle of the capsule and trabecular (Zheng et al., 2015).

2-1-4 Accessory spleen:

An accessory spleen is a small splenic nodule extra to the spleen usually formed in early embryogenesis. Accessory spleens are found in approximately 10% of the population and are typically around 1 cm in diameter. Splenosis is condition where displaced pieces of the spleen tissue (often following trauma or after splenectomy, auto transplant in the abdominal cavity as accessory spleens). Polysplenia is a congenital disease manifested by multiple small accessory spleens rather the single, full sized normal spleen. Poly splenia sometimes occur alone, but is often a companied by other developmental abnormalities, such as intestinal malformation, biliary atresia or cardiac abnormalities such as dextrocardia. These accessory spleens are non – functional (Xu et al., 2016).

Figure (2-6) shows accessory spleen (Benter et al., 2011)

2-2 Physiology of the spleen:

2-2-1Spleen function:

The Spleen is useful for the production antibodies against antigen present in blood and it is the only organ that performs such function, Other organs may produce antibodies against antigens seen or present in tissue the spleen also produces large amounts of B and T lymphocytes through its white pulp It is the body It therefore removes old or bad blood cells and platelets and it destroys bacteria and foreign organism by a process of opsonization and also phagocytosis to include its function of process of producing antibodies .The spleen stores about 33% of all platelets to in the entire body and It is involved in hematopoiesis in the fetus and may be implicated in extra medullary hematopoiesis in certain disease condition in the adult . In addition to these function of the spleen also serves in many lower animals , and to little extent in man a reservoir for storing up blood which may then be released into circulation when it is required, as in sudden loss of blood (Paraskevas et al., 2016).

2.2.2 Microcirculation in the spleen;

The open system suggests that there is on continuity between the ellipsoids and the sinusoids Blood from the ellipsoids are discharged into the reticulum of the spleen from which they are absorbed into the sinusoids. The sinusoid makes up the red pulp of the

splenic pulp they are connected to the venules as per any of the mechanisms above and from the venules they discharge their blood into the splenic vein. The sinusoid are lined by special endothelial cells which are banana shaped and contain myofibrils that allow them to contract thereby opening up channels by which blood is discharged into the splenic substance. They are called stave cells. Red blood cell passes through the sinusoidal spaces. When they are old, they are unable to pass across and they are then destroyed by the splenic macrophagic system (Paraskevas et al., 2016).

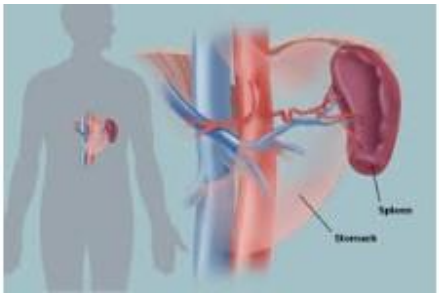

Figure (2-7) spleen function (Paraskevas et al., 2016)

2-3 Splenomegaly:

Splenomegaly is enlargement of the spleen, and is one of the four clinical signs of hyper splenism, which includes; some reduction in the number of circulations, blood cells affecting granulocyte, erythrocytes or platelets in any combination, a compensatory proliferative response in the bone marrow, and the Potential to correction these abnormalities by splenectomy. Splenomegaly is usually associated with increased workload (such as in anemia's, which suggests that it is response to hyper function. It is there for not surprising that splenomegaly is associated with any disease process that involves abnormal red blood cells being destroyed in spleen. Other common causes include congestion due to hypertension and infiltration by leukemia and lymphoma (Menezes et al., 2014).

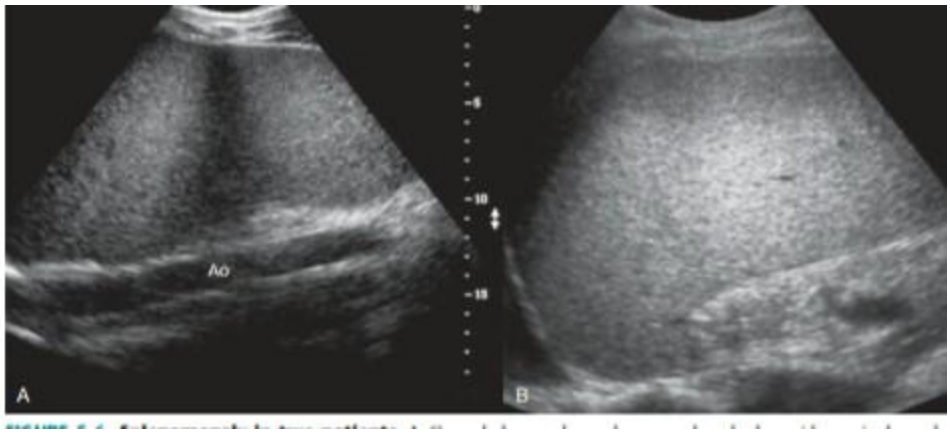

Figure (2-8) shows splenomegaly (Xu et al., 2009)

2 - 4 Ultrasound Technique:

The left upper quadrant may be imaged as the sonographer carefully manipulates the 2.5 MHz curvilinear transducer between costal margins to image the left kidney, spleen and diaphragm. The sector transducer may fit between the intercostal margins better than the larger curved-array transducer. The spleen generally lies in an oblique pathway in the posterior left upper quadrant; therefore, the transducer may be placed in the intercostal margin and with a slow anterior to posterior sweep may demonstrate the long axis of the spleen (Al-Salem et al., 1998).

