Sudan University of Science and Technology

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Characterization of Appendicular Pathology using Ultrasonography

توصيف أمراض الزائدة الدودية باستخدام الموجات فوق الصوتية

A Thesis Submitted for Partial Fulfillment of the Requirements of MSc

Degree in Medical Diagnostic Ultrasound

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2017

الأية

بسم الله الرحمن الرحيم

قال الله تعالي :

(وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا(113))

صدق الله العظيم

سوره النساء الآية 113

Dedication

To

My family, parents, husband, sisters, brothers and sons

To

My friends

To

Anyone who taught me a letter.

Acknowledgement

In the beginning, I am grateful to Allah who had the knowledge and know – how to finish this study.

I would like to express my supervisor Dr. Asma Ibrahim for the useful comments, remarks and engagement through the learning process of this master thesis.

I would like to express my deepest appreciation to all those who provided me to complete this study.

I also thank my colleagues at the Almangil Teaching Hospital, especially my colleague Murtada Alhag Saeed who had supporting me.

Abstract

A descriptive cross sectional study aimed to characterize the appendicular pathology using ultrasonography. The study carried out in Sudan, Algezera State at the Almanagil City(Almanagil Teaching Hospital) during the period from January to June 2017.

There were50 patients with symptoms of appendix pathology and exclude other right iliac fossa pathology, scanned trans abdominally using ultrasound machine sonoscape 20 with linear probe(5-7.5MHz) and sector array(3.5 -5MHz) (Murtada Ultrasound Clinic) and other patients were scanned with mindary Digi prince DP- 6600(china), multi frequency curvilinear probe(3.5-5MHz) and sector array(3.5 -5MHz) (Almanagil Teaching Hospital).

The data was collected, classified, analyzed by using SPSS. The study showed that the use of ultrasound in the diagnosis of appendix to see how the appendix inflamed or not, and this by either a presence of fluid collection around it or the mass. The analysis of the results found that the appendicular pathology were more in female than male, patients with acute appendicitis(74%) more than appendicular mass(26%), The patients with local abdominal pain(62%) more than patients with general abdominal pain(38%), the appendix situated more common in right iliac fossa(86%).

The study conclude , ultrasound helps in diagnosing appendicular pathology and excluding other causes of RIF pain, so the ultrasound is the first choice for diagnosis of appendicular pathology .

ملخص الدراسة

هذه الدراسة وصفيه الهدف منها توصيف أمراض الزائدة الدودية باستخدام الموجات الصوتية . أجريت الدراسة في السودان , ولاية الجزيرة , مدينة المناقل, مستشفى المناقل التعليمي في الفترة من يناير 2017الي يونيو 2017 .

أجريت الدراسة على خمسين مريض لديهم أعراض أمراض الزائدة الدودية و أستبعدت الأمراض الأخري في الحفرة الحرقفية اليمني تم فحص البطن باستخدام جهاز الموجات الصوتية تم جمع البيانات وتحليلها بواسطة برنامج التحليل الإحصائي, وجدت الدراسة أن الاصابة عند النساء اكثر من الرجال, 74% من المرضي لديهم التهاب في الزائدة الدودية بينما 26% لديهم ورم في الزائدة الدودية, 62%من الرضي لديهم الم موضعي بينما 38% من المرضي لديهم الم منتشر في البطن, كما وجدت الدراسة ايضا أن الزائدة الدودية شائعة الوجود في الحفرة الحرقفية اليمني.

توصلت الدراسة الي أن الملامح الأساسية لأمراض الزائدة الدودية تكون بوجود التهاب بها وذلك بان يكون قطرها اكثر من 6 مليمتر, و تجمع سوائل , أو وجود ورم بها.

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Chapter One

Introduction

Introduction

1-1 Introduction:

The appendix is a small blind-ended tube like extension from the posteromedial cecum. Its lumen is continuous with that of the cecum. the appendix is approximately 5mm in diameter and 9cm long. It is connected by a small mesentery to the mesentery of the terminal ileum. peristalsis is usually present and the lumen is empty.it has no known function, removal of the appendix appears to cause no change in digestive function.(Zwieble ,1998).

The normal appendix is at least partially compressible. The normal appendix shows little or no flow on color and power doppler. locating The normal appendix may be difficult. In descending order of frequency for successful demonstration of the appendix, the following landmarks are suggested: the origin from the cecal tip; over the iliac vessels ; anterior to the iliacus muscle; posterior to the terminal ileum; lateral, medial or posterior to the cecum and finally in the pelvis, either near the right adnexa or in the posterior cul-de-sac (Devin Dean, 2005).

Appendicitis is an inflammation of the appendix. Appendicitis is a medical emergency that requires prompt surgery to remove the appendix. Left untreated, an inflamed appendix will eventually burst, or perforate, spilling infectious materials into the abdominal cavity. This can lead to peritonitis. Sometimes a pus –filled abscess forms outside the inflamed appendix. Appendicitis is rare under age 2 and most common between ages 10 and 30 years.(WebmD-2014).

The signs of acute appendicitis are Appendix calculus(0,5-6cm), Sentinel loop-dilated atonic ileum containing a fluid level, Dilated caecum, Widening of the properitoneal fat line , Blurring of the properitoneal fat line , Right lower quadrant haze due to fluid and oedema, Scoliosis concave to the right, Right

lower quadrant mass indenting the caecum, Blurring of the right psoas out line-unreliable and Gas in the appendix-rare ,unreliable. (Webmd- com,2014).

Ultrasound is preferred method for diagnosis and evaluation of appendicoliths and the demonstration of an abnormality distended or thick-walled appendix and can detect periappendiceal and pericecal inflammatory changes. Acute appendicitis is the commonest acute surgical condition in the developed world and carries an overall mortality of about 1%. The diagnosis of acute appendicitis should be considered in patient who present with RLQ pain, nausea, vomiting and leukocytosis. It is essential to visualize the entire appendix as segmental appendicitis can involve only the fundus. Cross sectional images are used for measurements. Abscess formation results in indentation of the caecum on its medial border, when inflammation permeates into the adjacent fat, the lower part of the properitoneal fat line and the right psoas muscle shadow will disappear. Intestinal obstruction may occur as several loops of small bowel becomes matted together or stuck to the inflamed appendix.(WebmD-2014).

1-2 The problem:-

The Late diagnosis of acute appendicitis and appendix pathology lead to serious complications, so the use full the ultrasound as first diagnostic tool for early diagnosis of appendix pathology to avoid these complications.

1-3 Objectives:-

1-3-1 General objective:

To Characterize of appendicular pathology using ultrasonography.

1-3-2 Specific objectives:

To determine the features of appendicular pathology by ultrasound.

To correlate appendicular pathology with gender.

To correlate appendicular pathology with different age groups.

To practice proper techniques of scanning appendix.

1-4 Overview of the study :

This study falls into five chapters with chapter one was introduction which include the problem of the study, objectives , overview of the study. Chapter two was literature review. Chapter three was methodology that include material . Chapter four included the result, presentation, and finally chapter five included discussion, conclusion and recommendations.

Chapter Two

Literature review

Literature review

2-1 Anatomy

2-1-1 Large intestine:-

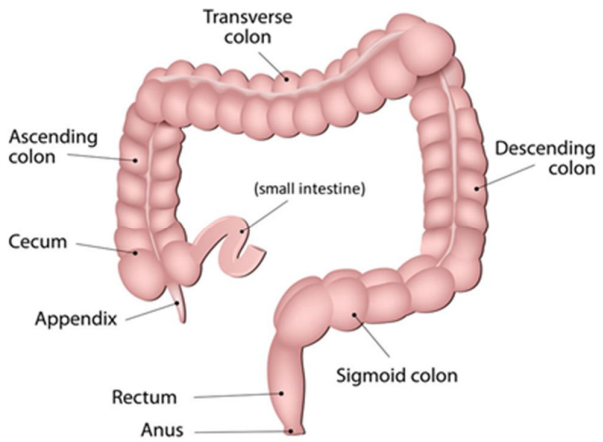
The large intestine, also called the large bowel, forms a three sided perimeter in the abdominal cavity around the centrally located small intestine. From its origin at the ileocecal junction to its termination at the a nus, The large intestine has an approximate length of 1,5 meters(5 feet) and a diameter of 6,5 centimeter (2,5 inches). The large intestine absorbs most of the water and ions from the remaining digested materials. In so doing, the watery material that first enters The large intestine soon solidifies and becomes faces. The large intestine stores the feces until the body is ready to defecate (expel the feces). The large intestine also absorbs a very small percentage of nutrients still remaining in the digested material. (Michael Mckinley et al, 2008).

No digestion takes place in the colon. The only secretion of the colonic mucosa is mucus, which lubricates the passage of the fecal material. The longitudinal smooth muscle layer of the colon is in three narrow bands called taeniae coli. The rest of the colon is(gathered)to fit these bands. This gives the colon a puckered appearance; the puckers or pockets are called sacculations or haustra, which provide for more surface area within the colon (Valerie C et al,2007).

The main subdivisions of the large intestine are the ascending colon and descending colon are retroperitoneal. the caecum, transvers and sigmoid portions are intra peritoneal and have mesocolons which anchor them to the posterior abdominal wall. The total length of the rectum is approximately 12cm. the proximal third is intra peritoneal, the middle third is covered anteriorly with peritoneum and the distal third is below the level of the peritoneum and

therefore has no serosal covering. The rectal wall is similar to the rest of the colon. the anal canal is 2-4cm long and contains internal and external anal sphincters. the large intestine forms a curve within which the small intestine lies the terminal part of the ileum becomes continuous with the large intestine at the ileocaecal junction near this junction, the caecum is also joined by as short, narrow blind tube called the vermiform appendix. The ascending colon meets the transverse colon at the right colic flexure, and the junction of the transverse colon with the descending colon is called the left colic flexure.(Michael Mckinley et al, 2008).

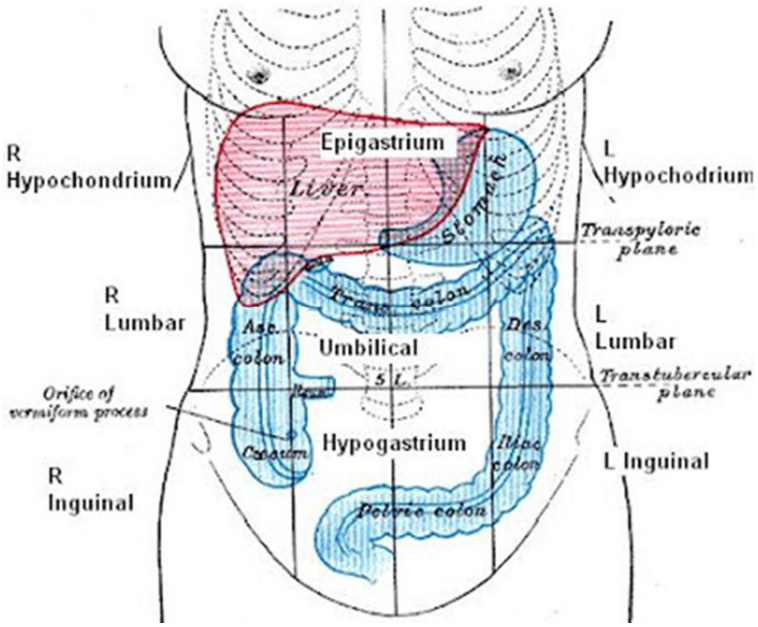
The caecum is initial or first region of the large intestine is a blind sac called The caecum, which is located in the right lower quadrant. It is about 2.5 in. (6cm) long and is completely covered with peritoneum.it possesses a considerable amount of mobility although it does not have a mesentery. The presence of peritoneal folds in the vicinity of the caecum creates the superior ileocecal, the inferior ileocecal and the retrocecal recesses. This pouch extends inferiorly from the ileocecal valve, which represents the attachment of the distal end of the small intestine to the proximal region of the large intestine. Projecting inferiorly from the posteromedial region of the cecum is the vermiform appendix; a thin, hollow, finger like sac lined by lymphocyte-filled lymphatic nodules. Both the cecum and the vermiform appendix are intra peritoneal organs.(Michael Mckinley et al , 2008).



