Sudan University of Sciences and Technology

College of Graduate Studies

Comparison of Abdominal Clinical Diagnosis Findings and CT Findings in Khartoum state CT Centers

مقارنة نتائج التشخيص السريري للبطن مع نتائج تشخيص الأشعة المقطعية بمراكز الأشعة المقطعية ولاية الخرطوم

A Thesis submitted for Partial Fulfillment for the award of M. Sc Degree in Diagnostic Radiologic Technology

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الآيــه

بسم الله الرحمن الرحيم

﴿ اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِنْ شَجَرَةٍ مُبَارَكَةٍ زَيْتُونَةٍ لَا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَنْ يَشَاءُ وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ ﴾

(سورة النور:35)

Dedication

To;

My family…

and my friends…

Acknowledgment

First of all, I thank Allah the Almighty for helping me complete this project. I thank Dr. Duha Abdu Mohamed, my supervisor, for her help and guidance. I would like to express my gratitude to my colleagues and to the whole staff of Khartoum state Hospitals for their great help and support. Finally I would like to thank everybody who helped me to prepare and finish this study.

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List of abbreviations

ALARA	As Low As Reasonably Achievable
CT	Computed Tomography
CTDI	Computed Tomography Dose Index
CTDIw	Weighted Computed Tomography Dose Index
CTU	Computed Tomography Urography
EMI	Electric and Musical Industries
FUS	Feline Urologic Syndrome
HCC	Hepatocellular carcinoma
Gy	Gray
IBD	Inflammatory Bowel Disease
IV	Intra Venous
IVC	Inferior Vena Cava
Kv	Kilovolt
mAs	Milliampere second
US	Ultra Sound

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Abstract

Abdominal computed tomography (CT) scanning has revolutionized patient care in the past two decades. Abdominal CT scanning is used in the evaluation of trauma victims for visceral injury and in the evaluation of acute abdominal pain, with a major role in the evaluation of renal calculi, acute appendicitis, and complex abdominal pathology. The Study was performed in Khartoum state hospitals. The purpose of this study was to compare the abdominal clinical findings and CT diagnosis findings. Abdominal CT scans were taken in 150 patients with abdominal problem. 100 patients with general abdominal scan, 50 patients with urinary system pathology for CTU. 70 patients with general abdominal scan were correctly diagnosed (46.7%), 33 patients were misdiagnosed (22%) and 47 patients presented with another pathology (31.3%) as presented in table (4-3). 43 patients with GIT or liver pathology were correctly diagnosed (43%), 25 patients were misdiagnosed (25%) and 32 patients presented with another pathology (32%) as presented in table (4-4). 27 patients with urinary system pathology were correctly diagnosed (54%), 8 patients were misdiagnosed (16%) and 15 patients presented with another pathology (30%) as presented in table (4-5). 40 patients were clinically diagnosed with mass lesions (38.8%), 25 patients with stones (24.3%) and 38 patients with other pathology (36.9%) as presented in table (4-6). 80% of mass lesions were correctly diagnosed, 72% of stones were correctly diagnosed and 52.6% of the other pathologies were correctly diagnosed. The study concludes that CT imaging in the diagnosing patients presenting with acute abdominal pain is well established. The usefulness is limited by certain factors: the absence of detailed clinical history, the variability in the interpretation of non-specific image findings. Awareness of these limiting factors is vital to clinicians, radiologists and radiology technologists in the diagnosis and treatment of patients.

ملخص الدراسة

التصوير المقطعي (CT) للبطن قد أحدث ثورة في رعاية المرضى في العقدين الماضيين. ويستخدم التصويرالمقطعي للبطن في تقييم ضحايا الصدمات وتقييم ألم البطن الحاد، مع دوراً رئيسياً في تقييم حصيات الكلى، التهاب الزائدة الدودية الحاد، وأمراض البطن المعقدة. قد أجريت الدراسة في مستشفيات ولاية الخرطوم. وكان الهدف من هذه الدراسة مقارنة نتائج التشخيص السريري للبطن مع نتائج التصوير المقطعي. اتخذت النتائج من 150 مريضا. 100 مريض في فحص البطن و50 مريضا بالجهاز البولي. تم تشخيص 70 مريضا في فحص البطن العام بشكل صحيح (46.7٪)، وقد تشخص خطأً 33 مريضا (22٪) و 47 مريضا يعانون من أمراض أخرى (31.3٪) كما هو مبين في الجدول رقم (4-3). تم تشخيص 43 مريضا بالجهازالهضمي أو أمراض الكبد بشكل صحيح (43٪)، وتشخص خطأ 25 مريضا (25٪) و 32 مريضا يعانون من أمراض أخرى (32٪) كما هو مبين في الجدول رقم (4-4). تم تشخيص 27 مريضا بالجهاز البولي بشكل صحيح (54٪)، وتشخص خطأ 8 مرضى (16٪) و 15 مريضا يعانون من أمراض أخرى الحالي (30٪). تم تشخيص 40 مريضا سريريا بكتلة ورمية (38.8٪)، و 25 من المرضى يعانون من الحصوة (24.3٪)، و 38 مريضا يعانون من أمراض أخرى (36.9٪) كما هو مبين في الجدول رقم (4-6). 80٪ من الآورام شخصت بشكل صحيح، 72٪ من الحصوات شخصت بشكل صحيح و6،52٪ من الأمراض الأخرى تم تشخيصها بشكل صحيح. وتخلص الدراسة إلى أن التصوير المقطعي في تشخيص المرضى الذين يعانون من آلام البطن الحادة له أهمية راسخة. في أقلية من الحالات، الفائدة محدودة بسبب بعض العوامل: عدم وجود التاريخ الطبي المفصل، واستخدام التصوير غير المتباين والتباين في تفسير النتائج بصورة غير محددة. الوعي بهذه العوامل ضروري للأطباء وأخصائيين وتقنيين الأشعة في تشخيص وعلاج المرضى.

Chapter one

Introduction

1.1 Introduction

The CT scanner is a device using an x-ray source which can be used to give precise information on the attenuation properties of a thin sectional volume of the body. The basic elements of the CT scanner include the x-ray tube and the detector or detector array located in the gantry and known as the data acquisition system, the image processing system, and the image display system. The x-ray tube rotates around the patient producing a tightly collimated x-ray radiation photon beam. Once attenuated by the patient the attenuated beam strikes the detectors which convert the photon intensity to a digital signal. Multiple profiles of patient attenuation are collected (Brenner, 2007).

The introduction of CT technology is widely viewed by medical practitioners as one of the major medical advances. Abdominal computed tomography (CT) scanning has revolutionized patient care in the past two decades. Abdominal CT scanning is used in the evaluation of trauma victims for visceral injury and in the evaluation of acute abdominal pain, with a major role in the evaluation of renal calculi, acute appendicitis, and complex abdominal pathology (Taylor, 2015).

CT imaging in the diagnosis, management and outcome of patients presenting with acute abdominal pain is well established. In a minority of cases, the usefulness is limited by certain factors; specifically, the use of non-contrast imaging, the inability of CT to define various pathologies, the lack of imaging findings in uncommon conditions and the variability in the interpretation of non-specific imaging findings. Awareness of these limiting factors is vital to both clinicians and radiologists in the diagnosis and management of these patients **(**Chin, 2012).

In a minority of cases, the utility of CT is more limited, especially in the diagnosis of early inflammatory changes such as in inflammatory bowel disease, mesenteric ischaemia and mild acute pancreatitis, and in patients who have a history of chronic abdominal disease, with disagreement between the radiological and clinical diagnoses more likely(Goldstraw, 2012).

CT radiation exposure has come under increasing scrutiny because of dramatically increased utilization. Multiphase CT studies (repeated scanning before and after contrast injection) are a potentially important, overlooked source of medically unnecessary radiation because of the dose-multiplier effect of extra phases (Guite, 2011).

1.2 Problem of the study

The huge gap between the clinical diagnosis and CT diagnosis and to asses radiology request forms, are they adequately filled by clinicians?

1.3 Significance of the study

This study is important to quantify the degree to which clinical and radiological diagnoses may differ in a consecutive series of patients with abdominal CT requests.

1.4 Objectives of the study

General objective

To Compare Abdominal CT Findings and Clinical Diagnosis Findings (for Patients referred to x-ray departments in Khartoum state hospitals)

Specific objective

- To quantify the degree to which radiological and clinical findings may differ.
- To determine if it matches the clinical history of the patient.

1.5 Overview of study

This study consists of five chapters.

Chapter one: introduction, problem and objectives.

Chapter two: theoretical background and literature review.

Chapter three: materials and methods.

Chapter four: the results.

Chapter five: discussion, conclusions and recommendations.

References.

Appendices.

Chapter Two

Theoretical Background &
Literature Review

2.1 Theoretical background

2.1.1 Anatomy of the abdomen

The abdominal cavity located underneath the diaphragm contains the main organs of the digestive system (liver, spleen, stomach and intestine). The greater omentum partly fixed to the transverse colon covers the small intestine. The liver, stomach, and superior part of the duodenum are connected to the lesser omentum covering the omental bursa, the entrance of which is the epiploic foramen. The hepatoduodenal ligament contains the portal vein, the common bile duct, and the hepatic arteries. The spleen is located dorsally underneath the diaphragm (Rohen, 2011).