When the patient is lying supine, the problem of overlying air-filled stomach or bowel anterior to the spleen may interfere with adequate visualization; thus the patient should be rotated into a steep right decubitus position to permit better transducer contact between the ribs without as much bowel interference. The patient should be instructed to raise his or her left arm over his or her head to further open up the intercostal spaces to allow the transducer better access to the spleen (Benter et al., 2011).

The right lateral decubitus or axillary position enables the sonographer to scan in an oblique fashion between the ribs. Variations in patient respiration may also facilitate imaging of the spleen; deep inspiration causes the lungs to expand with air and displaces the diaphragm; the lungs may expend so fully that the cost phrenic angle is obscured and

visualization of the spleen is impeded. The sonographer should observe the patient's breathing pattern and modify the amount of inspiration to adequately image the spleen without interference from the air-filled lungs (Benter et al., 2011).

At least two images of the spleen should be recorded in the longitudinal and transverse plane. The longitudinal plane should demonstrate the left hemi diaphragm, the superior and inferior margins of the spleen, and the upper pole of the left kidney. Sonographer should look at the left pleural space superior to the diaphragm to see if fluid is present in the lower costal margin. The long axis of the spleen is measured from its superior-to-inferior border. After the longitudinal oblique scan is completed, the transducer is rotated 90 degrees to survey the spleen in a transverse plane. The sonographer should obtain at least on transverse image at the hilum of the spleen. The sonographer should observe the flow of the splenic artery and vein with color Doppler (Xu et al., 2009).

Figure (2-9) shows Intercostal scan plane and normal spleen image (Benter et al., 2011)

2.5 Ultrasound appearance of the spleen:

The normal spleen has affine, homogeneous texture, with smooth margins and a pointed inferior edge. The texture of the spleen is actually considered to be more echogenic than that of the liver. As the spleen enlarges, echogenicity further increases. The shape of the spleen has considerable variation .The spleen has two components joined at the hilum: a super medial component and an inferolateral component. On transverse scans, it has a "crescan" inverted comma appearance, usually with a large medial component and a thin

component extending anteriorly. This part of the spleen may be seen to indent the fundus of the stomach moving inferiorly, only the lateral component is imaged. On longitudinal scans, the superior component extends more medially than the inferior component. The superomedial component or the inferolateral component may enlarge independently. The irregularity of these component makes it difficult to assess mild splenomegaly accurately (Benter et al., 2011).

Figure (2-10) show normal spleen image (A) long and (B) transverse (https:/www medical news today .com)

2.6 Ultrasound measurements:

The spleen is of variable size and shape (e.g., "orange segment," tetrahedral, triangular) but generally is considered to be ovoid with smooth, even borders and a convex superior and concave inferior surface .The size of a normal spleen depends on gender, age and body-height. The wide range of what normal sized adult spleen is combined with its complex three dimensional shape makes it particularly difficult to establish a normal range of sonogrphic measurements (Benter et al., 2011).

2.6.1 Measurement for adults:

Study of almost 800 normal adults found that in 95% of patients, the length of the spleen was less than 12 cm, the breadth less than 7 cm and the thickness less than 5 cm. The measurements are obtained by measuring the longest dimension in a sagittal ' parasagittal or coronal plane thickness on a transverse scan the hailer thick ness is measured from the hilum perpendicular to the medial concave surface and the lateral convex surface and width on a transverse scan the width is measured as the greatest dimension perpendicular to the thickness (Catalano et al., 2006).

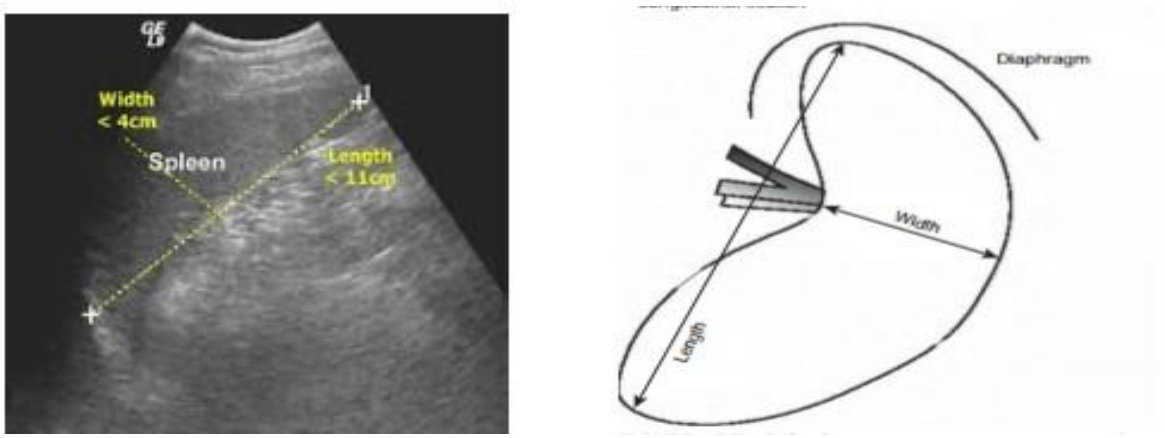

Figure (2-11) show Sonographic measurements of spleen (Catalano et al., 2006)

2-7 Previous study:

Many studies were conducted to show how to measure spleen and measurement of the ratio between the spleen and left kidney length by ultrasound to detect splenomegaly.

(Eze et al., 2014a) in their study showed that the spleen to left kidney ratio according to age and somatometric parameters is constant at about 1.13 with 1.3 as the upper limit of normal in the studied population.