Figure(2-1) show anatomy of the large intestine(peter L. William,1995)

2-1-2 Surface marking of abdomen:-

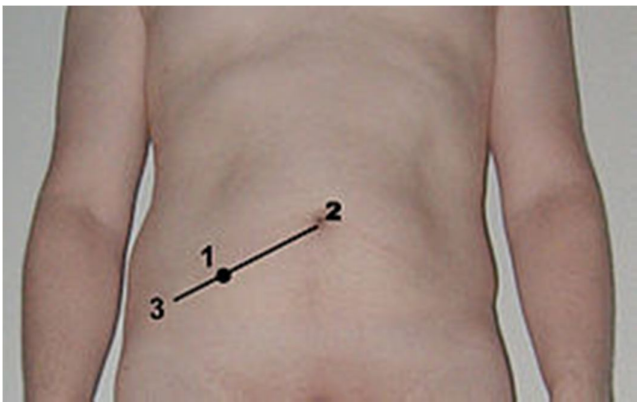
The abdomen can be divided into nine regions by using two horizontal and two vertical plane which are as following: a-The superior horizontal plane(the subcostal plane) is immediately inferior to the costal margins, which places it at the lower border of the costal cartilage of rib 10th and passes posteriorly through the body of vertebra L3 (note, however, that sometimes the trans pyloric plane) halfway between the jugular notch and the symphysis pubis or halfway between the umbilicus and the inferior end of the body of the sternum, passing posteriorly through the lower border of vertebrae LI and intersecting with the costal margin at the ends of the ninth costal cartilages is used instead. b-The inferior horizontal plane(the inter tubercular plane) connects the tubercles of the iliac crest, which are palpable structures 5cm posterior to the anterior superior iliac spines, and passes through the upper part of the body of vertebra L5. c-Vertical planes (RT& LT Lateral planes) passes from the midpoint of the clavicles inferiorly to a point midway between the anterior superior iliac spine and pubic symphysis. (Richard L et al, 2007).



Figure(2-2)Surface marking of the abdomen(peter L. William ,1995)

2-1-3 Surface marking of the appendix:-

In relation to abdominal wall the position of the base of the appendix found as follows, draw a line joining the anterior superior iliac spine to the umbilicus and divide it into three equal parts. The base lies at the lateral and middle thirds of the line. this referred as Mc Burney's.(peter L. William ,1995).



Figure(2-3) Location of Mc Burney's point(1), located two third the distance from the umbilicus(2) to the right anterior superior iliac spine(3).(Wikipedia.org,2016)

2-1-4 The vermiform appendix anatomy:-

The appendix, also known as the vermiform(worm-shaped) appendix is a narrow, blind ended of the tube attached to the posteromedial end of the cecum. The appendix contains large aggregations of lymphoid tissue in its wall. It varies in length from 3 to 5 in.(8 -13cm).the base is attached to the posteromedial surface of the cecum about 1 in(2.5cm) below the ileocecal junction. the reminder of the appendix is free. Has a base that lies deep to MC Burney's point, which occurs at the junction of the lateral one third of the line between right anterior superior iliac spine and the umbilicus. This is the site of maximum tenderness in acute appendicitis. it has a complete peritoneal covering, which is attached to the mesentery of the small intestine by a short mesentery of its own, the mesoappendix. The base of the appendix is easily found by identifying the taniae coli of the cecum and tracing them to the base of the appendix, where they coverage to form a continuous longitudinal muscle coat. The normal appendix should have at least 5 layers in longitudinal – serosa, muscularis, apposed mucosal layers(mucosa and sub mucosa), muscularis and serosa again. (Richard S .Snell, 2003).

2-1-4-1 The variations position of the appendix:-

The position of the free- end of the appendix is highly variable and can be categorised into seven main locations. The most common positions are retrocaecal and subileal. A simple way to remember the positions is by imagining The appendix as the hour hand of o clock: a-pre-ileal: anterior to the terminal ileum-1 o clock, b-Post-ileal: posterior to the terminal ileum-3 o clock, c-promontoric (subileal), d-Pelvic: descending over the pelvic brim-5 o clock, e-Sub-caecal: below the cecum-6 o clock, f-Para caecal: a long side the lateral border of the cecum- 10 o clock, g-Retro-caecal: behind the cecum-11 o clock. (peter L. William ,1995).

Pelvic appendix, an appendix hanging down in the pelvis may result in abscent abdominal tenderness in the right lower quadrant, but deep tenderness may be experienced just above the symphysis pubis, rectal or vaginal examination may reveal tenderness of the peritoneum in the pelvis on the right side.(Richard S .Snell, 2003).

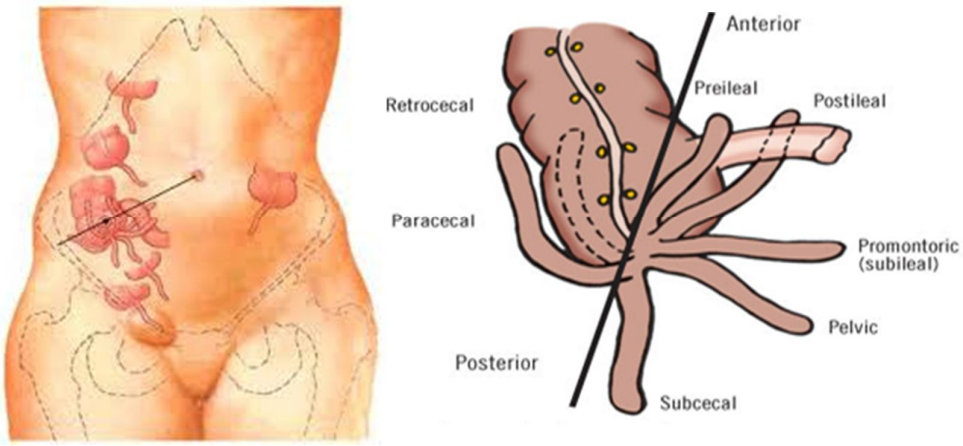


Figure (2-4)Normal variants of appendix(wikipeadia.com, 2016)

2-1-4-2 The neurovascular supply:-

The appendix receives its blood supply via the appendicular artery(derived from the ileocolic artery— from superior mesenteric artery), and drains through the appendicular vein. the appendicular vein drains into the posterior caecal vein. Both are contained, along with lymphatic vessels and nerves, within the mesoappendix, a fold of mesentery which suspends the appendix from the terminal ileum. The autonomic nervous system innervates the cecum and appendix. It achieves this by means of the ileocolic branch of the superior mesenteric plexus, which follows the same course as the ileocolic artery.(Harold Ellis, 2006).

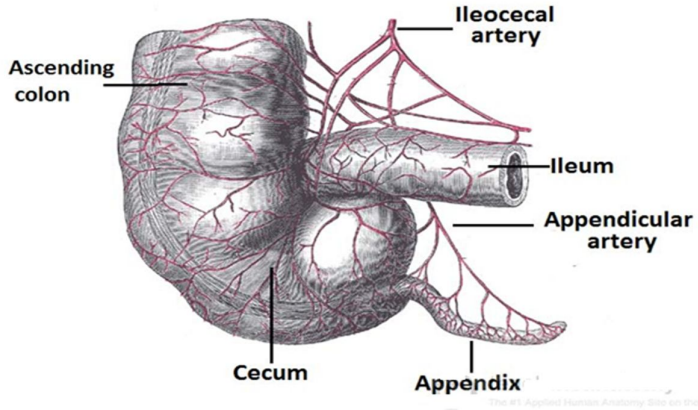


Figure (2-5)Arterial supply to the cecum and appendix via the ileocecal artery. (Harold Ellis, 2006)

2-1-4-3 Lymphatic drainage:-

Lymph from the cecum and appendix ultimately drains into the upper and lower ileocolic lymph nodes, which surround the ileocolic artery. However, lymph from the cecum travels via a number of intermediate mesenteric nodes, where as that of intermediate node in the mesoappendix. (peter L. William ,1995).

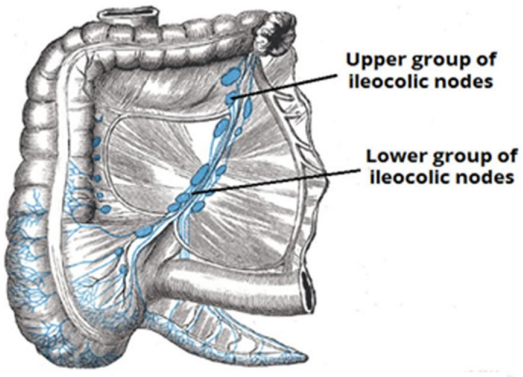


Figure (2-6)Lymphatic drainage of the cecum and appendix,

(wikipeadia.com, 2016)

2-2 Physiology:-

Surprising functions of the appendix:- Far from being useless , the appendix may produce and protect beneficial probiotic colonies in the digestive system. According to researchers, the human digestive system is full of bacteria necessary to digest food. When attack from diseases, sometimes these important kinds of bacteria are purged or killed off. In such situations, the appendix can act as a reserve for good bacteria. After the immune system beats off the disease, the bacteria emerge and re-colonize the gut. for the past few decades, conventional medicine believed the appendix was an unimportant organ and served very little function. the appendix may play a vital function in the development of the immune system. The lymphoid tissue accumulates in the appendix after birth, the appendix helps in the maturation of B lymphocytes and the production of antibodies. What's more, the appendix produces specific molecules that aid in the movement of lymphocytes to varies locations within the body. When illness reduces good bacteria from the intestines, the appendix may store some of that good bacteria for backup. It's also been shown that individuals without an appendix may be four times more likely to suffer from recurrent clostridium difficile colitis, an irritation of the large intestines by spore-forming bacteria. This condition is often present when the body is running low on gut flora, potentially explaining the connection between the appendix and its role in maintaining probiotic levels.(global healing center ,2015).

2-3 Pathology:-

2-3-1 acute appendicitis:-

acute appendicitis is an acute inflammation of the appendix, usually resulting from bacteria or viruses that are trapped by an obstruction of the lumen by faces, a foreign body, or cancer. Blockage may also occur from infection, since the appendix swells in response to any infection in the body. acute appendicitis is most common explanation for the <acute abdomen presentation > to an emergency departments. It occurs in 7% of the population, is more common in males than in females and has variable symptoms that often consist of periumbilical pain, which may move downward and to the right near Mc Burney's point, followed by nausea, vomiting, fever, diarrhoea, or constipation. the specific physical finding are rebound tenderness, pain on percussion, rigidity, and guarding. Patients typically have right lower quadrant pain, tenderness, and leucocytosis. Amass may also palpable. The patient with a classic presentation usually has an appendectomy without preoperative imaging. This approach often becomes complicated when a normal appendix is removed in a patient with symptomatology caused by other factors. Sever complications of a rupture appendix include widespread, painful inflammation of the inner lining of the abdominal wall and sepsis. On the other hand surgery may be delayed in some patients with acute appendicitis if the presentation is a typical. This approach may lead to perforation before the surgery. Making it a complicated and difficult procedure, often followed by abscess formation. In the clinical literature, laparotomy resulting in removal of normal, non inflamed appendices is reported in 16%to 47% of cases(mean 26%), also, perforation may occur in up to 35% of patients. (Rumack et al, 2011).