The abdomen is subdivided into four quadrants and nine areas:

The quadrants are labeled by location: the right upper quadrant, right lower quadrant, left upper quadrant, and left lower quadrant. The nine divisions or regions are smaller than the four abdominopelvic quadrants and are the right hypochondriac, right lumbar, right inguinal (or right iliac), epigastric, umbilical, hypogastric (or pubic), left hypochondriac, left lumbar, and left inguinal (or left iliac). The perineum is considered to be the 10th division. The abdomen is subdivided into four quadrants and nine areas (Rohen, 2011).

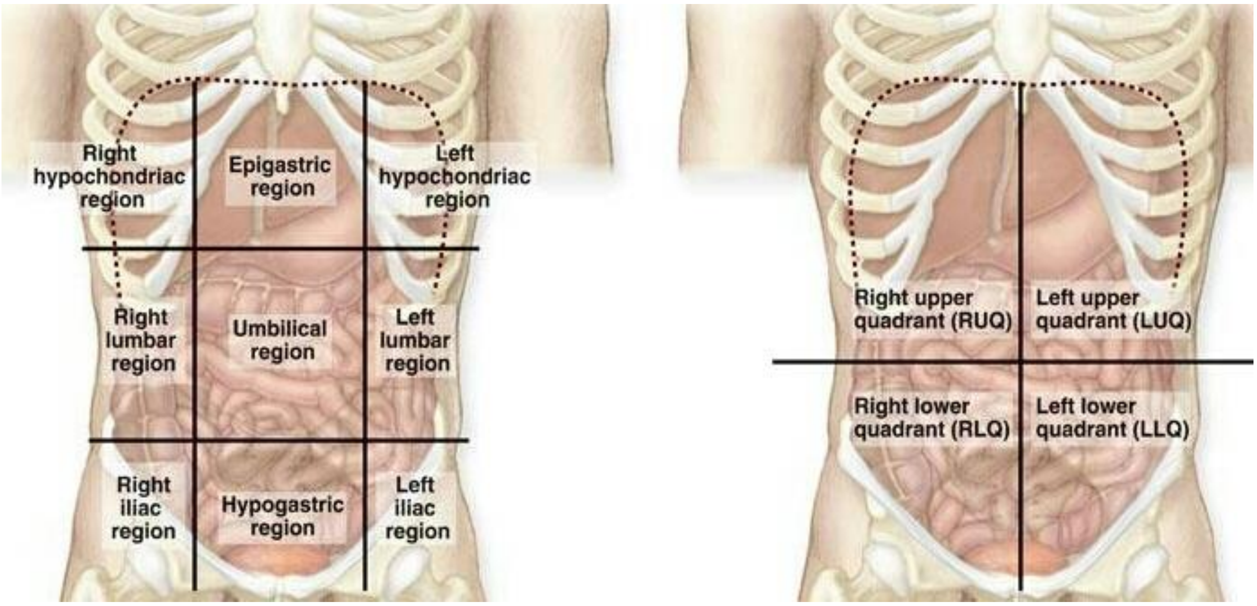

Fig. 2-1 Abdominopelvic quadrants and regions.

(http://www.focmag.com/p/abdominopelvic-cavity-contains.html)

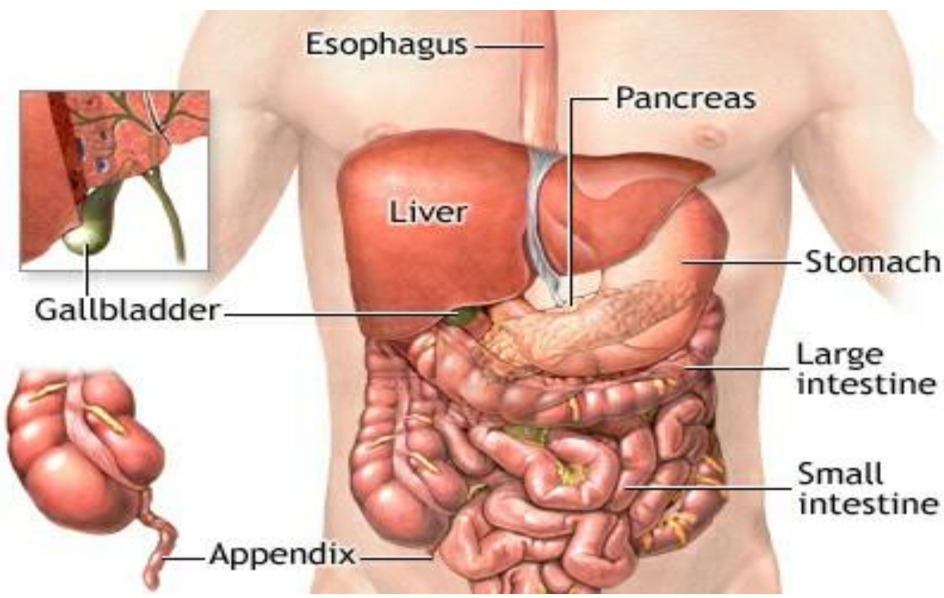

Fig. 2-2 Abdominal organs.

(https://www.nlm.nih.gov/medlineplus/ency/imagepages/19574.htm)

2.1.1.1 Abdominal viscera

The viscera of the abdomen proper include the stomach, intestine, liver and biliary system, pancreas, spleen, kidneys, ureters, and suprarenal glands. Most of the stomach and intestine is anchored to the body wall by peritoneal mesentery, whereas the three paired glands (kidneys, suprarenals, and gonads before birth) lie retroperitoneally. The positions of the abdominal viscera vary with the individual and with gravity, posture, respiration, and degree of filling. Radiological studies have shown that "the normal abdominal viscera have no fixed shapes and no fixed positions, and every description of them must be qualified by a statement of the conditions existing at the time of observation (Ronan, 2008).

2.1.1.2 Peritoneum

The peritoneum is a smooth, glistening, serous membrane that lines the abdominal wall as the parietal peritoneum and is reflected from the body wall to various organs, where, as visceral peritoneum, it forms an integral part as the outermost, or serosal, layer. The pericardium, pleura, and peritoneum have a similar arrangement in the parietal and visceral layers, with a cavity between. The extraperitoneal tissue external to the parietal peritoneum is carried with the reflections to the organs and becomes a part of the serosal layer. Organs, like most of the intestine, that are almost completely invested by peritoneum are connected to the body wall by a mesentery. Other viscera, however, such as the kidneys, are retroperitoneal; they lie on the posterior abdominal wall and are covered by peritoneum only anteriorly (Ronan, 2008).

2.1.1.2 Liver

The liver is the largest organ of the abdomen, occupying a major portion of the right hypochondriac and epigastric regions, sometimes extending into the left hypochondriac and umbilical regions. The liver is bordered superiorly, laterally, and anteriorly by the right hemidiaphragm. The medial surface is bordered by the stomach, duodenum, and transverse colon; the inferior surface is bordered by the hepatic flexure of the colon; and the posterior surface is bordered by the right kidney. The liver is surrounded by a strong connective tissue capsule (Glisson's capsule) that gives shape and stability to the soft hepatic tissue. It is also entirely covered by peritoneum except for the gallbladder fossa, the surface apposed to the inferior vena cava (IVC), and the bare area (liver surface between the superior and inferior coronary ligaments) (Kelley, 2007).

The basic functional unit of the liver is the *liver lobule,* which is a cylindrical structure several millimeters in length and 0.8 to 2 millimeters in diameter. The human liver contains 50,000 to 100,000 individual lobules (Guyton, 2006).

The liver can be divided into lobes according to surface anatomy or into segments according to vascular supply. The four lobes commonly used for reference based on surface anatomy are the left, right, caudate, and quadrate (Fig. 2-4). The left lobe is the most anterior of the liver lobes, extending across the midline. It is separated from the right lobe by the inter lobar fissure, an imaginary line drawn through the gallbladder fossa and the middle hepatic vein to the inferior vena cava. The smallest lobe is the caudate lobe, which is located on the inferior and posterior liver surface, sandwiched between the lVe and the ligamentum venosum. The quadrate lobe is located on the anteroinferior surface of the left lobe between the gallbladder and the ligamentum teres (Kelley, 2007).