Another study conducted by (Hosey et al., 2006) revealed that the Mean (SD) splenic length was 10.65 (1.55) cm and width, 5.16 (1.21) cm. Men had larger spleens than

women ($p<0.001$). White subjects had larger spleens than African-American subjects ($p<0.001$). A previous history of infectious mononucleosis or the presence of recent cold symptoms had no significant affect on spleen size. In more than 7% of athletes, baseline spleen size met current criteria for splenomegaly.

(Megremis et al., 2004) in their study spleen length in childhood with Ultrasound normal value based on age ,sex and somatometric parameters that resulted to spleen length was highly correlated with age, height, weight, and BSA; there was no statistically significant difference between the sexes. The exact pattern of these relationships was nonlinear (polynomial type of third order for age, height, and weight and exponential type for BSA). Multiple regression analysis indicated that age, height, and either weight or BSA had significant positive associations with spleen length. The spleen lengths among the sample of 58 children whose height and weight were outside the normal ranges of growth parameters did not influence the proposed upper limits (almost all were within the 90% UCLs with respect to height and weight for the main sample).

(Suliman et al., 2019) in their research article measurements of the normal size of spleen and spleen to left kidney ratio among Sudanese children up to five years age using ultrasonography reported that, there was strong significant positive correlation between spleen and left kidney measurement with age, height, weight of individual. The spleen to left kidney ratio for children up to five years ranged (0.86-1.23) with mean 1.04, so if the ratio less or more than this ranged it should be considered in clinical context for diagnosis of splenomegaly or shrunken spleen in children up to five years of age.

Chapter Three
Materials and Methods

3-1 Machine used:

Material used in this study was Siemens ultrasound machine (Acuson X300) premium edition model 10566144 from Siemens medical solutions USA manufactured on 2012. With power (100-240) volt, (50-60) Hz and convex probe 2 to 5 MHZ.

3-2 Duration and place of study:

This study was conducted in Saudi Arabia in Kharj city in the middle east of the country at Taawn medical clinic during the period from June 2019 to December 2019.

3-2-2 source of data (the patient):

50 school age children, 28 female and 22 male their age ranged from 7 to 15 year without any symptoms of renal or spleen disorders. Children less than 7 and more that 17years, ill patient and patient with known pathology were exclude from the study.

3-2-3-Data collection:

Data collected from ultrasound images of the sample by measuring the spleen and left kidney and take the ratio of these measurements. In addition subjects demographic data were obtained.

3-3-The technique used in this study:

Ultrasound transmission gel (hypoallergic-water soluble) was first applied to the area being scanned to ensure good transmission of the ultrasound beam into the subjects. Right lateral decubitus position in the coronal plane was used for the spleen length

measurement. Longitudinal size measurement was performed between the most superomedial and the most inferolateral points of the spleen

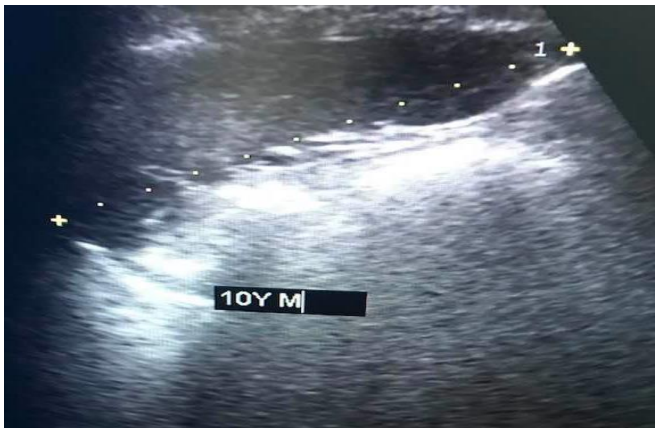

Figure 3 -1 Sonogram of the length of the spleen measured between the most superomedial and the most inferolateral margin of the spleen.

The child lies supine or slightly right lateral decubitus position a longitudinal size measurement was obtained in the coronal plane passing through the renal hilum of the left kidney with or without deep inspiration.

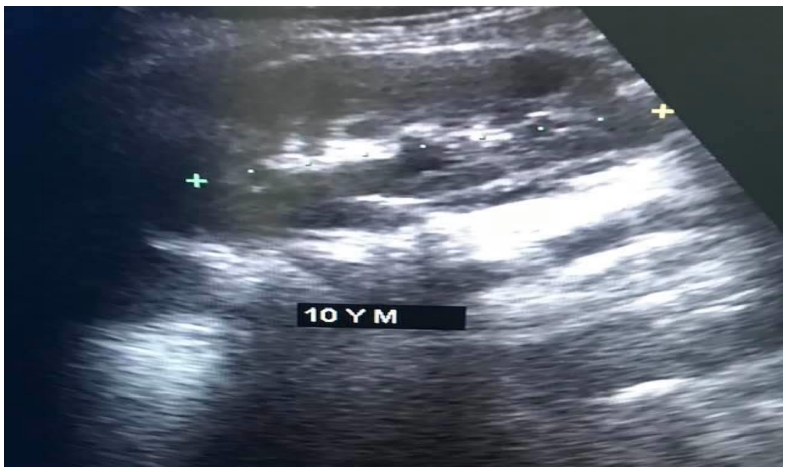

Figure 3-2 Sonogram of bipolar measurement of left kidney length.

These two types of techniques were selected because they were the best way of obtaining easily the longest dimension of the spleen and left kidney and repeated of measurements

to take the main values of sizes to record. Spleen and left kidney lengths were measured three times, and the mean values were recorded. Both had normal position, shape and echotexture prior to measurements. The measurement of left kidney dimensions was made during deep inspiration.