Symptoms of appendicitis overlap with a variety of other gastrointestinal conditions, including acute typhlitis, acute mesenteric adenitis, variations of

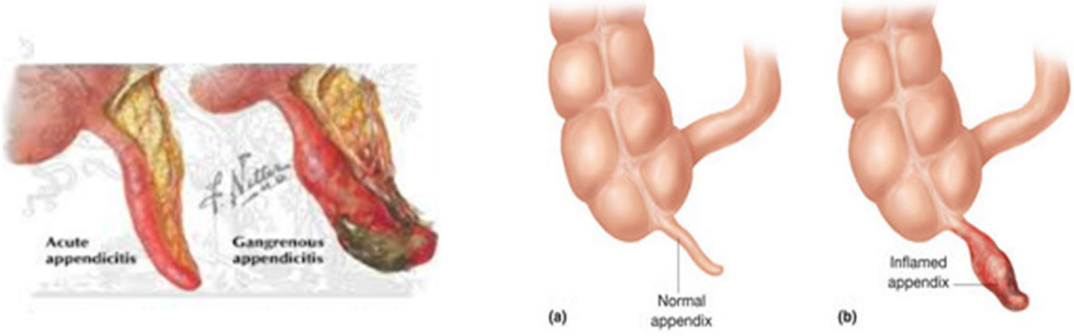
crohn's disease, right-sided diverticulitis, acute segmental infarction of the omentum, and in women, acute gynaecologic conditions(particularly acute pelvic inflammatory disease. This occurs most often when the appendix is located in the true pelvis. The pathophysiology of acute appendicitis likely involves obstructions of appendiceal lumen, once this obstruction occurs, the appendix becomes filled with mucus and swells. This continued production of mucus leads to increased pressures within the lumen and the walls of the appendix. The increased pressure results in thrombosis and occlusion of the small vessels, and stasis of lymphatic flow. As the occlusion of the blood vessels progresses, the appendix becomes ischemic and then necrotic. As bacteria begin to leak out through the dying walls, pus forms within and around the appendix(suppuration).the end result is Appendiceal rupture(a burst appendix) causing peritonitis, which may lead to sepsis and eventually death.(Cotran et al , 1999).

Both clinical and experimental data support the belief that some patients have repeated attacks of appendicitis. Surgical specimens have shown chronic inflammatory infiltrate in patients with recurrent attacks of RLQ pain before appendectomy. This particular pathology is optimally studied with transvaginal placement of the ultrasound probe because the appendix is often intimately related to either the uterus or the ovaries. Cross sectional images are used for measurements. acute appendicitis often demonstrates hyper vascularity on power Doppler. Twenty percent of patients with appendicitis may have an incorrect clinical diagnosis of this number, 6 to 8 percent will be false –positive. clinical diagnosis is especially difficult in young children or the elderly. an Appendiceal abscess is usually a complication of appendicitis, through occasionally (especially in the older age group) it may be the first and only sign of appendicitis. There is no way to prevent appendicitis, however, appendicitis

is less common in people who eat foods high in fiber, such as fruits and vegetables.(Carol. Krebs et al,1993).

Sonographic criteria for acute appendicitis are a-The diameter is greater than 6 mm (outer wall to outer wall), b-point tenderness localized to the appendix, c-Presence of an intraluminal stone (appendicolith or calculus) in a patient with acute abdominal pain, an appendicolith is 90% predictive of acute appendicitis, d-Appendix not compressible, e-Distention of the lumen with fluid (because the appendix is obstructed).(Devin Dean , 2005).

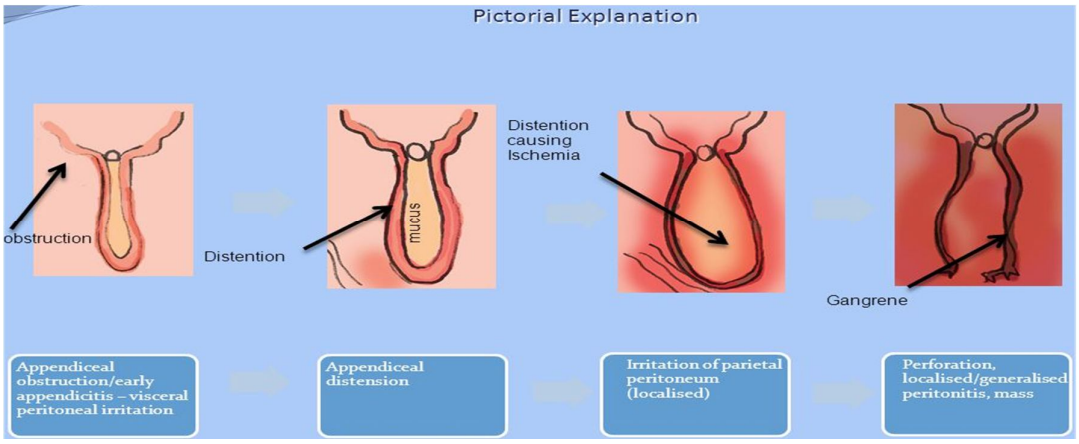
The following factors contribute to the appendix's predilection to infection It is a long, narrow, blind-ended tube, which encourages stasis of large-bowel contents. it has a large amount of lymphoid tissue in its wall, the lumen has a tendency to become obstructed by hardened intestinal contents(enteroliths), which leads to further stagnation of its contents.(Richard S. Snell, 2003).



Figure(2-7)Inflamed appendix(webmd- com,2014)

Predisposition of the appendix to perforation are the appendix is supplied by along small artery that does not anastomose with other arteries. The blind end of the appendix is supplied by the terminal branches of the appendicular artery. Inflammatory edema of the appendicular wall compresses the blood supply to the appendix and often leads to thrombosis of the appendicular artery. These

conditions commonly result in necrosis or gangrene of the appendicular wall, with perforation. Perforation of the appendix or transmigration of bacteria through the inflamed appendicular wall results infection of the peritoneum of the greater sac. (Richard S. Snell, 2003)



Figure(2-8) pictorial explanation of appendix to perforation(webmd- com,2014)

2-3-2 Appendiceal abscess:-

Appendicular abscess is considered the most common complication of acute appendicitis. Obstruction of the lumen of the appendix by an appendicolith, foreign, or inflammation ay lead to appendicitis or the formation of an Appendiceal abscess. These conditions occur most commonly between 10 and 30 years of age and are slightly more prevalent in males. Complications of appendicitis and Appendiceal abscess include peritonitis, pyelophlebitis with portal vein thrombosis, liver abscess, septicaemia, and sub phrenic abscess. with Appendiceal abscess there is a mortality rate of 5 percent.(Carol. Krebs et al,1993).

Perforation of an inflamed appendix is a common complication. Generally the Perforation remains localized in a walled of abscess; occasionally the Perforation becomes freely intra peritoneal resulting in acute peritonitis. Sonographically, the abscess is a complex mass adjacent to the swollen

appendix. fluid collection(hypo echoic) in the appendicular region which may be well circumscribed and rounded or ill-defined and irregular in appearance. Appendiceal stones or gas bubbles will be highly reflective with acoustic shadowing. Untreated appendicitis may result in a chronic walled off abscess. Perforation of the appendix may result in a demonstrable periappendiceal fluid collection, or free fluid plus or minus dilated loops of non-peristaltic small bowel. The presence of an ill-defined fluid mass in the right iliac fossa of a symptomatic patient is highly suggestive of acute appendicitis with perforation. (Devin Dean , 2005).

2-3-3 Appendicular mass:-

An Appendicular mass is an inflamed appendix with an adherent covering of omentum and small bowel. The history is similar to that of appendicitis with a longer duration since onset located in the right lower quadrant. Examination reveals a mass in the right iliac fossa. There is debate whether an appendix mass should require early surgery, or, whether conservative treatment is most appropriate. Appendix may be visualized within the mass. (webmd- com,2014).

2-4 Differential diagnosis:-

2-4-1 Rectus sheath hematoma:-

Rectus sheath hematoma(RSH) is an uncommon and often clinically misdiagnosed cause of abdominal pain and localized tenderness in the right iliac fossa. RSH are generally caused either by rupture of one of the epigastric arteries or by a muscular tear with shearing of a small vessels. The immediate cause of the rupture may be external trauma to the abdominal wall. Iatrogenic trauma from surgery, or excessively vigorous contractions of the rectus muscle. These vigorous contractions are often seen in strenuous exercise or repeated valsalva manoeuvre's with sever coughing, vomiting or straining at the stool. (Mohan, 2000).

2-4-2 Acute pancreatitis:-

Long standing alcohol consumption and biliary stone disease cause most cases of acute pancreatitis, but numerous other etiologies are unknown. acute pancreatitis should be considered in the differential diagnoses of all adults suspected of acute appendicitis and when appropriate excluded by serum urinary amylase and lipase measurements (Mohan, 2000).

2-4-3 Perforated duodenal ulcer:-

Duodenal contents pass along the paracolic gutter to the right iliac fossa. There is usually a history of dyspepsia and a very sudden onset of pain, which starts in the epigastrium and passes down the right paracolic gutter. In appendicitis the pain starts classically in the umbilical region. Rigidity and -tenderness in the right iliac fossa are present in both conditions, but in Perforated duodenal ulcer the Rigidity is usually greater in the right hypochondrium.(COTRAN et al, 1999).

2-4-4 Ureteric colic :-

This can cause pain that may be intermittent and (shooting). A stone may cause microscopic haematuria. 70% are visible on plain x-ray. Ultrasound is a good diagnostic technique. Uretric colic does not commonly cause diagnostic difficulty as the character and radiation of pain differ from those of appendicitis.(Mohan, 2000).

2-4-5 Right sided pyelonephritis:-

Pyelonephritis is an inflammation of the kidney tissue, calyces, and renal pelvis. It is commonly caused by bacterial infection that has spread up the urinary tract or travelled through the blood stream to the kidneys. Acute Pyelonephritis signs are vomiting, nausea, dysuria, very high temperature. Pain is unlikely to radiate to the groin, chronic pyelonephritis is often asymptomatic.(Mohan, 2000).

2-4-6 Testicular torsion:-

Torsion of the testis may more accurately be called torsion of the spermatic cord. Testicular torsion is a common urological emergency a mong adolescent boys and young men. Pain can be referred to the right iliac fossa, and shyness on the part of patient may lead the unwary to suspect appendicitis unless the scrotum is examined.(Mohan, 2000).

2-4-7 Crohn's disease:-

This is a chronic, intermittent inflammation disease which usually involves the distal ileum and colon. The lesions involves the entire thickness of the wall and involved by segments are often separated by normal portions of bowel. Sonographically there is circumferential thickening of the effected bowel segment more than 5mm. the strictures are demonstrated as fixed narrowing of the lumen. Doppler indicates increased blood flow to thickened areas reflecting

active inflammation. Mesenteric lymphadenopathy is demonstrated as multiple oval hypo echoic masses.(Devin Dean , 2005).

2-4-8 Typhlitis:-

This is inflammation of the cecum occurring most often in severely immunosuppressed patients such as, patients with AIDS or leukemia. Sonographically, the cecum has a thickened echogenic wall with an anechoic rim. It may also be demonstrated as echogenic polypoid thickening of the mucosa.(Devin Dean , 2005).

2-4-9 Sigmoid diverticulitis:-

The incidence of misdiagnosis is increased in elderly patients. in some patients with along sigmoid loop, the colon lies to the right of the midline and it may be impossible to differentiate between diverticulitis andappendicitis.(wikipedia.org , 2016)

2-4-10 Carcinomas of the caecum:-

Carcinoid tumors of the midgut (jejunum, ileum, appendix, and cecum) are associated with carcinoid syndrome. They have a very slow growth rate compared to most malignant tumors.(COTRAN et al , 1999).

2-4-11 Salpingitis:-

The most frequent misdiagnoses are pelvic inflammatory disease, followed by gastroenteritis and urinary tract infection. salpingitis is an inflammation of the fallopian tubes. Almost all cases are caused by bacterial infection, including sexually transmitted diseases such as gonorrhoea and chlamydia. Salpingitis is one of the most common causes of female infertility. (COTRAN et al, 1999).

2-4-12 Ovarian torsion:-

This usually happens when an ovary is enlarged by cyst. Diagnosis can be difficult. There may be adnexal tenderness. When suspected, pelvic ultrasound and agyencological opinion should be sought.