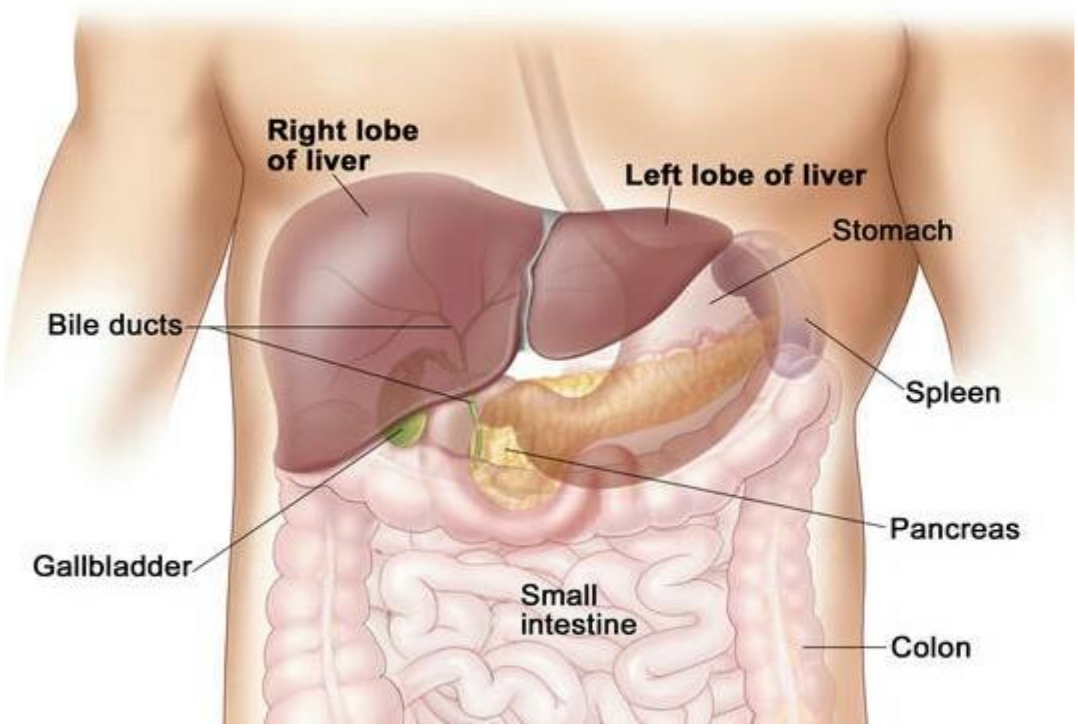

Fig. 2-3 liver relations, anterior view.
(https://www.dana-farber.org/images/pdq/CDR0000658698.jpg)

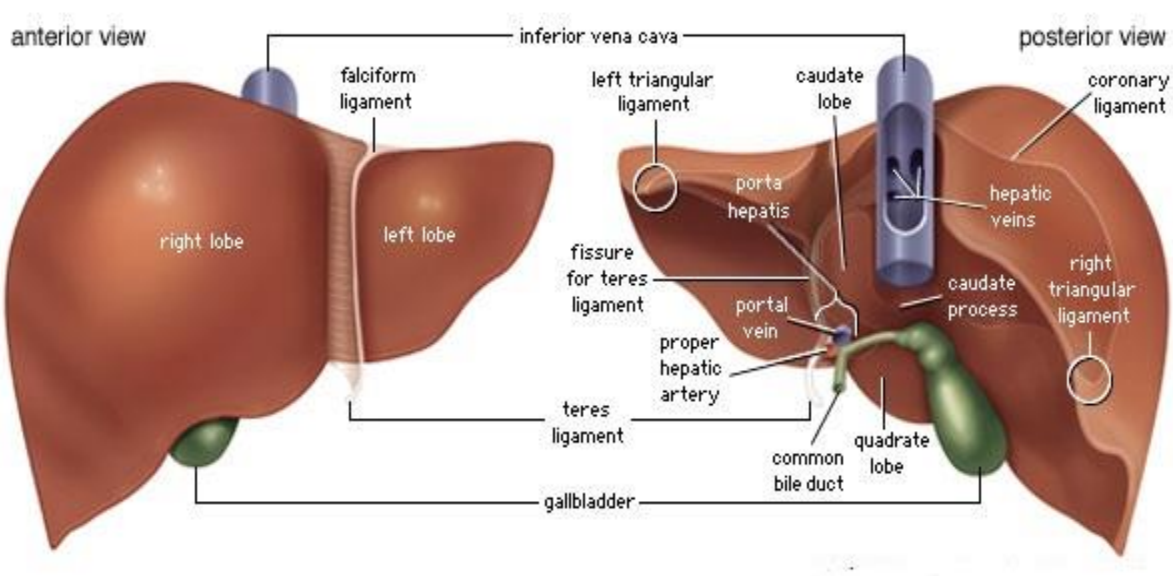

Fig. 2-4 liver lobes, anterior and posterior views.
(http://www.britannica.com/science/liver)

2.1.1.3 Urinary system

The organs of the urinary system (kidney, ureter, and, in the female, genital organs) are located together with vessels and nerves (aorta, inferior vena cava, plexus solaris, etc.) within the retroperitoneal space. The upper part of the kidneys reaches the level of the margin of the lung. During respiration, the kidneys move slightly within their fasciae of Gerota. Parallel with the vertebral column, the ureter runs towards the urinary bladder. The great center of the autonomic nervous system, the solar plexus (celiac ganglion, etc.), is located in front of the abdominal aorta. The genital organs of the female (uterus, uterine tube, and ovary) are located within the pelvic cavity. In the male, the testis has moved out of the abdominal cavity and penetrated the inguinal canal to be finally located within the extragenital organs (Rohen, 2011).

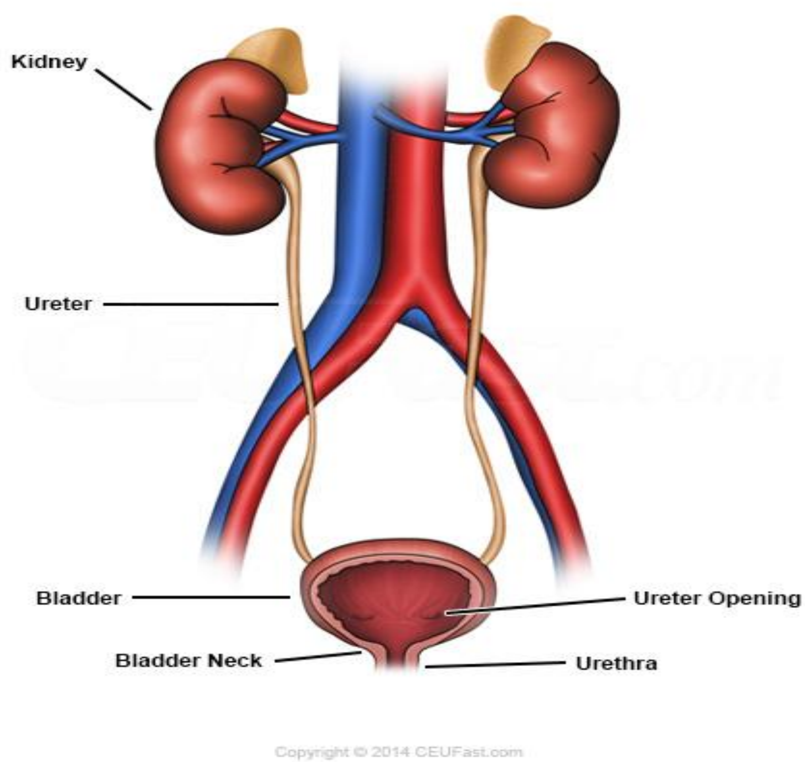

Fig. 2-5 Urinary system, anterior view.
(https://ceufast.com/course/urinary-tract)

2.1.2 physiology of the abdomen

The alimentary tract provides the body with a continual supply of water, electrolytes, and nutrients. To achieve this requires: movement of food through the alimentary tract; secretion of digestive juices and digestion of the food; absorption of water, various electrolytes, and digestive products; circulation of blood through the gastrointestinal organs to carry away the absorbed substances; and control of all these functions by local, nervous, and hormonal systems. Each part is adapted to its specific functions: some to simple passage of food, such as the esophagus; others to temporary storage of food, such as the stomach; and others to digestion and absorption, such as the small intestine. (Guyton, 2006).

2.1.2.1 Liver

The liver is a large, complex organ with numerous functions that include metabolic regulation, hematologic regulation, and bile production. The liver receives 30% of the resting cardiac output and acts as a giant chemical processing plant in the body. These chemical reactions, called metabolism, are central in the regulation of body homeostasis. The liver cells, called hepatocytes, contain thousands of enzymes essential to perform vital metabolic functions. They are supermodels in the world of cellular metabolism. The liver metabolises both beneficial and harmful substances. It stores nutrients and other useful substances, as well as detoxifying or breaking down harmful compounds. These can be then excreted from the body in bile via the liver; in urine via the kidney, or by other means. (Guyton, 2006).

2.1.2.2 Kidneys

Each kidney in the human contains about 1 million *nephrons*, each capable of forming urine. The kidney cannot regenerate new nephrons. Therefore, with renal injury, disease, or normal aging, there is a gradual decrease in nephron number.

After age 40, the number of functioning nephrons usually decreases about 10per cent every 10 years; thus, at age 80, many people have 40 per cent fewer functioning nephrons than they did at age 40. This loss is not life threatening because adaptive changes in the remaining nephrons allow them to excrete the proper amounts of water, electrolytes, and waste products (Guyton, 2006).