3-2-5-Data analysis:

A total of 50 age school children were scanned and all the parameters recorded in excel sheet of Microsoft office. Descriptive statistics were applied on the available data. Mean ± SD was presented for age, height, weight, S/K ratio, data analysis was carried out using SPSS Version 20.

Chapter Four
Results

4-1 Results:

Table 4-1showed frequency distribution of gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	28	56.9	56.9	56.9
Male	22	43.1	43.1	100.0
Total	50	100.0	100.0	

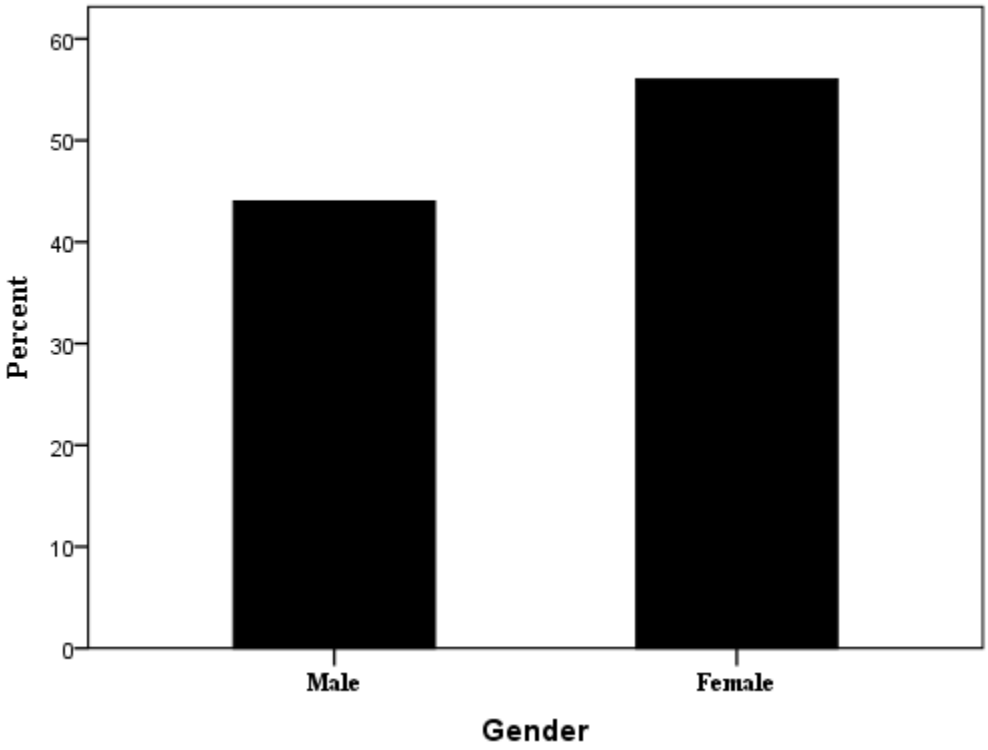

Figure 4-1 shows frequency distribution of gender

Table 4 - 2 Age Groups					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7 - 9	24	48.0	48.0	48.0
	9 - 11	7	14.0	14.0	62.0
	11 - 13	8	16.0	16.0	78.0
	13 - 15	11	22.0	22.0	100.0
	Total	50	100.0	100.0	

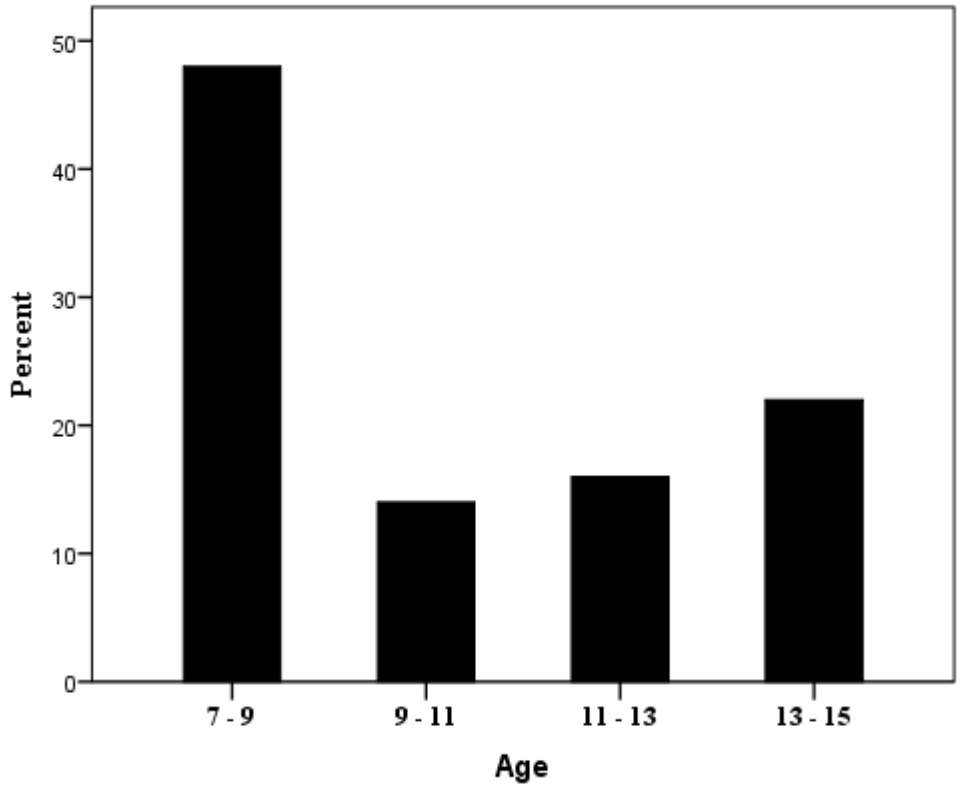

Figure 4-2 frequency distribution of age groups

Table 4-3 Descriptive Statistics of study variables					
	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	7	15	10.38	2.9
Length	50	102	158	131.66	14.12
Weight	50	14	71	30.72	15.54
Spleen Length	50	7.28	13.00	9.72	1.79
Lt Kidney Length	50	6.70	12.40	8.90	1.72
S/K Ratio	50	0.9	1.3	1.1	.076