2-4-13 Ectopic pregnancy:-

Ectopic pregnancy in the right fallopian tube pain rather than vaginal bleeding is the prominent feature. If in doubt, admit. when rupture occurs bleeding is profuse and two or three litres of blood can be lost in a short space of time, with consequent hypovolemic shock.(Mohan, 2000).

2-4-14 Mesenteric adenitis:-

Enlarged and clustered lymphadenopathy in mesentery and RLQ , normal appendix, may have ileal wall thickening due to GI involvement, pain when pressure applied with ultrasound transducer over nodes, diagnosis of exclusion as appendicitis(especially perforated appendicitis) may show enlarged mesenteric nodes.(Ahuja Griffith et al, 2007).

2-4-15 Pelvic inflammatory disease :-

Complex adnexal mass, dilated fallopian tube with fluid –fluid level (pyosalpinx), ‘’indefinite uterus’’ sign with obscuration of posterior wall of myometrium. (Ahuja Griffith et al, 2007).

2-5 Ultrasound of the appendix protocol:-

Ultrasound is sound with frequency greater than 20,000 cycles per second or 20KHz. Audible sound sensed by the human ear are in the range of the 20Hz to 20KHz. Creating an ultrasound image is done in three steps- producing a sound wave, receiving echoes, and interpreting the echoes. ultrasound waves are Produced by a transducer. A transducer is a device that takes power from one source and converts the energy into another form eg: electricity into sound wave. The sound waves begin with the mechanical movement(oscillations) of a crystal that has been excited by electrical pulses, this is called the piezoelectrical effect. The sound waves are emitted from the crystal similar to sound waves being emitted from a loud speaker. (ultrasoundpaedia ,2014).

Figure(2-9) Diagnostic ultrasound equipment(wikipedia, 2016)

2-5-1 Indications:-

Focal RIF pain ,Rebound tenderness, Pelvic pain, Elevated WCC(white cell count).

2-5-2 Limitations:-

Bowel gas and patient habitus are the biggest limiting factors to visualising the appendix. Up to 60% of appendix are retrocaecal and thus may be obscured. Not identifying an appendix does not exclude appendicitis.

2-5-3 Preparation:-

ideally the patient has fasted for 6 hours. Water in the bladder is an advantage to rule out ovarian pathology. Unfortunately the appendix is usually an urgent(fit in) and the Preparation cannot always be adhered to.(ultrasoundpaedia ,2014).

2-5-4 Equipment selection and technique:-

use of a high resolution probe(7-15 MHz) is essential. Beam steering or compounding can help to overcome anisotropy in linear structures such as tendons, good colour/power/Doppler capabilities. Be prepared to change frequency output of probe(or probes) to adequately assess both superficial and deeper structures. The appendix is best evaluated using the graded compression technique with 7-15 MHz linear array probes. By applying and gradually increasing the pressure with the transducer, gasses-filled bowel loops can be displaced from the right lower quadrant or from the area of maximal tenderness. This manoeuver also helps to reduce the distance from the transducer to the appendix. (Devin Dean.2005).

2-5-5 Localising the appendix:-

The following is a step by step guide to localising the appendix in an adult: step one: locate the caecum, the caecum is located by following the ascending colon down transversely. the caecum is usually the most lateral structure in the right lumber and /or right lower quadrant. It is identify by looking for a" bumpy gas'' pattern. This gas pattern is caused by gas bubbles in the interstices of semi-solid

stool. the caecum is also much larger than any adjacent small bowel. (Rapp et al,1998).

Step two: locate the terminal ileum, the distal ileum typically medial to the caecum. It has ‘’smooth gas’’ pattern because it is layered on liquid bowel contents. It is usually smaller than the caecum, and displays active peristalsis. The distal ileum is then tracked until the junction at the caecum is identified- this is the ileocaecal valve. This is an important step in excluding terminal ileum pathology that may mimic appendicitis.

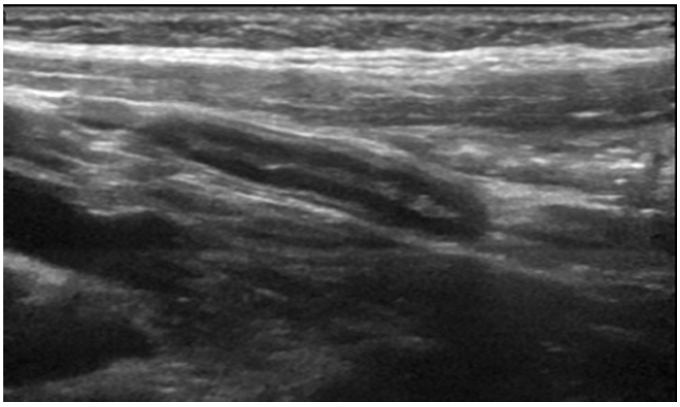
Step three: identify the appendix, once the caecal pole has been identified, the area just medial to and inferior to the tip is searched. As the location of the terminal ileum has already been established, this should not be able to be confused with the appendix. A blind-ended tube of less than 6mm is sought. Due to the majority of appendices being retrocaecal, a gradual increase in probe pressure is required in an attempt to displace gas. (Rapp et al,1998).

Mc Burney marked the base of the appendix opposite the mid- junction of an imaginary line that joins the anterior superior iliac spine to the umbilicus. This is called ‘’McBurney’s point’’, and is used as the incision site for appendectomies. (Bau et al, 2000).

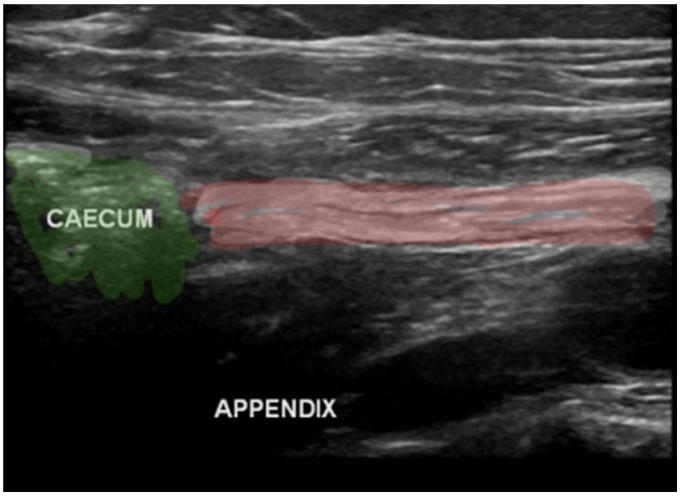
When the above approaches fail, then the appendix is most likely retrocolic or posterior to the terminal ileum. This is when the areas immediately lateral, medial and posterior to the caecum are carefully examined. An alteration of patient position to a lateral decubitus or posterior oblique position may be advantageous. Visualisation of the retrocolic appendix may not be possible, and certainly an enlarged, inflamed appendix will be more likely to be identified. The pelvic appendix may not be able to be visualised trans abdominally due to its deep location, and may only be seen endovaginally.(Bau et al, 2000).

2-5-6 The normal Sonographic appearance of appendix:-

a-Compressible with an ovoid configuration in the transverse section, b-Antero posterior diameter is normally less than 6mm, c- compared with the terminal ileum, no peristalsis is visualised in the normal appendix**.**



Figure(2-10)normal appendix, long axis.(webmd- com,2014).



Figure(2-11)This image highlights the position of the caecum and the appendix (mouseover) .(webmd- com,2014).

2-5-7 Investigations for Appendix:-

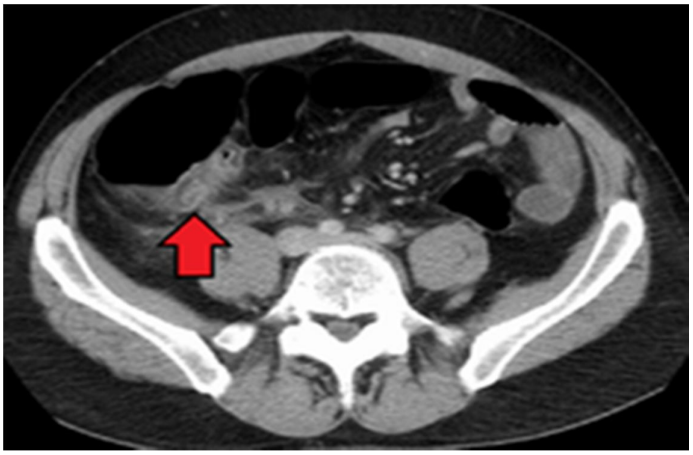
Medical examination: the original test for appendicitis, simple examination of the belly remains important in making the diagnosis. Changes in the abdominal exam help doctors tell if appendicitis is processing, as well.(webmd- com,2014).

2-5-7-1 Lab Investigation:-

Complete blood count(CBC): an increased number of white blood cells- a sign of infection and inflammation are often seen on blood tests during appendicitis.

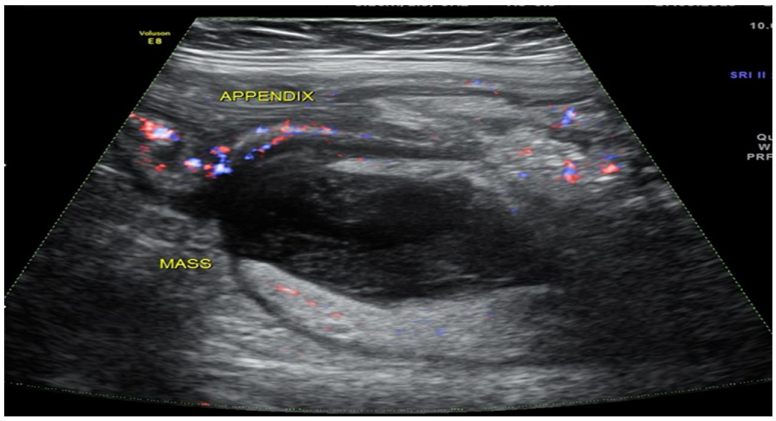
2-5-7-2 Radiographic imaging:-

computed tomography scan(CT): A CT scanner uses x-rays and a computer to create detailed images. In appendicitis , CT scans can show the inflamed appendix and whether it has ruptured.



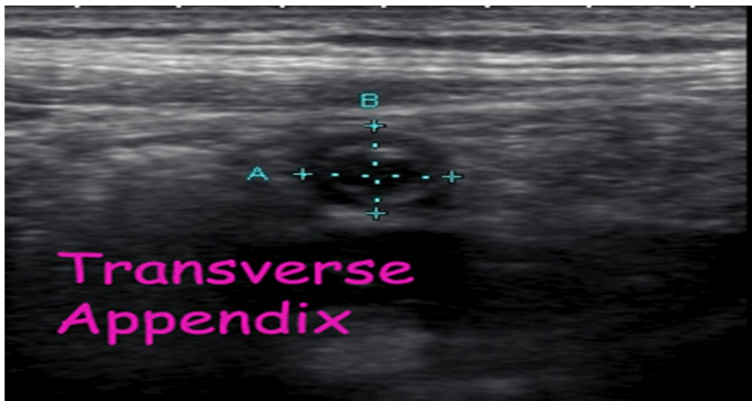
Figure(2-12)Appendicitis shows on CT image(webmd- com,2014).

Ultrasound: an ultrasound uses sound waves to detect signs of appendicitis, such as a swollen appendix. And to detect the appendicular mass.



Figure(2-13)Appendicular mass(webmd- com,2014)

Appendicitis can be diagnosed when the outer diameter of the appendix measures greater than 6mm.



Figure(2-14) show appendix in transverse section. (webmd- com,2014).