The kidneys maintain the homeostasis of several important internal conditions by controlling the excretion of substances out of the body. The kidney can control the excretion of potassium, sodium, calcium, magnesium, phosphate, and chloride ions into urine. (Website http://www.innerbody.com/image/urinov.html)

2.1.3 Pathology of the abdomen

2.1.3.1 Abdominal Hernia

Any weakness or defect in the wall of the peritoneal cavity may permit protrusion of a serosa-linedpouch of peritoneum called a hernia sac (Appendix E). Acquired hernias most commonly occur anteriorly, through the inguinal and femoral canals or umbilicus, or at sites of surgical scars. (Kumar, 2007)

2.1.3.2 Intestinal obstruction

Obstruction of the gastrointestinal tract may occur at any level, but the small intestine is most often involved because of its relatively narrow lumen. Collectively, hernias, intestinal adhesions, intussusceptions, and volvulus account for 80%of mechanical obstructions while tumors and infarction account for most of the remainder (Solomon, 2007).

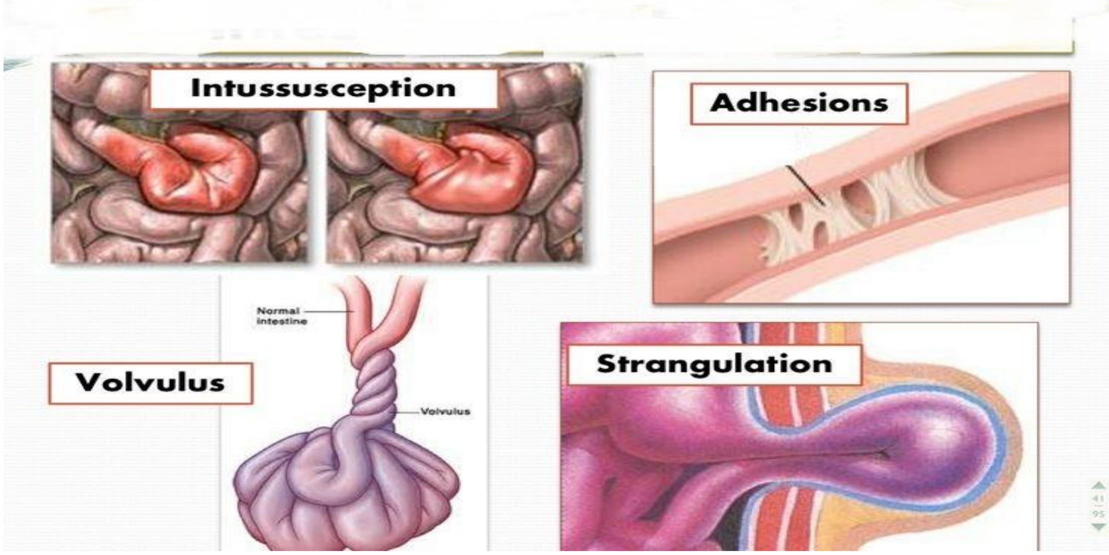

Fig. 2-6 Intestinal Obstruction.
(https://www.pinterest.com/pin/928868110388871147/)

2.1.3.3 The small intestine and colon

Account for most of the length of the gastrointestinal tract and are the sites of a wide variety of diseases, many of which affect nutrient and water transport. Perturbation of these processes can cause malabsorption and diarrhea. It is not surprising that the small intestine and colon frequently are involved by infectious and inflammatory processes. Finally, the colon is the most common site of gastrointestinal neoplasia in Western populations (Kumar, 2007)

2.1.3.4 Inflammatory bowel disease (IBD)

IBD is a chronic condition resulting from inappropriate mucosal immune activation. IBD encompasses two major entities, Crohn disease and ulcerative colitis.

The distinction between ulcerative colitis and Crohn disease is based, in large part, on the distribution of affected sites and the morphologic expression of disease at those sites Ulcerative colitis is limited to the colon and rectum and extends only into the mucosa and submucosa (Kumar, 2007)

2.1.3.5 Cirrhosis

Cirrhosis is the liver's end-stage response to ongoing injury. When hepatocytes are injured, they fibrose (Appendix E). It results in diffuse fibrosis of the hepatocytes; this fibrosis is then converted into nodules in the healing process. These nodules often affect the blood flow through the liver (Derek, 1994).

2.1.3.6 Hepatocellular carcinoma

HCC is cancer of the hepatocytes, the cell that make up most of the liver. While HCC is not common in the US it is one of the most prevalent cancers worldwide, especially in Asia and Africa (Derek, 1994).

2.1.3.7 Urinary system

Diseases of the kidney are divided into four categories depending on which component of the kidney is primarily affected; these are glomerular, tubular, interstitial and vascular. The first big circulatory problem in the kidney is infarction.

2.1.3.8 Pyelonephritis

Pyelonephritis happens when bacteria come up from the bladder. There is always cystitis (bladder inflammation) associated with pyelonephritis. The organisms have such a good time in the bladder that they decide to go on a little trip up the ureter, and the pelvis of the kidney and the collecting ducts there become inflamed.

2.1.3.9 Urinary tract obstruction

Obstruction is common in male and is called feline urologic syndrome (FUS) or BLOCKED CAT. The blockage is due to small stones, almost like sand. Urinary calculi (uroliths) may be found in the renal pelvis (nephroliths), ureter (ureterolith), urinary bladder (urocystolith), or urethra (urethrolith). They are most commonly found in the bladder (Solomon, 2007).

2.1.4 Computed tomography

2.1.4.1 Basic principles of computed tomography CT:

Computed tomography uses a computer to process information collected from the passage of x-ray beams through an area of anatomy (Fig. 2-7). The basic principle behind CT is that the internal structure of an object can be reconstructed from multiple projections of the object (Karthikeyan, 2007).

The individual CT slice shows only the parts of the anatomy imaged at a particular level Each CT slice represents a specific plane in the patient's body. The thickness of the plane is referred to as the Z axis. The Z axis determines the thickness of the slices. The data that form the CT slice are further sectioned into elements: width is indicated by X, while height is indicated by Y. Each one of these two-dimensional squares is a pixel (picture element) (Fig. 2-8). A matrix is the grid formed from the rows and columns of pixels. In CT, the most common matrix size is 512. This size translates to 512 rows of pixels down and 512 columns of pixels across. The total number of pixels in a matrix is the product of the number of rows and the number of columns, in this case 512 × 512 (262,144). Because the outside perimeter of the square is held constant, a larger matrix size (i.e., 1,024 as opposed to 512) (Romans, 2011).

Fig. 2-7 CT Machine.
(http://www.medicalnewstoday.com/articles/153201.php)

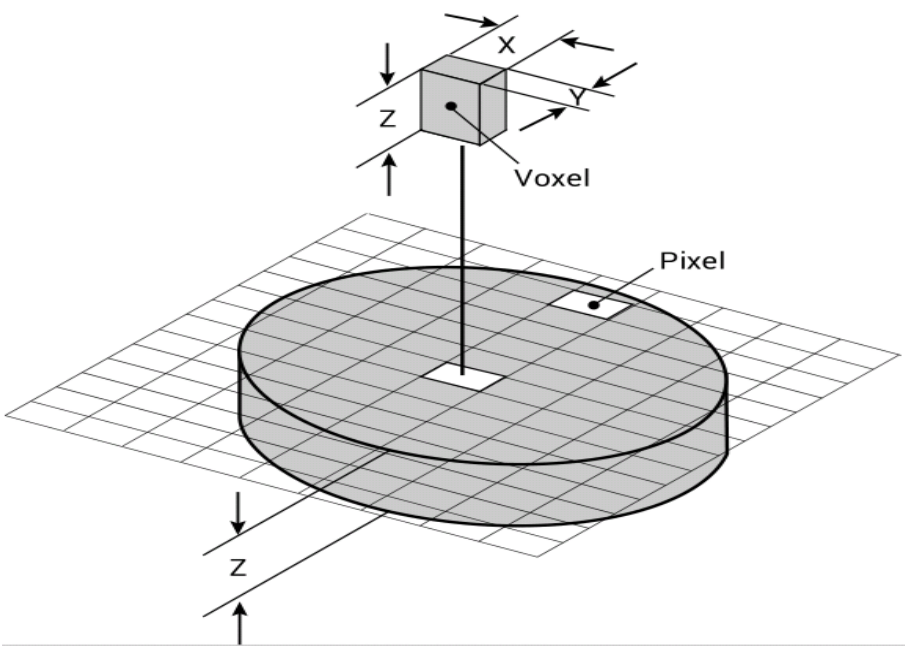

Fig. 2-8 The data that form the CT slice are sectioned into elements.
(Romans, 2011).

2.1.4.2 Historical Development of CT System:

Each change in the fundamental CT tube-detector structure is known as a CT generation. The CT generation has changed from the first introduced in 1972 up to the fifth in more recent years. The generation development has improved acquisition time and image quality. (Website: http://www.state.nj.us/dep/rpp).