Table 4-4 shows group statistics of the spleen length, kidney length and spleen to Lt Kidney ratio in male and female

Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
Spleen Length	Male	22	9.69	1.82	0.39
	Female	28	9.74	1.79	0.34
Lt Kidney Length	Male	22	8.91	1.81	0.39
	Female	28	8.89	1.69	0.32
S/K Ratio	Male	22	1.09	0.071	0.01
	Female	28	1.10	0.079	0.01

Table 4-5 showed the correlation between the study variables

Correlations					
		Age	Spleen Length	Lt Kidney Length	Ratio
Age	Pearson Correlation	1	.901**	.890**	-.151
	Sig. (2-tailed)		.000	.000	.294
	N	50	50	50	50
Spleen Length	Pearson Correlation	.901**	1	.949**	-.004
	Sig. (2-tailed)	.000		.000	.975
	N	50	50	50	50
Lt Kidney Length	Pearson Correlation	.890**	.949**	1	-.284*
	Sig. (2-tailed)	.000	.000		.045
	N	50	50	50	50
Ratio	Pearson Correlation	-.151	-.004	-.284*	1
	Sig. (2-tailed)	.294	.975	.045	
	N	50	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

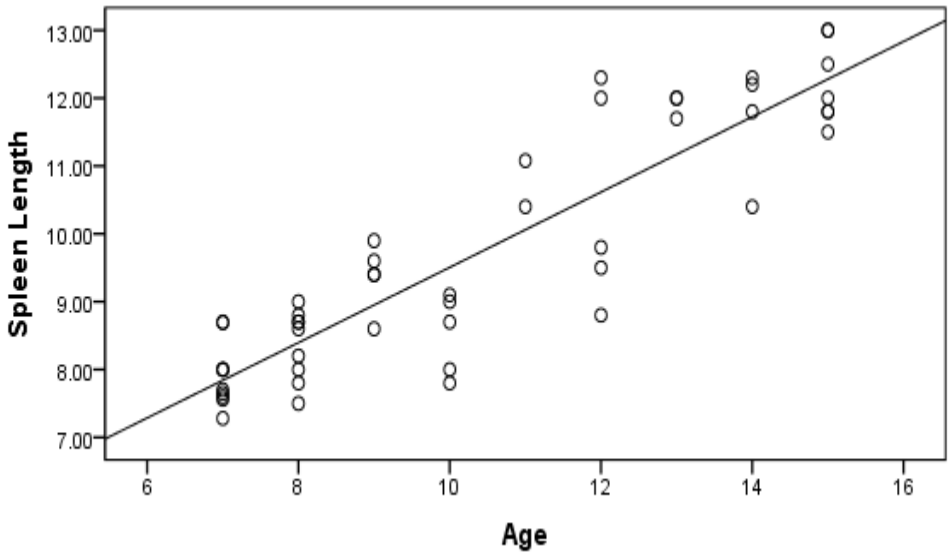

Figure 4-3 scatter showed positive relationship between spleen length and age

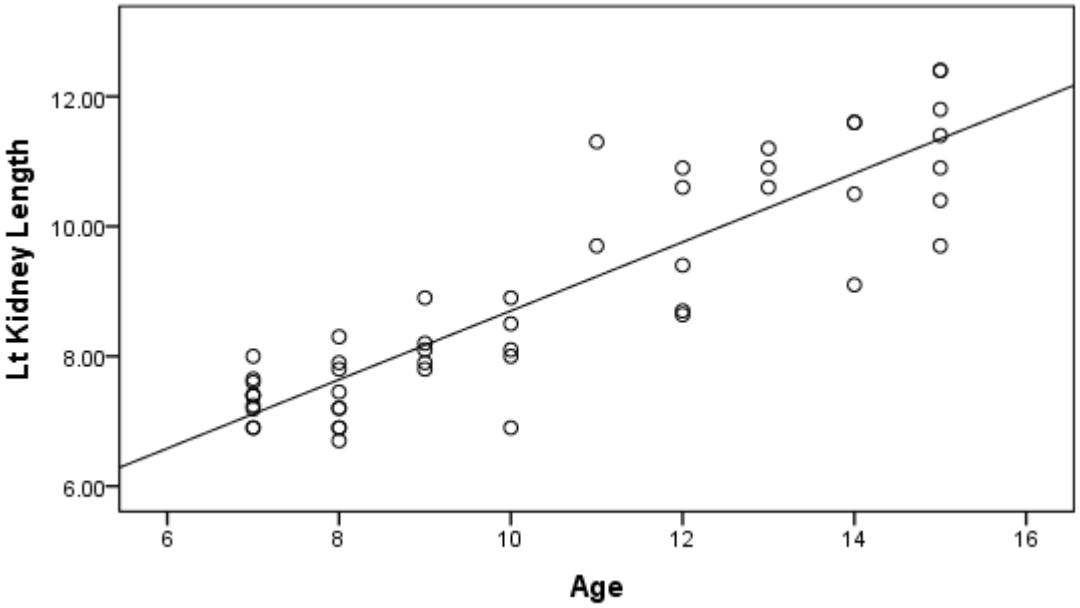

Figure 4-4 scatter plot showed positive relationship between left kidney length and age