Other imaging tests: when a rare tumour of the appendix suspected, imaging exams may locate it. These include magnetic resonance imaging(MRI), positron emission tomography(PET), and CT scans. (webmd- com,2014)

2-6 Previous studies:-

Nibras Gissmallah, 2011, aimed to examine the variability or accuracy of ultrasound findings in detecting appendicitis and to analyze the pathologic finding and demographics features, the study was used a total of 38 patients were examined in both the Khartoum Teaching Hospital and East Nile Hospital. Typical in the period from September to December 2011. The results of study is out of 38 cases that underwent ultrasonography, appendicitis is common in age group(10-20 years) and (21-30 years) with percentage (44, 47%) than the group age (31-40) with percentage (10.53%). Patients with symptoms of vomiting was 23 patient(61%) and fever in 6 patients(16%). The ultrasound findings (fluid collection) is seen more in(11 patients-29%), however, the mass seen in(8 patients-16%). The study concluded the ultrasound main features of inflamed appendix were the fluid collection, mass, perforated and non perforated.

Suresh H B et al, 2009, aimed to evaluate the role of ultrasonography in the diagnosis of acute appendicitis and to study the correlation between clinical signs ,laboratory investigations and ultrasonographic findings in the evaluation of the diagnosis of acute appendicitis. The method was used is a total number of 100 patients (52 men and 48 women) over a period of 2 years, with the clinical suspicion of appendicitis, were subjected to abdominal ultrasonographic examination. The result of study is out of 100 cases that underwent ultrasonography, 58 cases were sonographically positive for appendicitis and 3 cases were appendicular masses. Right iliac fossa tenderness, rebound tenderness and Rovsing's sign were the cardinal signs. The Murphy's triad of symptoms holds good in the diagnosis of appendicitis in the present study. The study was conclude that the acute appendicitis is a common indication for emergency abdominal surgery. Ultrasonography is still a useful tool in the diagnosis of acute appendicitis in spite of sophisticated investigations like CT

abdomen and laparoscopy; thus, reducing the cost of treatment and preventing negative laparotomies.

Anjana Trivedi et al, 2014,aimed to evaluate the role of ultrasound in evaluation of appendix and to correlate with surgical and histo-pathological findings. This is a prospective study and was carried out between February 2014 to July 2014 at the Department of Radiology, P.D.U. Govt. Medical College and civil hospital, Rajkot. Abdominal ultrasound & Doppler study with clinical & pathological correlation of 80 cases was done for diagnosing pathologies involving appendix accurately. The study was finding that out of 80 patients diagnosed by ultrasound, the appendicular lesions more in male than female, appendicular diameter between 6-9mm was 50 and 12 patients had diameter above 10mm. the most common pathologies seen in his study were-acute appendicitis(78%), lump formation(15%), perforation, mucocoele(6%) and carcinoid(1%). The diagnosis given on ultrasound was confirmed on per-op & histo-pathological findings. Ultrasound is useful in the diagnosis of appendicitis and should suffice as the modality of choice whenever the appendix is identified. The decision to perform appendectomy or to treat a patient conservatively should be made in association with clinical findings.

Chapter Three

Materials and Methods

Material and Methods

3-1 Material:-

3-1-1 Study Group:

A descriptive cross sectional study aimed to characterize the appendicular pathology using ultrasonography among Sudanese population. The study was conducted in Sudan, Algezera State, Almanagil City(Almanagil Teaching Hospital) and Murtada Ultrasound Clinic from January 2017 up to June 2017, sample frame was comprised of fifty patients presented to ultrasound department at the area of study with the symptoms of appendix pathology and Exclude other right iliac fossa pathology in different age and gender.

3-1-2Ultrasound machine:

The some patients were scanned with sonoscape 20 (ultrasound machine with linear probe(5-7.5MHz) and sector array(3.5-5MHz) (Murtada Ultrasound Clinic) and other patients were scanned with mindary Digi prince DP- 6600 (ultrasound machine with multi frequency curvilinear probe(3.5-5MHz) and sector(3.5-5MHz) (Almanagil Teaching Hospital).

3-2 Methodology:-

3-2-1 Technique:

For ultrasound examination Each patient was scanned twice , firstly by student and then by a qualified senior sonographer to confirm the findings, and diagnosis trans abdominal or trans vaginal scanning technique is performed with patient lying in supine position both longitudinal and transverse views of patient right iliac fossa and right lower quadrant contains was applied. Begins by placing the transducer in a transverse position, applying sonic coupling agent and applying deep graded compression to the displace the gas and bring the

bowel closer to the probe. Beginning at the hepatic flexure the bowel is traced down to the caecum. The patient should point to the location of the pain. Sometimes the external iliac artery and vein can provide a good landmark for finding the appendix because of the location and pulstility, compressible, and having Doppler flow.

3-2-2 Method of data collection:-

The data collected from ultrasound request that directed to ultrasound department, using data collection sheet which designed especially for this study.

3-2-3 Data analysis:-

The data have been analyzed by SPSS by using the various statistic computerize methods.

3-2-4 Ethical considerations :-

The ethical approval was granted from the hospital and radiology department; which include commitment of no disclose of any information can concerning the patient indentification.

Chapter Four

Results

Results

Table (4.1) shows the distribution of Gender.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Male	23	46.0	46.0	46.0
Female	27	54.0	54.0	100.0
Total	50	100.0	100.0	

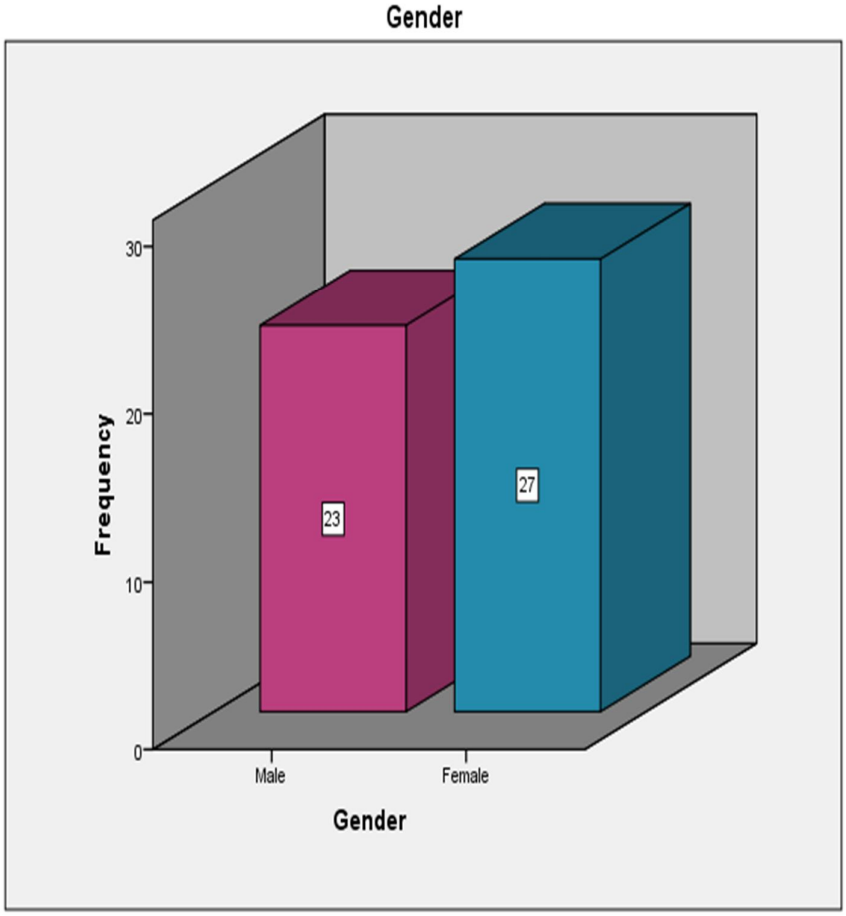


Figure (4.1) shows Gender distribution .

Table (4.2) shows distribution of age group.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
11-20 years	13	26.0	26.0	26.0
Above30 years	16	32.0	32.0	58.0
1day-10 years	3	6.0	6.0	64.0
21-30years	18	36.0	36.0	100.0
Total	50	100.0	100.0	

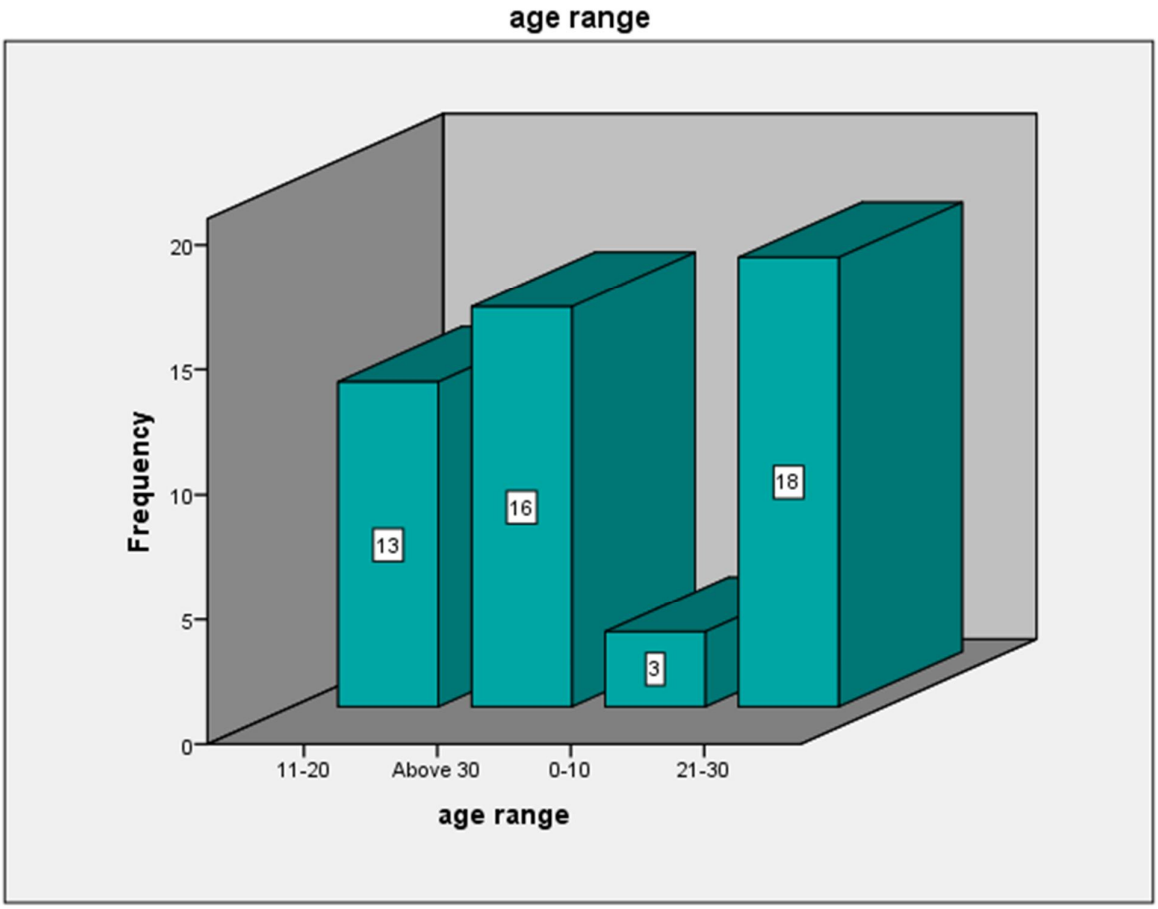


Figure (4.2) shows age group distribution.