Computed Tomography (CT) first became feasible with the development of modern computer technology in the sixties, but some of the ideas on which it is based can be traced back to the first half of the twentieth century. In 1917, the Bohemian mathematician J.H. Radon proved in a research paper of fundamental importance that the distribution of a material in an object layer can be calculated if the integral values along any number of lines passing through the same layer are known. Although it was nearly forty years before the first practical application of reconstruction mathematics, some early work was done on optical reconstruction. For example, in 1938, G. Frank of C.H.F. Müller in Hamburg (now the German Philips Medical Systems organization) proposed an optical back projection technique for reconstructing transaxial X-ray images (Hounsfield GN., 1980).

2.1.4.3 First generation:

The first experiments on medical applications of this type of reconstructive tomography were carried out by the physicist A. M. Cormack, who worked on improving radiotherapy planning at Groote Schuur Hospital, Cape Town, South Africa. Between 1957 and 1963, and without knowledge of previous studies, he developed a method of calculating radiation absorption distributions in the human body based on transmission measurements. He postulated that, for radiological applications, it must be possible to display even the most minute absorption differences, i.e. different soft-tissue structures. However, he never had occasion to put his theory into practice and first learned of Radon's work much later.

A successful practical implementation of this theory was first achieved in 1972 by the English engineer G. N. Hounsfield, who is now generally recognized as the inventor of computed tomography (appendix C). In 1979, Hounsfield and

Cormack, an engineer and a physicist, were awarded the Nobel Prize for medicine in recognition of their outstanding achievements. The EMI scanner was designed for brain scanning, and its applications were limited to the head. The pencil beam employed in the first generation scanner resulted in poor geometrical utilization of the X-ray beam and consequently long scanning times (Hounsfield GN., 1980).

2.1.4.4 Second generation:

In the second-generation scanner, the X-ray beam was collimated to a 10-degree fan, which encompassed an array of 8 to 30 radiation detectors, rather than the previous pencil beam with only a single detector. Although the second-generation scanner also used the complicated translate-rotate mechanical motion, the fan beam permitted multiple angles to be obtained with a single translation across the patient. The fastest second-generation CT units could achieve a scanning time of 18 seconds per slice. The image quality was substantially improved. In addition, the cumbersome water bag was omitted on this and subsequent CT scanners. However, the second-generation units had definite speed limitations resulting from the inertia of the heavy X-ray tube and gantry, as well as the use of the complicated translate-rotate motion (Hounsfield GN., 1980).

2.1.4.5 Third and four generation:

Third- and fourth-generation to increase speed, systems were developed that used rotation only. These devices eliminated the necessity for a back-and-forth translation and permitted the rotation to be accomplished in a continuous smooth motion. Because the back and- forth motion was eliminated, it was necessary for the fan of the X-ray beam to be wide enough to completely envelop the patient from side-to-side (Hounsfield GN., 1980).

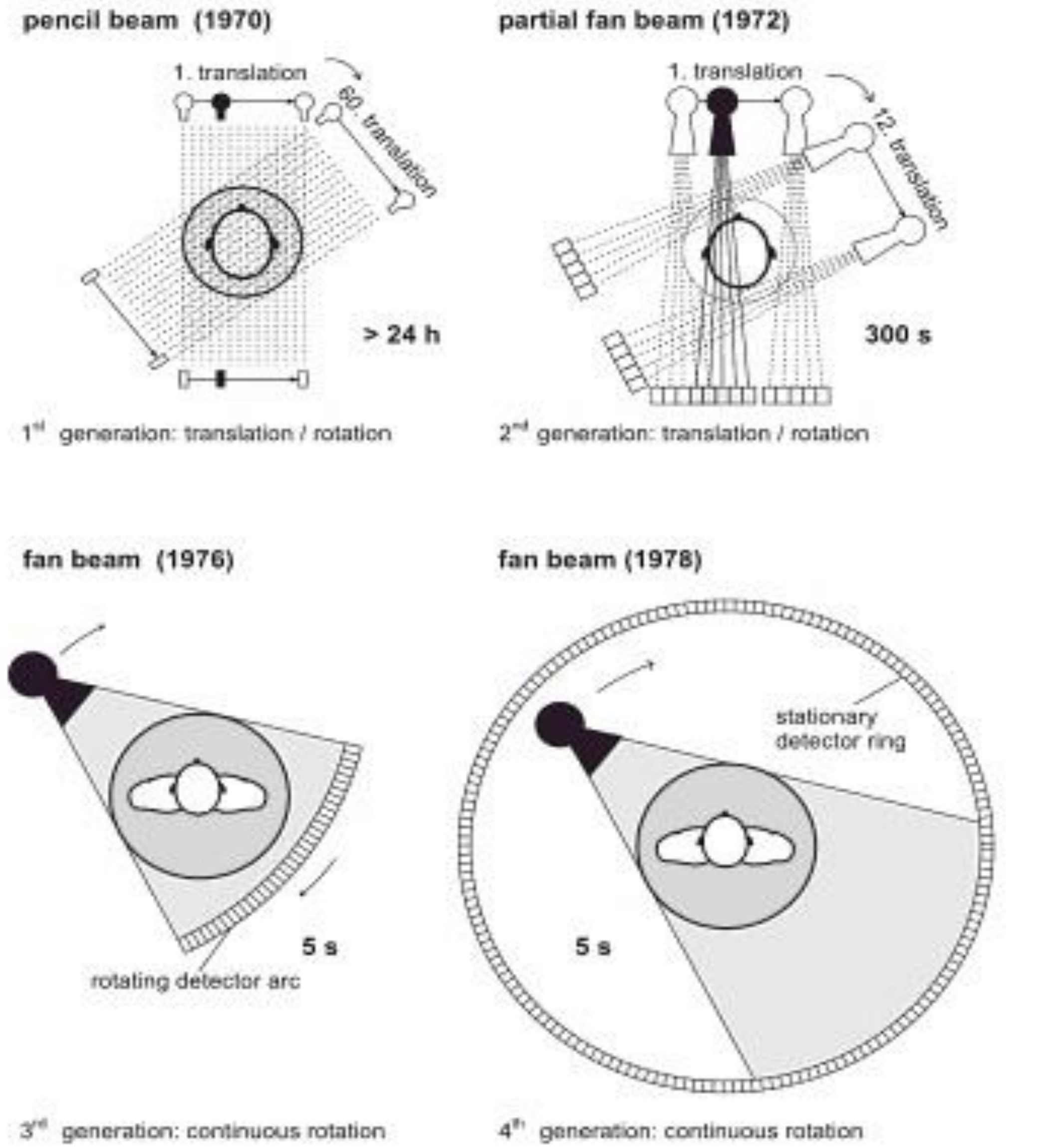

Fig. 2-9 CT Generations.

(http://mustikamax.blogspot.com/2012/07/four-ct-scanner-generations.html)

2.1.4.6 Spiral CT

In spiral CT the scanning mode has the x-ray tube continuously rotating together with a continuous linear translation of the patient through the gantry aperture in order to achieve volumetric data acquisition (fig. 2-8). The introduction of slip ring technology makes the spiral possible. The slip ring technology consists of multiple sets of parallel rings and electrical components that rotate without constrain by cables (Radiol, 2001).

2.1.4.7 Fifth Generation: Scanning Electron Beam

Fifth-generation scanners are unique in that the x-ray source becomes an integral part of the system design. The detector array remains stationary, while a high-energy electron beams is electronically swept along a semicircular tungsten strip anode. X-rays are produced at the point where the electron beam hits the anode, resulting in a source of x-rays that rotates about the patient with no moving parts Projection data can be acquired in approximately 50 ms, which is fast enough to image the beating heart without significant motion artifacts (Cunningham, 2000).

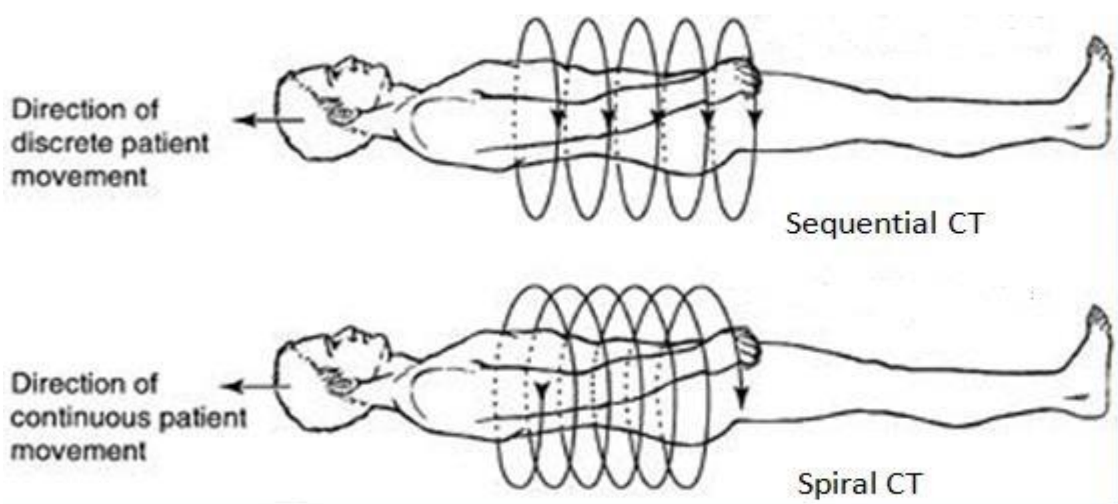

Fig. 2-10 spiral CT. (https://miac.unibas.ch/BIA/08-Xray.html)

2.1.5 CT protocol for Abdomen

- *Patient preparation:* Information about the procedure, exclude high density contrast from previous investigations, oral application of contrast media for the intestine, restraint from food, but not fluid, is recommended.
- *Scan projection radiograph:* Frontal from lower chest to pelvis (Appendix D)
- *Patient position:* supine with arms at chest or head level.
- *Slice thickness:* 7-10mm, 4-5mm (suspected small lesion).
- *Intravenous contrast media:* useful for differentiating vessels and organ from adjacent structures and to detect parenchymal lesions (Chegu, 2007).