Table 4-6 Spleen/Kidney Ratio according to age group

Age Group	N	Mean	Std. Deviation	Std. Error
7 - 9	24	1.121	.0833	.0170
9 - 11	7	1.043	.0787	.0297
11 - 13	8	1.075	.0463	.0164

13 - 15	11	1.091	.0539	.0163
Total	50	1.096	.0755	.0107

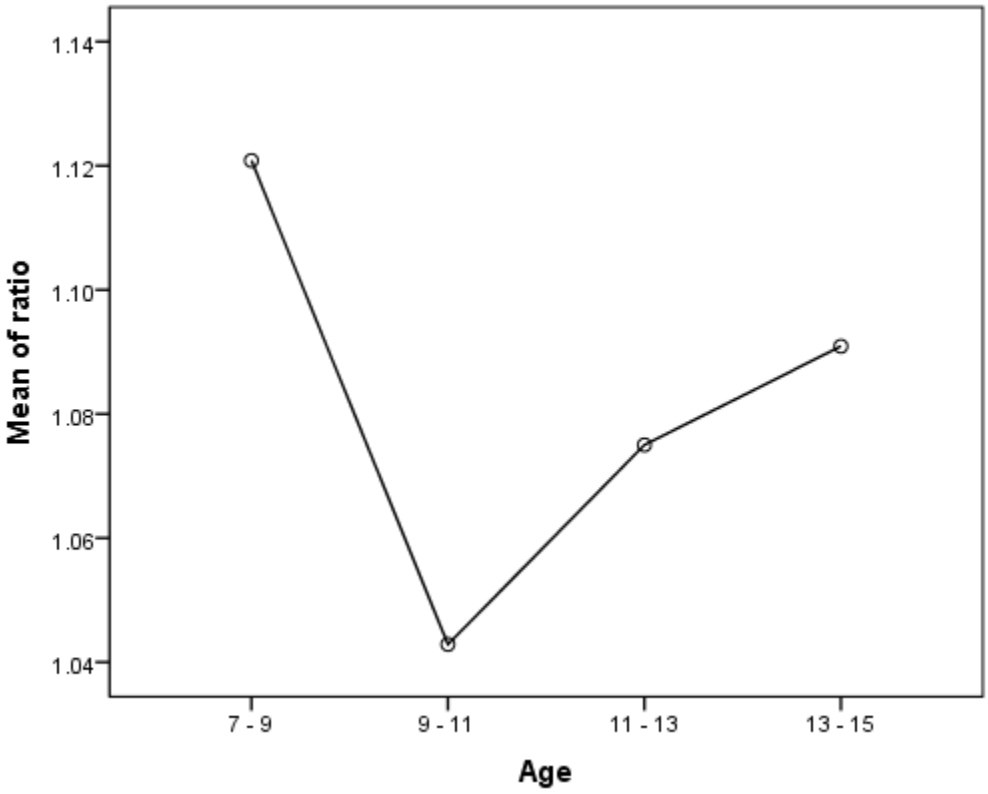

Figure 4-5 shows mean plot of spleen to kidney ratio among different age groups

Chapter Five
Discussion, Conclusion and Recommendation

5-1 Discussion:

Spleen and left kidney measured using ultrasound in longitudinal length measurement. The scan and measurements in this study were performed by the researcher by using main values of three measurements of spleen and left kidney dimension to reduce observer errors. A previous study has shown that experience has an influence on measurement accuracy during ultrasound scanning[15].

The study used school age children ranging from 7 – 15 years which was compatible with school-age Saudi Arabia. Study found that there were no significant differences in the measured spleen and left kidney lengths with respect to gender, the result was similar to the findings of other previous studied (Al-Imam et al., 2000, Loftus and Metreweli, 1998). Therefore, sex certainly is not a determining factor for spleen and left kidney lengths in school-age children in this population. The absence of gender difference in the dimension of both ultrasound of left kidney and spleen suggests a non – involvement of sex hormones in the development of these organs until the age of 18 years.

As the spleen length found to be affected by age, height and weight, the most common method to detect mild splenomegaly is to compare the length of the spleen to the length of the left kidney.

Some investigators have sought to establish an internal reference standard against which the spleen size can be calibrated. The most common of such strategy is to compare the length of the spleen to the length of the left kidney.

(Suliman et al., 2019) as well as (Eze et al., 2014b)found that the spleen to left kidney ratio was constant for all children age groups with a mean value of 1 and proposed a ratio of 1.3 as the upper limit of normal in a pediatric population. In this study the spleen to left kidney ratio is constant at around 1.1 for all ages as well as other biometric parameters such as height and weight, using 2 standard deviations above the mean as a guide, the upper limit of normal for the spleen to left kidney ratio is 1.3. Thus, splenomegaly should be suspected in this school age children population if the spleen is more than 1.3 times longer than the adjacent left kidney in the absence of renal disease, a similar study in adult population, spleen length was correlated with left kidney length in women, but not in men (Spielmann et al., 2005); they found the spleen to left kidney ratio to be an unreliable index for spleen size in adults and proposed the use of Look-up tables as references for daily use in busy practice settings.

The results of this study could be generalized to the wider international community where there is need for each country, especially tropical regions where malaria and typhoid fever are endemic, to establish their own population specific ratios of the spleen to left kidney size in school age children because of possible variations in this ratios in different ethnic origins or races. A multicentre study in other regions of the country might improve the precision of the estimates and also the generalizability of the data. Furthermore, the socio economic status of the children studied was not recorded. It is hoped that further studies will address these limitations.