Table (4.3) shows distribution of Clinical indications.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Local pain	31	62.0	62.0	62.0
General pain	19	38.0	38.0	100.0
Total	50	100.0	100.0	

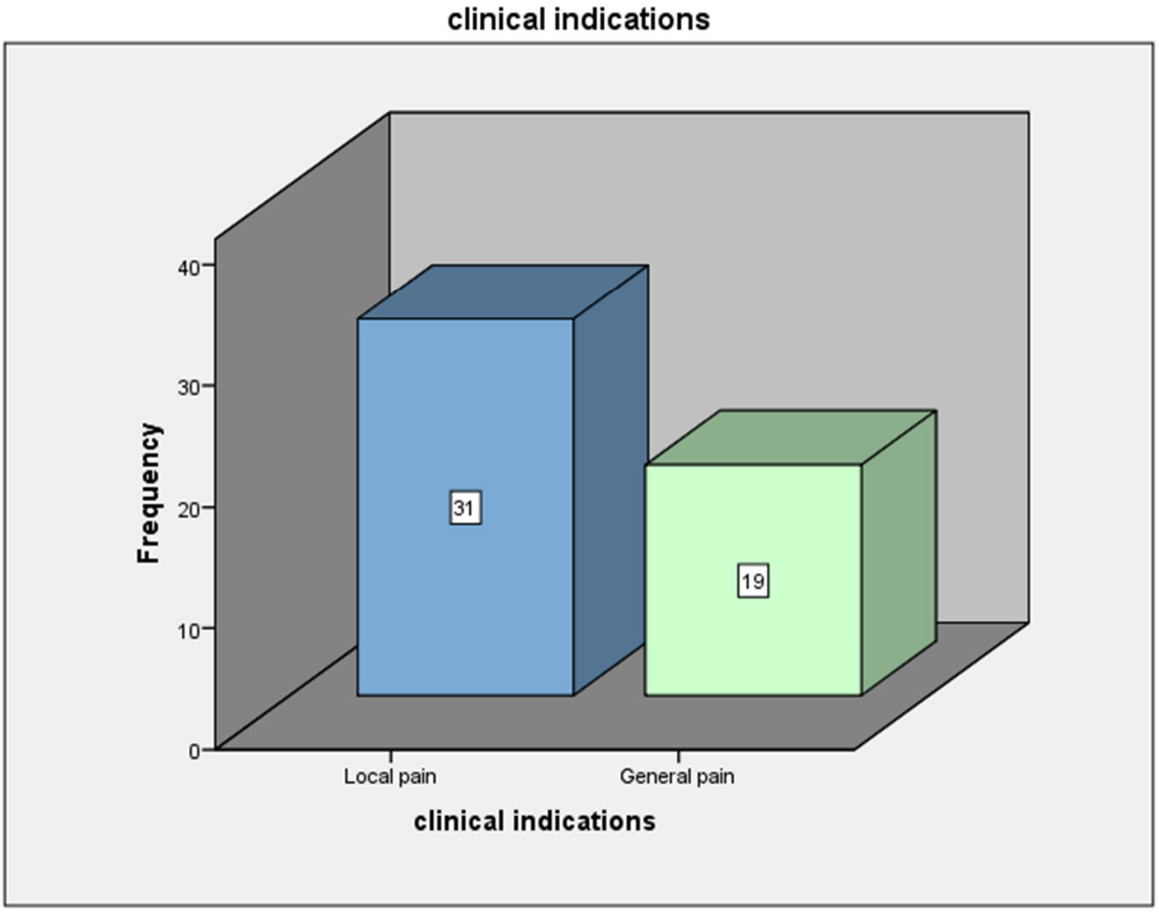


Figure (4.3) shows of Clinical indications distribution.

Table (4.4) shows distribution of signs and symptoms.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Vomiting	14	28.0	28.0	28.0
RIF tender	10	20.0	20.0	48.0
Both	26	52.0	52.0	100.0
Total	50	100.0	100.0	

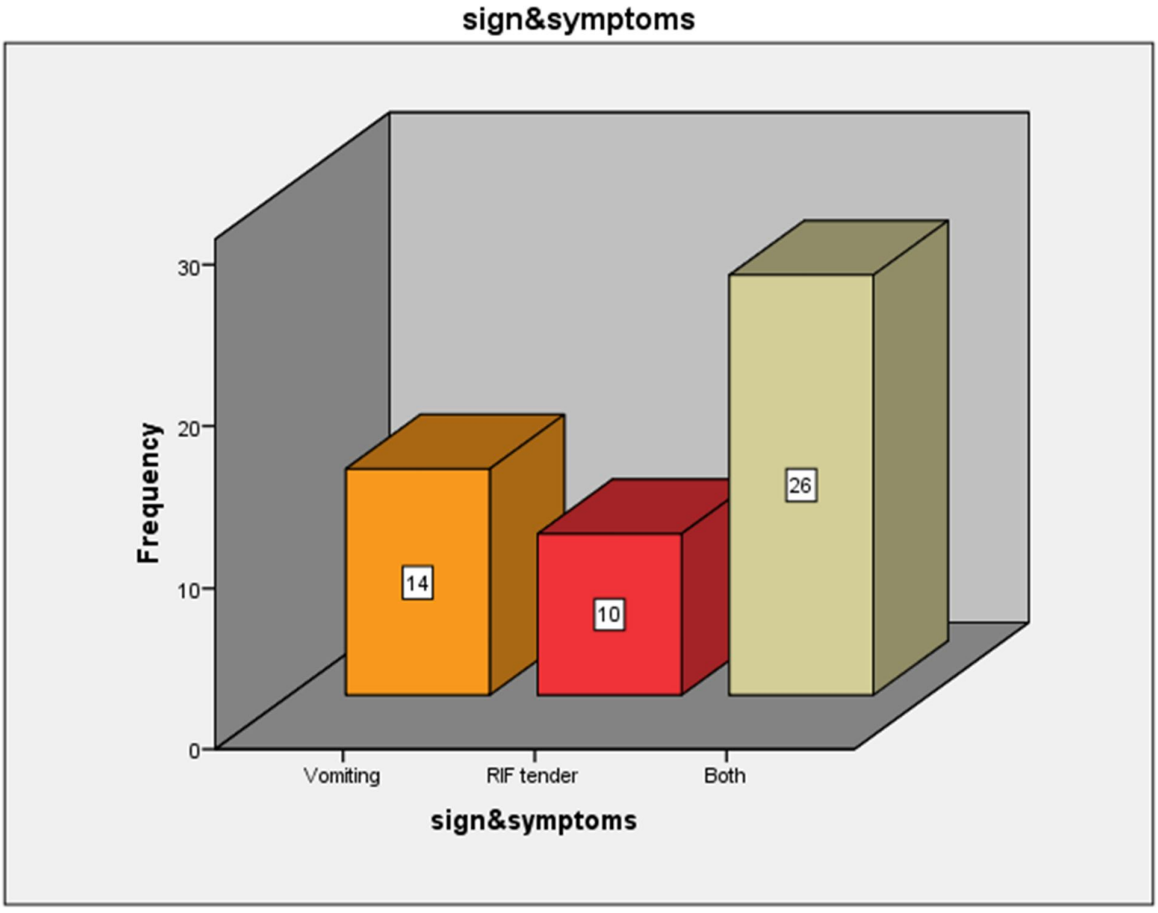


Figure (4.4) shows signs and symptoms distribution.

Table (4.5) shows distribution of patient medical history.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
First	31	62.0	62.0	62.0
Recurrent	19	38.0	38.0	100.0
Total	50	100.0	100.0	

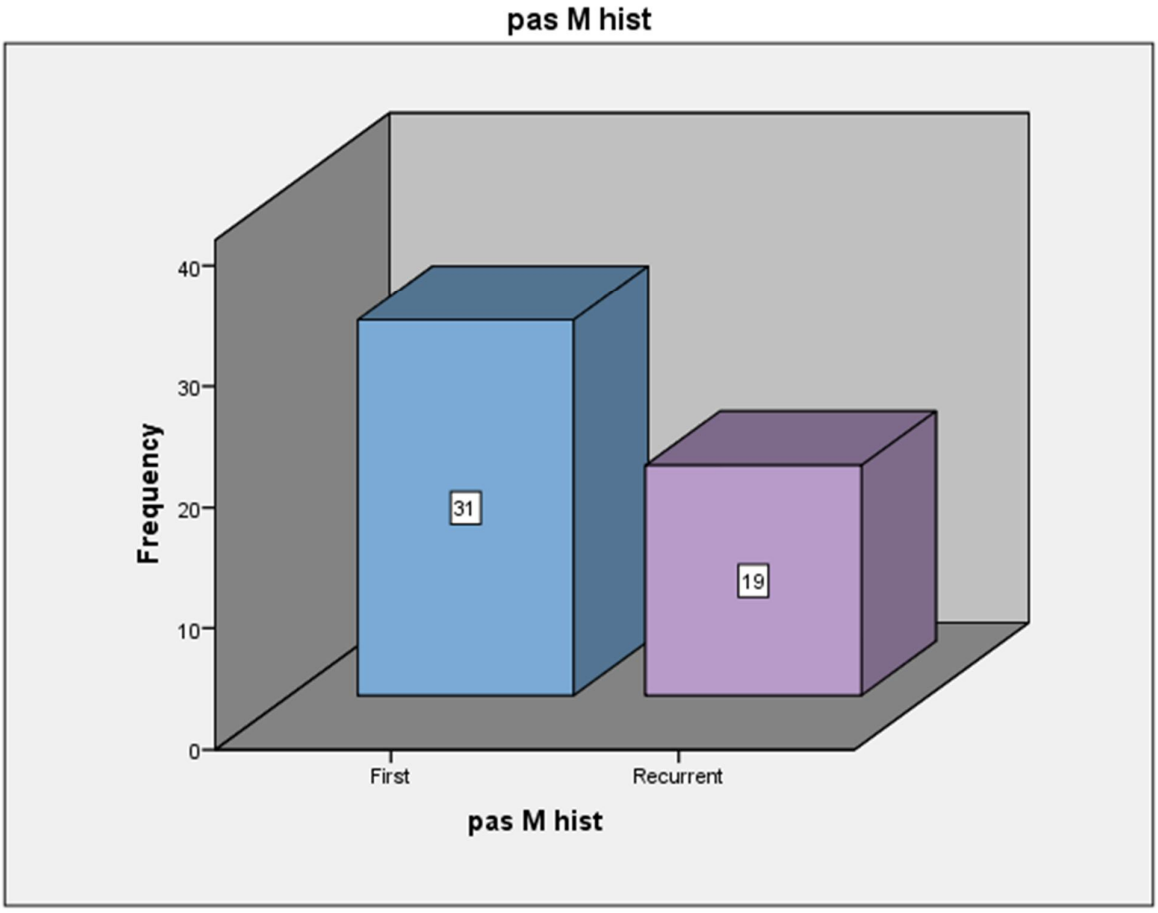


Figure (4.5) shows patient medical history distribution.