CTU is a computerized tomography (CT) urogram is an imaging exam used to evaluate the urinary tract, including kidneys, bladder and the tubes (ureters) that carry urine from the kidneys to the bladder. (http://www.mayoclinic.org/tests-procedures/ct-urogram/basics/20123966).

2.6 Contrast media in CT examination

The contrast media used in a CT examination can be either positive or negative (Baert, and Sartor, 2001). Positive contrast media can be iodinated or a diluted barium suspension, and may be administered orally, rectally or intravenously. Negative contrast media, such as gas or water, may also be used in the examination. Both kinds of contrast may be used together to optimize the detection of abnormalities. CT examinations can be carried out contrast enhancement based on the clinical situation (slone, 2000).

2.1.7 Risk of radiation

The probability for absorbed x-ray to induce cancer or heritable mutations leading to genetically associated disease in offspring is thought to be very small for radiation doses of the magnitude that are associated with CT procedures.

Under some rare circumstances of prolonged, high-dose exposure, x-ray can cause other adverse health effects, such as skin erythema (reddening), skin tissue injury, and birth defects following in-utero exposure. But at the exposure levels associated with most medical imaging procedures, including most of CT procedures, these other adverse effects would not occur (Fred A. et al., 2008)

CT Dosimetry Radiation dose depends on tube current (amperage), slice scan time, and tube peak kilovoltage. As in radiography, tube current and slice scan time are taken together as mAs in relation to radiation dose and image quality. Increasing the mAs (by increasing current or slice scan time) increasing the dose proportionally: 300 mAs deliver twice the dose of 150 mAs. Consequently, a higher peak kilovoltage dose not necessarily means an increased patient dose, in fact, may allow the dose to be reduced. (Ware DE, et. al., 1999)

The American College of Radiology recommends CTDIW limits of 6 cGy (60 mGy) and 3.5 cGy (35 mGy) for routine head and abdomen scans, respectively. (Shope TB, et. al., 1982)

2.1.8 Radiation safety in imaging

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

2.2 Previous studies

J Y CHIN et.al (2012) studied the role of CT imaging in the diagnosis and management of acute abdominal pain. Interobserver variability in CT reporting was also assessed. The methods is: Clinical data and CT reports were analysed retrospectively for any discrepancies by comparing CT diagnosis, clinical diagnosis as stated on the discharge summary and final diagnosis (based on consensus review of all information). Blinded review of all CT imaging was performed to determine interobserver variability. The results is: 120 consecutive scans fulfilled the inclusion criteria (114 patients; 79 women; mean age 55 years). The correct clinical diagnosis was made in 87.5% of cases based on CT findings. The lack of intravenous contrast limited diagnostic interpretation in 6 of the 15 discrepant cases. CT was unable to define early inflammatory changes in three patients and early cecal carcinoma in one. A right paraduodenal internal hernia was difficult to detect in another patient. Interobserver agreement was 93%, but with a low value of 0.27. A paradox exists due to an imbalance in the positive and negative agreement of 96% and 31%, respectively.

Sun Ho Ahn, et.al (2012) studied to compare the diagnostic yield of abdominal radiography with that of computed tomography (CT) in adult patients presenting to the emergency department with nontraumatic abdominal pain. The method is: Records of 1,000 consecutive patients presenting to the emergency department with acute abdominal pain from April to June 1998 were retrospectively reviewed. A total of 871 patients underwent abdominal radiography, and 188 underwent abdominal CT. The report interpretations of the abdominal radiographs and CT scans were divided into normal, nonspecific, and abnormal categories. Final discharge diagnoses were compared with the interpretations of the imaging examination results, and sensitivities and specificities of each modality were calculated and compared. The result is: Interpretation of abdominal radiographs was nonspecific in 588 (68%) of 871 patients, normal in 200 (23%), and abnormal in 83 (10%). The highest sensitivity of abdominal radiography was 90% for intraabdominal foreign body and 49% for bowel obstruction. Abdominal radiography had 0% sensitivity for appendicitis, pyelonephritis, pancreatitis, and diverticulitis. Sensitivities of abdominal CT were highest for bowel obstruction and urolithiasis at 75% and 68%, respectively.

John Sherck, et. al (1994) Studied the accuracy of computed tomography in the diagnosis of blunt small-bowel perforation. The methods were tracking 883 consecutive stable trauma victims who had abdominal CT because of equivocal physical findings. Initial "wet reading" results were compared with laparotomy findings and patient outcome. The results are Small-bowel perforation occurred in 26 patients (3%). Twenty-four had CT abnormalities suggesting the injury. Twelve had CT findings considered diagnostic: contrast extravasation (n = 5) and/or extraluminal air (n = 11). One additional patient was thought to have free air on CT, but had no intestinal injury at laparotomy. Another 12 patients had CT scans that were nondiagnostic but suggestive: free fluid without solid organ injury (n = 10), or small-bowel thickening (n = 4) or dilatation (n = 3). Two patients with small-bowel injuries had normal CT scans. Of 857 patients without small-bowel disruption, 802 had normal abdominal CT scans, and 67 CT findings suggesting intestinal injury. Thus, CT diagnosed small-bowel perforation with a sensitivity of 92%, a specificity of 94%, and negative and positive predictive accuracies of 100% and 30%, respectively. The test had an overall accuracy (validity) of 94%.

Chapter Three

Material &Method

Material & Method

3.1 Material

3.1.1 Study group

The study population was composed of 150 patients with abdominal examination requests presenting to the CT units in Khartoum state hospitals. 100 patients with general abdominal scan and 50 patients with CTU requests, 76 male and 74 female, their main age was >60.

3.1.2 CT machine

The study was executed using multi-detector computed tomography scanner MDCT64-Slice scanner.

Table feed 10 mm/rotation.

Effective tube current 685 mAs at 120 kV.

Pitch = 10/40 mm collimation = 0.25.

Average scan time = 5 s. (Appendix A)

3.2 Method

3.2.1 Technique used

CT scans were performed on a Toshiba Aquilion 64 scanner (Toshiba, Otawara, Japan) and acquired after i.v. contrast administration (Omnipaque 300 at 3ml). Oral contrast agent [1000 ml of 2% Gastrografin was administered 1 h prior to the scan. The scan was reconstructed to create contiguous 5mm axial sections from the lung bases to the pubic symphysis. Coronal and sagittal reconstructions were also made available.

3.2.2 Data collection and analysis

The data were collected by master data sheets using the variables of age, gender, scan type, clinical diagnosis finding, CT findings and diagnosis evaluation. (Appendix B)

And analyzed by using Excel program and the results were presented in form of tables and graphs.

3.3 Duration of the study

The data were collected during the period from August 2015 to December 2015.

3.4 Ethical consideration

- No identification or individual details will be published.
- No information or patient details will be disclosed or used for reasons other than the study.

Chapter Four

Results

Chapter Four

4.1 Result of diagnosis evaluation

The study was obtained in 150 subjects complained of abdominal pain, male 76 (50.7%) and female 74 (49.3%) as presented in table (4-1). Their mean age was >60 year (36.7%); presented in table (4-2).