5-2 Conclusion:

Ultrasound can be used to diagnose mild splenomegaly if the spleen is about 1.3 times longer than the adjacent left kidney in the absence of renal disease among school age children in the studied population. objectively among school age children in absence of renal disorder.

No significant difference in measured of spleen and left kidney in school age children length with respect to gender

The spleen to left kidney ratio is constant around 1.1 with a range of 1 - 3 with respect to age, height and weight among school age children.

5-3 Recommendations:

The spleen to left kidney ratio can be used to exclude non palpable splenic enlargement objectively among school age children in absence of renal disorder.

Beside that further researches advised with increases sample size including wide range of children age in different countries and study socio-economic status of population to obtain more precise results concerning spleen, kidneys length and spleen to left kidney ratio.

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Appendix

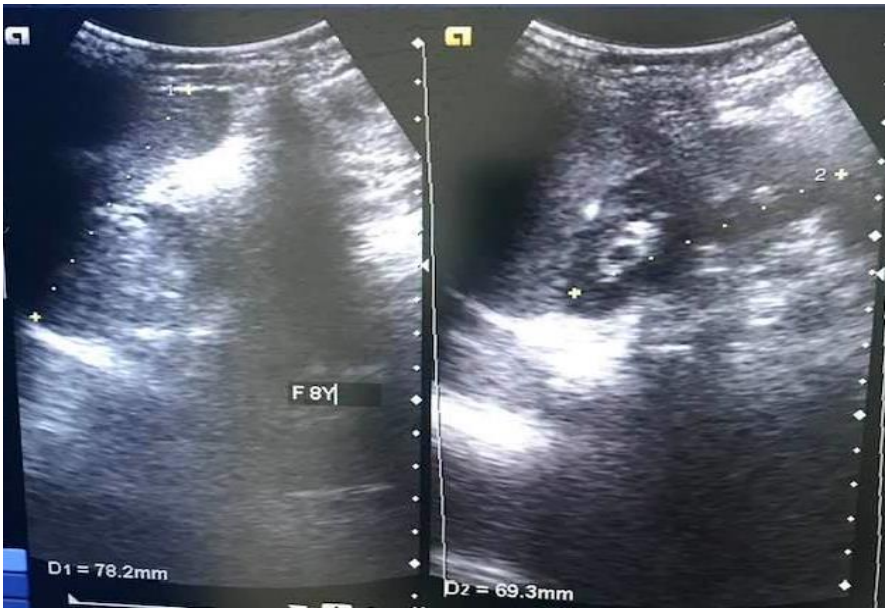

Image (1) Sonogram of spleen and left kidney lengths of 8years old female child.

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

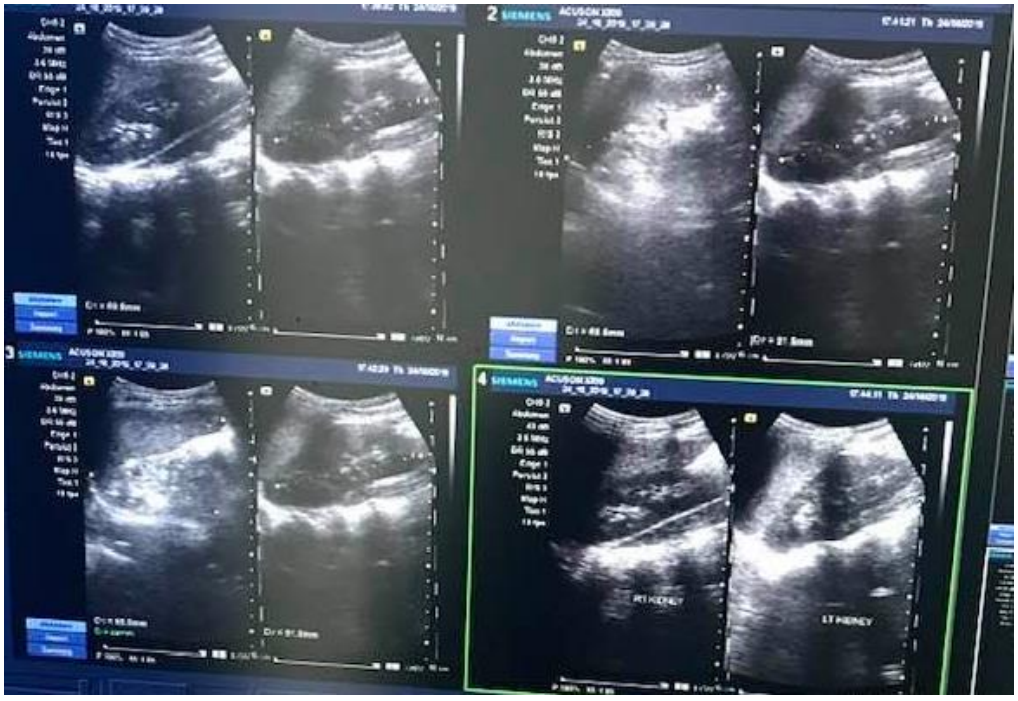

Image (3) Sonogram of main values of spleen and left kidney in 11year male

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

Image (5) Sonogram of left kidney lengths of 10year male child.