Table (4.6) shows distribution of Ultrasound Findings.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
>10mm	17	34.0	34.0	34.0
>6mm	18	36.0	36.0	70.0
Mass	12	24.0	24.0	94.0
More than 10mm +Fluid collection	3	6.0	6.0	100.0
Total	50	100.0	100.0	

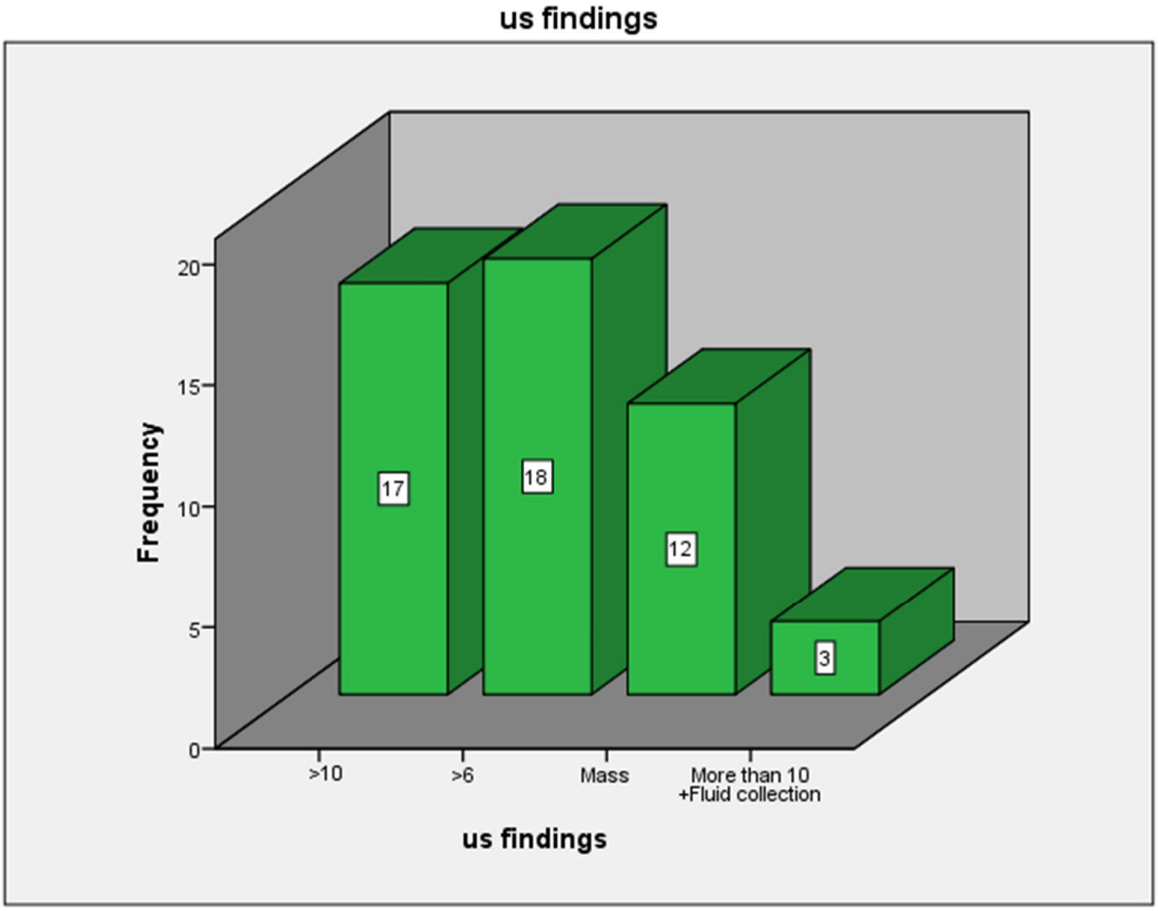


Figure (4.6) shows of Ultrasound Findings distribution.

Table (4.7) shows distribution of type of probe.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Linear	31	62.0	62.0	62.0
Sector	19	38.0	38.0	100.0
Total	50	100.0	100.0	

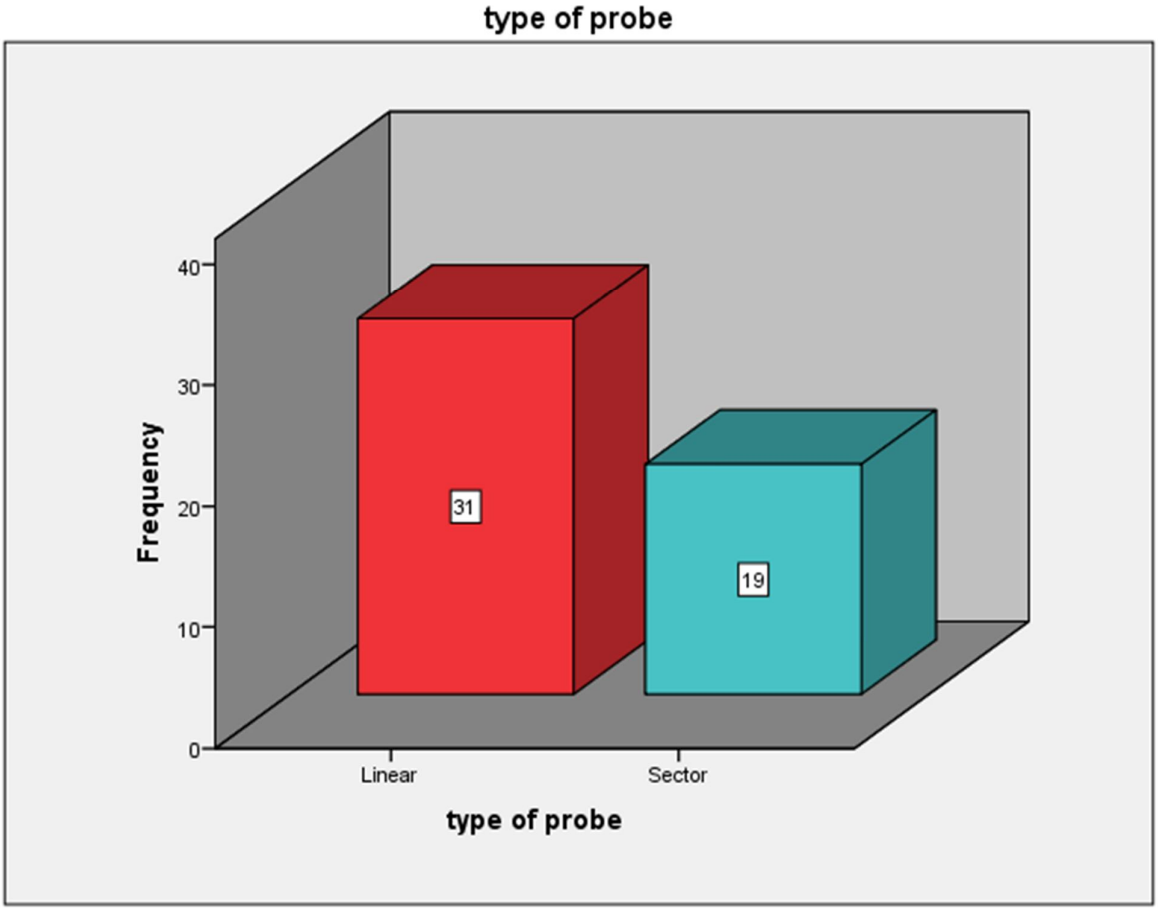


Figure (4.7) shows type of probe distribution.

Table (4.8) shows distribution of site of appendix.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Right iliac fossa	43	86.0	86.0	86.0
Right Lumbar	6	12.0	12.0	98.0
Supra pubic	1	2.0	2.0	100.0
Total	50	100.0	100.0	

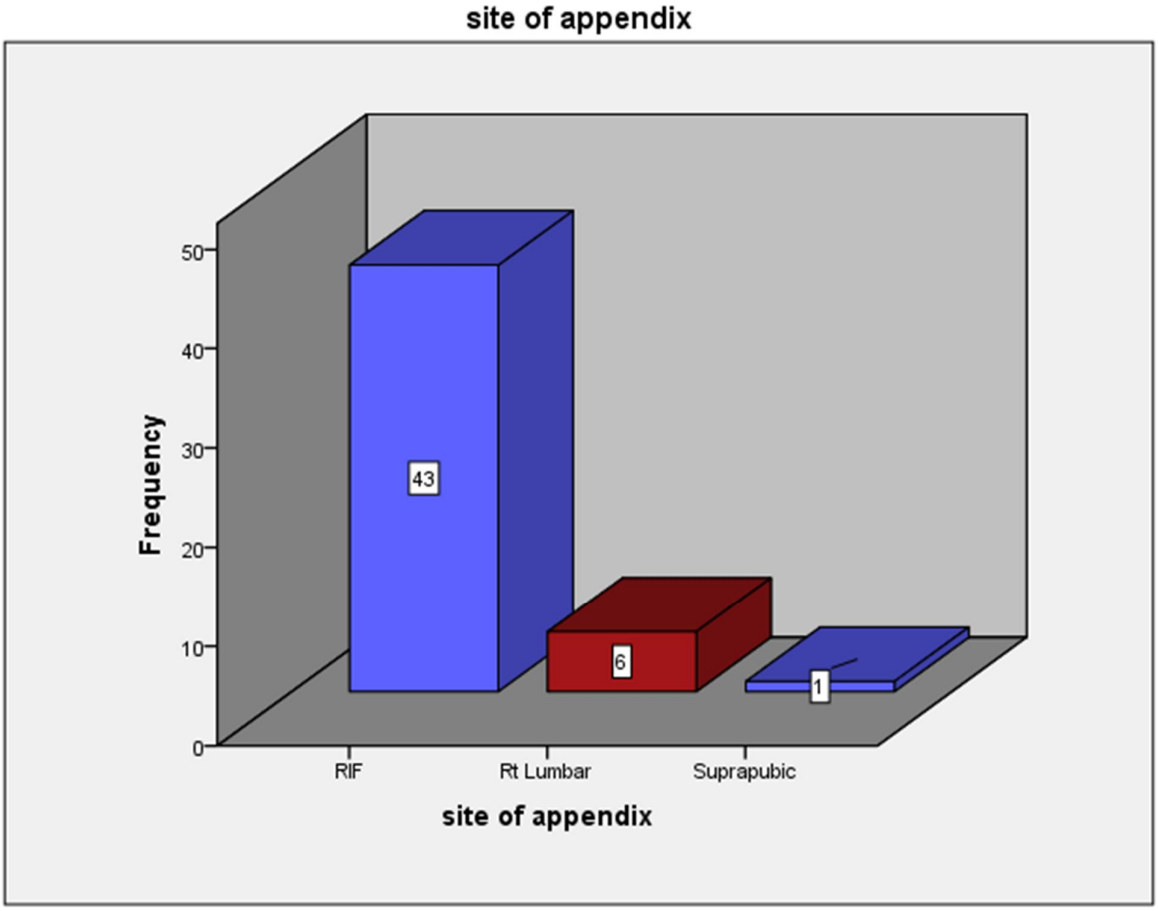


Figure (4.8) shows site of appendix distribution.

Table (4.9) shows distribution of lab investigation.

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Normal WBCs	5	10.0%	10.0	10.0
High WBCs	45	90.0%	90.0	100.0
Total	50	100.0%	100.0	

Figure (4.9) shows lab investigation frequency distribution.

Table (4.10) shows cross tabulation between gender and appendix pathology.

Gender	Lesion	Appendicitis	Total
Male	7	15	22
Female	5	23	28
Total	12	38	50

Table (4.11) shows cross tabulation between age group and appendix pathology.

Age group	Lesion	Appendicitis	Total
1-10 years	0	3	3
11-20 years	4	9	13
21-30 years	3	15	18
Above 30 years	5	11	16
Total	12	38	50

Chapter Five

Discussion, Conclusion and Recommendations

Discussion, Conclusion, Recommendations

5-1 Discussion:

This study aimed to characterize appendicular pathology using ultrasonography. The study was performed at the Almangil Teaching Hospital and Murtada Ultrasound Clinic during the period from January to June 2017.

23 patients out of 50 (46%) are male, while 27 female(54%). A mong the 50 patients with the appendicular pathology, showed in table (4-1). this result disagree with study done by(Anjana trivedi et al, 2014).

3 patients in range 1 day-10(6%), 13 patients in range 11-20(26%), 18 patients in range 21-30(36%), and 16 patients in range above 30(32%), showed in table (4-2).

31 patients(62%) with local abdominal pain, while 19 patients(38%) that have general abdominal pain, showed in table (4-3). this result agree with study done by (Suresh H B et al,2009).

14 patients (28%) have vomiting, 10 patients(20%) with right iliac fossa tenderness, and 26 patients (52%) have both, showed in table (4-4).

31 patients(62%) that feel groggy for first time, while the 19 patients (38%) they feel groggy for more than one(recurrent), showed in table (4-5).

18 patients(36%) were identified to have acute appendicitis by ultrasonography- the appendix diameter >6mm in transverse section, 17 patients(34%) %) were identified to have acute appendicitis by ultrasonography- the appendix diameter >10mm in transverse section, 3 patients(6%) also >10 with fluid collection , 12 patients(24%) were identified to have appendicular mass by ultrasonography. These means the acute appendicitis more common than appendicular mass),

showed in table (4-6). these result agree with study done by(Suresh H B et al,2009).

31 patients(62%) were scanned using linear transducer, while 19 patients(38%) were scanned using sector transducer, showed in table (4-7).