Table 4-1: Shows the Gender Distribution

Gender	Frequency	Percent %
Male	76	50.7
Female	74	49.3
Total	150	100

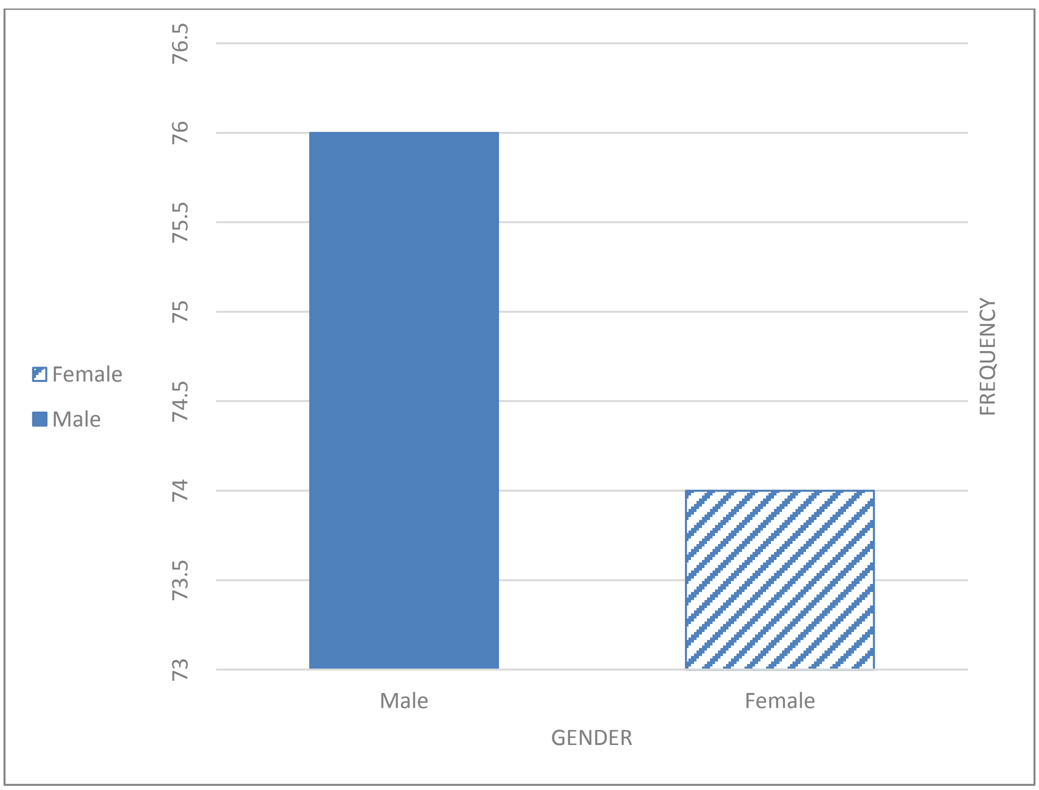

Fig. 4-1 Relation between gender and frequency

Table 4-2: Shows the Age Class Distribution

Age "Years"	Frequency	Percent %
<20	8	5.3
21-40	34	22.7
41-60	53	35.3
>60	55	36.7
Total	150	100

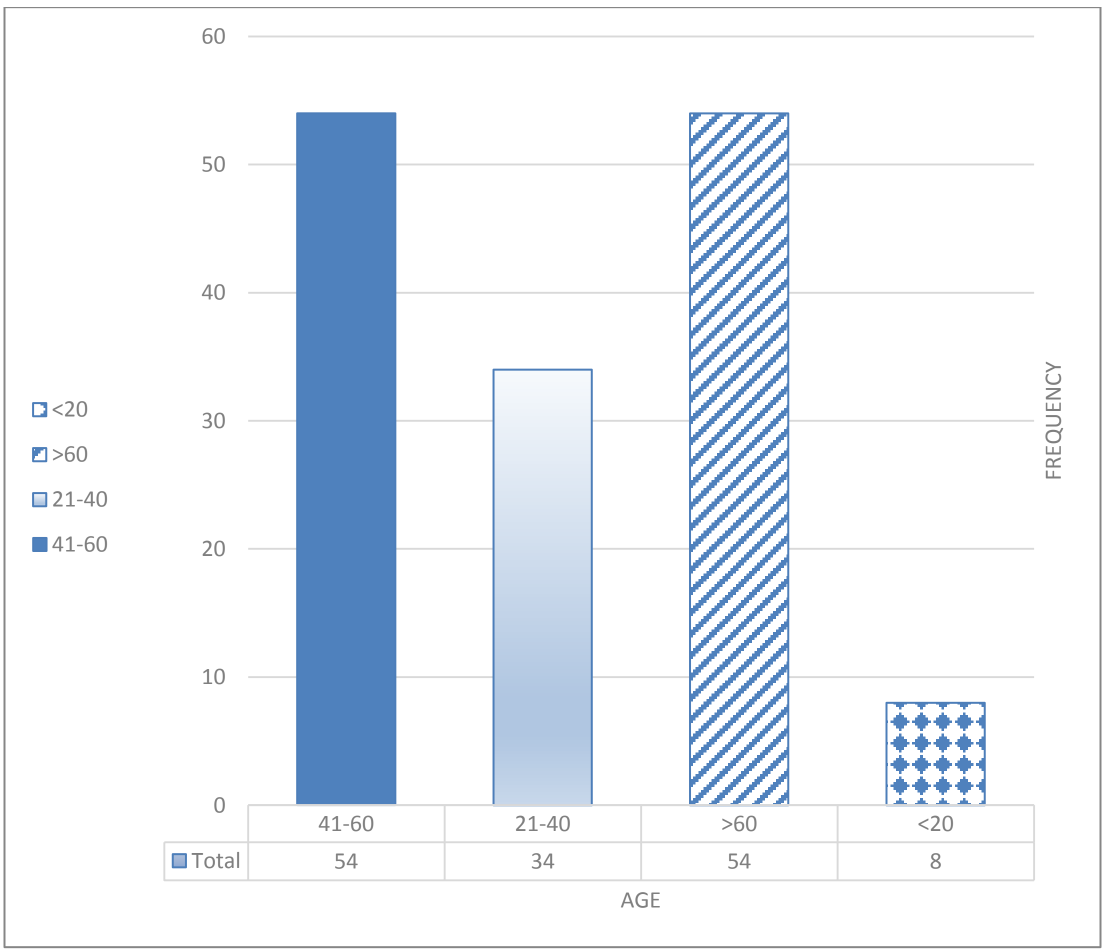

Fig. 4-2 Relation between Age and Frequency.

Table 4-3: Shows the result of All CT diagnosis and frequency and percentage for each

Result	Frequency	Percent %
correct	70	46.7
Incorrect	33	22
Non Specific	47	31.3
Total	150	100

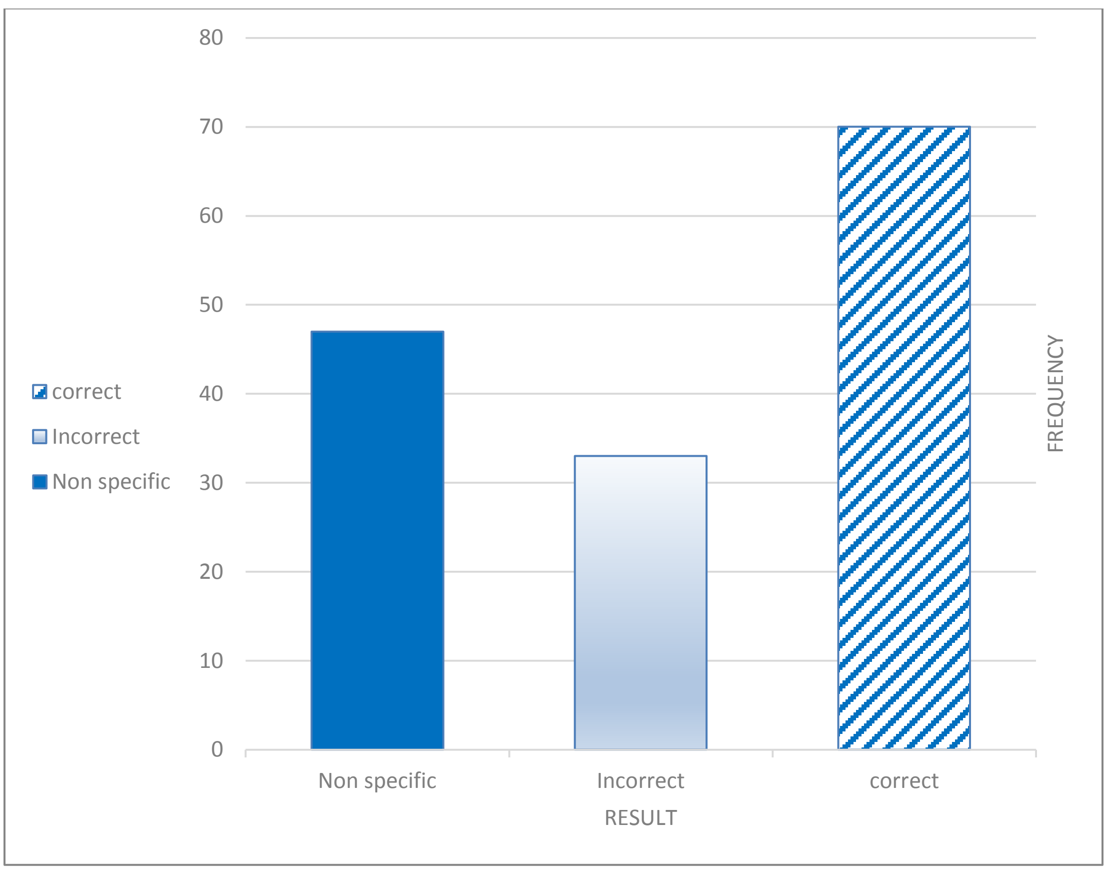

Fig. 4-3 Relation between result and Frequency.