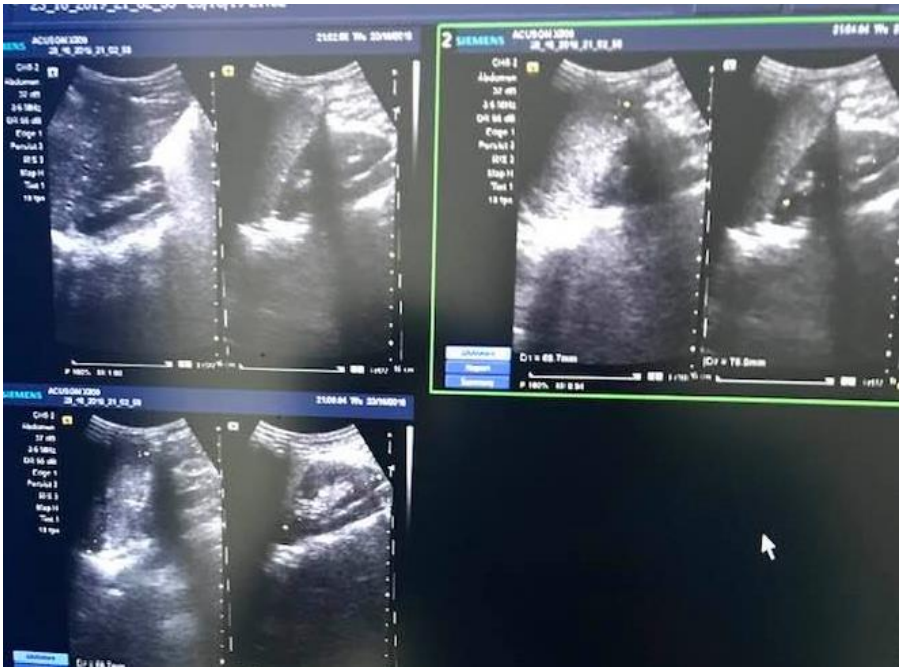

Image (6) Sonogram of left kidney and spleen lengths of 12year female child

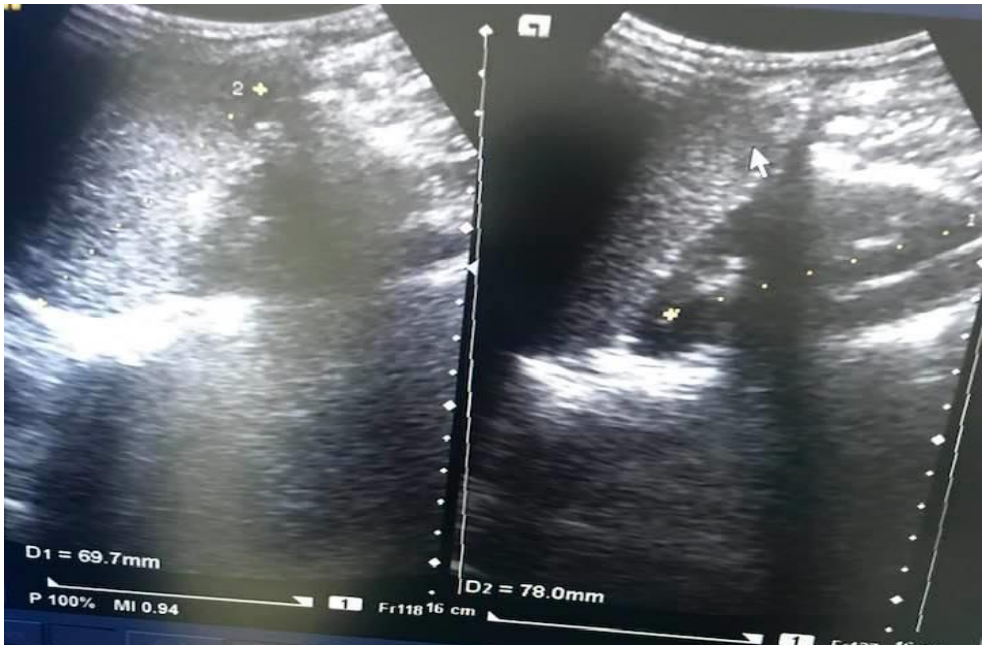

Image (7) Sonogram of left kidney and spleen lengths of 9year male child

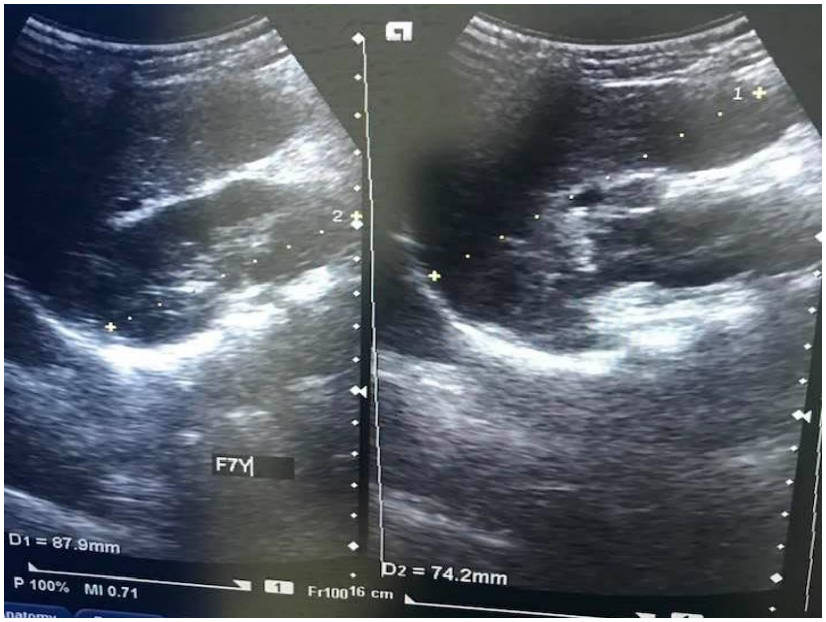

Image (8) Sonogram of left kidney and spleen lengths of 7year female child