43patients(86%) in right iliac fossa, 6 patients (12%) in right lumbar hypochondrium, and I patient(2%)in supra pubic region, showed in table (4-8).

5 patients(10%) were found with normal white blood cells, while the 45 patients(90%) were found high white blood cells, showed in table (4-9). these result agree with(Suresh H B et al,2009). (Leucocytosis was present in 75% of the cases).

The male have lesion was 7, while 15 male had appendicitis. The female have lesion was 5 while 23 had appendicitis, showed in table(4-10)

The prevalence of appendicitis in age group(21-30) and (above 30) years, when compare with age group(11-20)and (1-10)years, showed in table(4-11). these result agree with(Nibras Gissmallah, 2011).

while prevalence of lesion in age group(11-20)and (above 30)years, no significant in (1-10) years, showed in table(4-11).

5-2 Conclusion:

The ultrasound is the first choice for diagnosis of appendicular pathology. Ultrasound with graded compression has a great role in visualizing the abnormal appendix. ultrasound helps in diagnosing appendicular pathology and excluding other causes of RIF pain. the ultrasound main features of inflamed appendix were the diameter in transverse section more than 6mm, fluid collection, mass.

This study found that appendicular pathology in female more than male, the prevalence the patients with acute appendicitis more than appendicular mas, the study found that both right iliac fossa tenderness and vomiting were cardinal signs& symptoms when compared with each one alone, the study found linear array is more use full and accuracy to show the appendix pathology and study found significant between appendicular pathology and high white blood cells, also study found the relationship between age group(above 30)years and appendicular pathology.

5-3 Recommendations:

Ultrasound is a simple, time saving tool for evaluation parts diameter it should be the first investigation to be done to evaluation the normal index for populations.

linear transducer is very useful to exam the appendix pathology, so it is very important available in any ultrasound machine.

Educating and training technologist sonographers and radiologists to perform optimum examination and correct measurements.

The most profound limitation of the study was the small sample size, so we recommend that study with larger sample size be considered.

Further studies in characterize of appendicular pathology in different location with larger sample of population for more accurate results.

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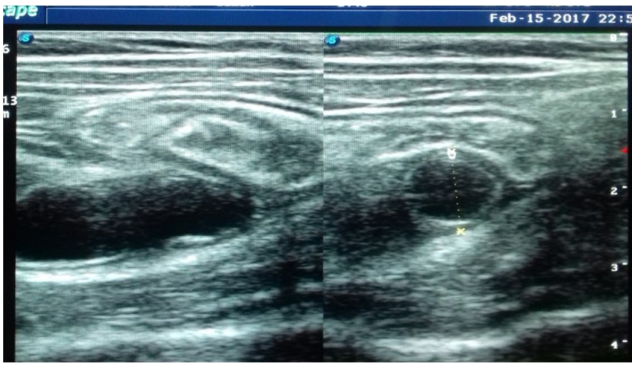
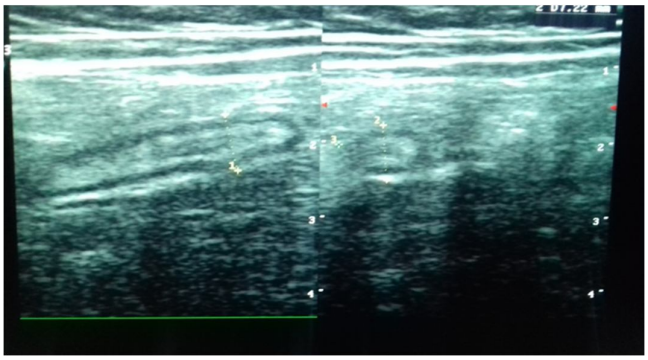
Appendices

Appendix A

Ultrasound images

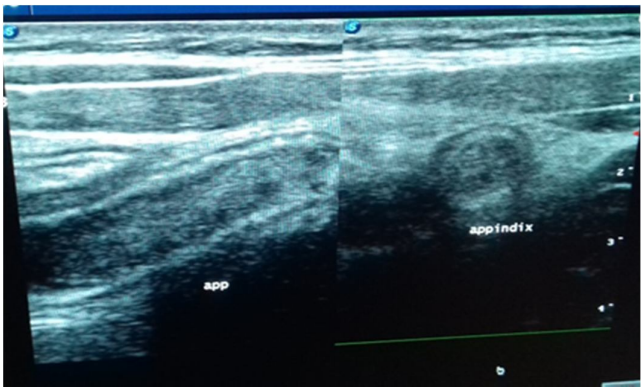


Appendix A-1 Sonogram of appendix female 35 years old, long and short axis, shows appendicitis measure(12mm) in short axis.

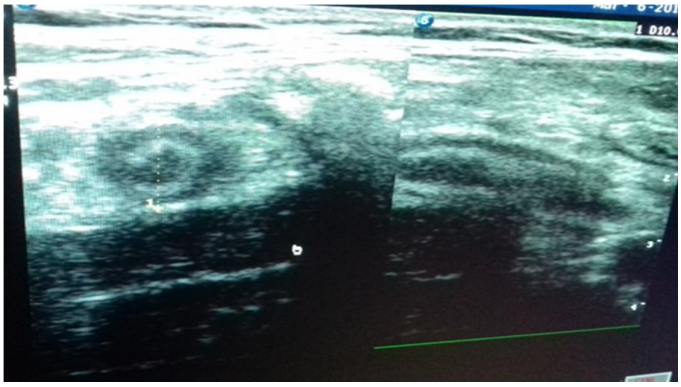


Appendix A- 2 Sonogram of appendix male 28 years old, long and short axis, shows appendicitis measure(7.22mm) in short axis.

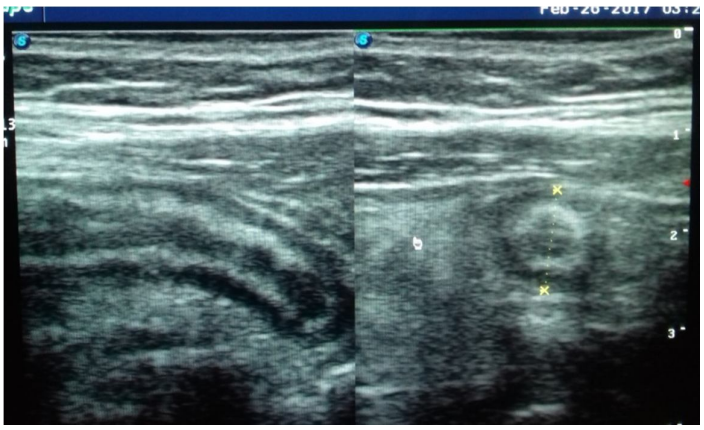
Appendix A-3 Sonogram of appendix female 17 years old, sector probe, shows appendicular mass measure(45.27*26.92mm).



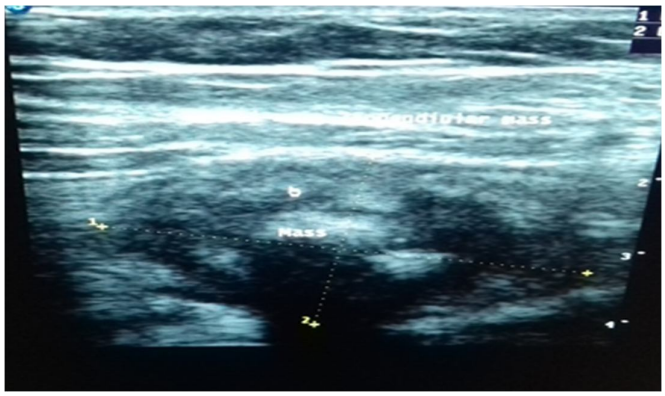
Appendix A-4 Sonogram of appendix male 30 years old, long and short axis, shows appendicitis measure(11.6mm) in short axis.



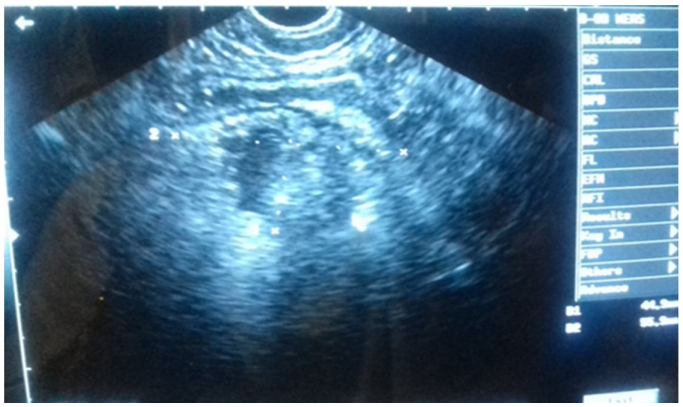
Appendix A-5 Sonogram of appendix male 25 years old, long and short axis, shows appendicitis measure(10.4mm) in short axis.



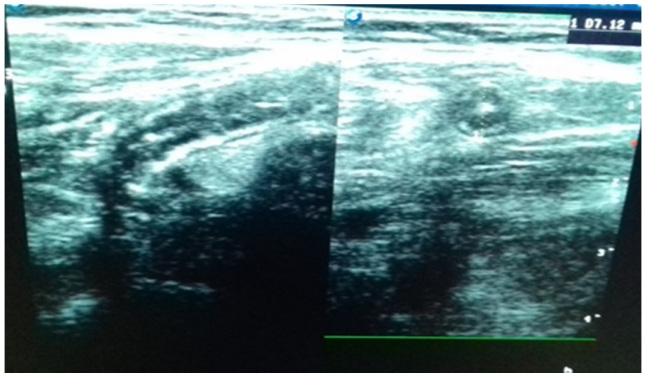
Appendix A- 6 Sonogram of appendix female 37 years old, long and short axis, shows appendicitis measure(9.5mm), in short axis.



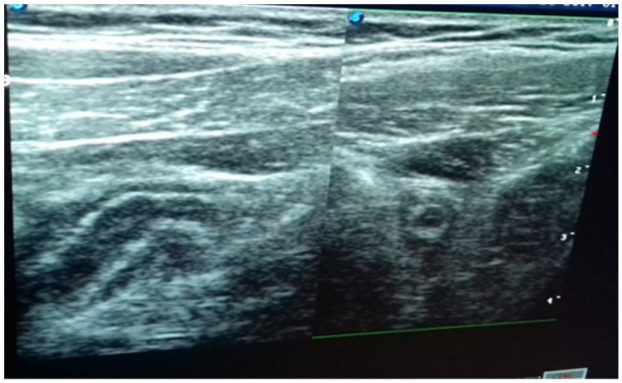
Appendix A-7 Sonogram of appendix male 33 years old, long axis, shows appendicular mass measure(38.37*23.35mm).



Appendix A-8 Sonogram of appendix female 12 years old, sector probe, shows appendicular mass measure(44.24*50.8mm).



Appendix A-9 Sonogram of appendix female 24 years old, long and short axis, shows appendicitis measure(8.9mm),in short axis.



Appendix A-10 Sonogram of appendix male 27 years old, long and short axis, shows appendicitis measure(6.8mm), in short axis.

Appendix B

Sudan University of Science and Technology

Characterization of appendicular pathology using ultrasonography

Data collecting sheet **Date:-**

patient gender:- Male …… Female……

patient age:-

1 -10…... 11-20 …… 21-30 ……. Above -30……. Years

Clinical indications:-

General abdominal pain…… Local abdominal pain……

Signs & symptoms:-

Vomiting…….. RIF tenderness……

Past medical history:-

First…… Recurrent ……

Lab Investigations:-

……

Site of appendix:-

RT Lumber Hypochondrium…… RT Iliac fossa……..

Deep pelvis…….. Others……

Types of probes:-

sector**……..** Linear**……**

ultrasound finding:-

appendix diameter in transverse > 6mm…… >10mm……

fluid collection……

measurement of appendicular mass ……
Others……..…