4.2 Result of Abdominal CT diagnosis

Table 4-4: Shows the result of Abdominal CT diagnosis and frequency and percentage for each

Result	Frequency	Percent %
correct	43	43
Incorrect	25	25
Non Specific	32	32
Total	100	100

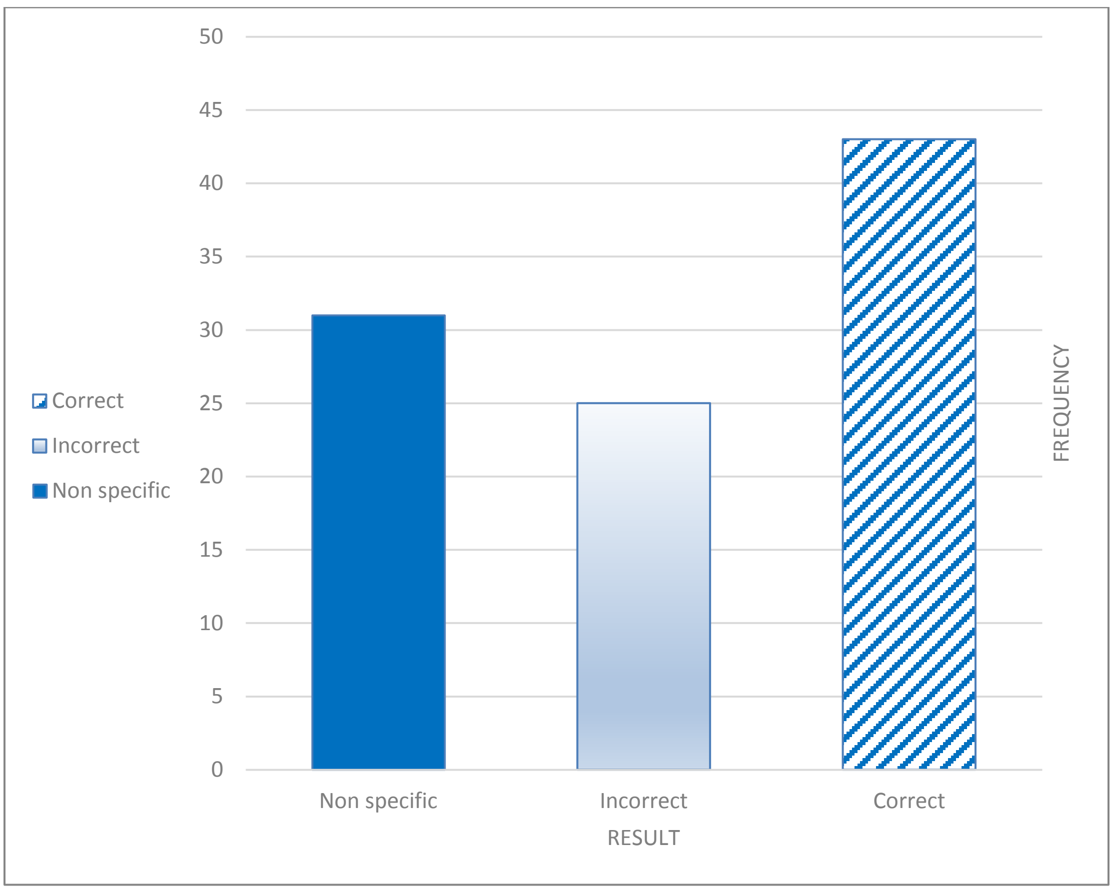

Fig. 4-4 Relation between result and Frequency

4.3 Result of CTU diagnosis

Table 4-5: Shows the result of CTU diagnosis and frequency and percentage for each

Result	Frequency	Percent%
correct	26	52
Incorrect	9	18
Non Specific	15	30
Total	50	100

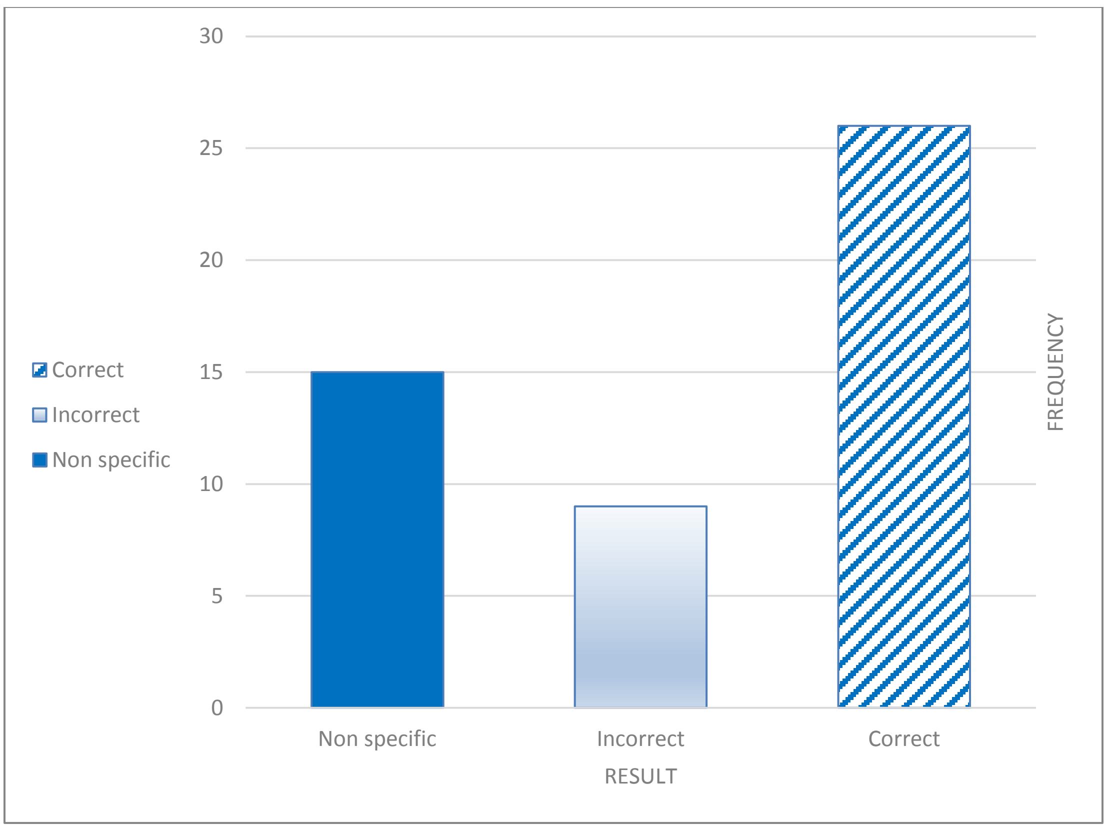

Fig. 4-5 Relation between result and frequency

Chapter Five

Discussion, Conclusion

&

Recommendations

Discussion, Conclusion & Recommendations

5.1 Discussion

The study was designed to compare the clinical diagnosis and CT diagnosis in patients with abdominal pain. The result was obtained from 150 subjects complained of abdominal pain, male 76 (50.7%) and female 74 (49.3%) as presented in table (4-1). Their mean age was >60 years (36.7%); this was presented in table (4-2). 70 patients with general abdominal scan were correctly diagnosed (46.7%) unlike the findings by CHIN, (87.5%). 33patients were misdiagnosed (22%) and 47 patients present with non specific results (31.3%) Unlike Sun Ho Ahn, (68%). as presented in table (4-3). 43 patients with GIT or liver pathology were correctly diagnosed (43%), 25 patients were misdiagnosed (25%) and 32 patients present with non specific results (32%) as presented in table (4-4). 27 patients with urinary system pathology were correctly diagnosed (54%), 8 patients were misdiagnosed (16%) and 15 patients present with non specific results (30%). 40 patients were clinically diagnosed with mass lesions (38.8%), 25 patients with stones (24.3%) and 38 patients with other pathology (36.9%) as presented in table (4-6). 80% of mass lesions were correctly diagnosed, 72% of stones were correctly diagnosed and 52.6% of the other pathologies were correctly diagnosed.

5.2 Conclusion

The utility of CT imaging in the diagnosis and management of patients presenting with acute abdominal pain is confirmed, but is limited in a minority of cases where poor negative interobserver agreement exists. Good communication to the reporting radiologist of the relevant patient history and clinical question becomes important. The usefulness is limited by certain factors: the absence of detailed clinical history, the use of non-contrast imaging, the variability in the interpretation of non-specific image findings. Awareness of these limiting factors is vital to clinicians, radiologists and technologists in the diagnosis and treatment of patients.

5.3 Recommendation

- The researcher recommends that clinicians should write a detailed clinical history through a properly filled request form.

- Good communication between the reporting radiologist and technologists is important.

- Data should be compared with the final diagnose to evaluate the role of CT in finding disease. And it is important to increase the number of patient for more finding.

- Usage of higher CT machine facilities (more than 64slice).

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Appendices

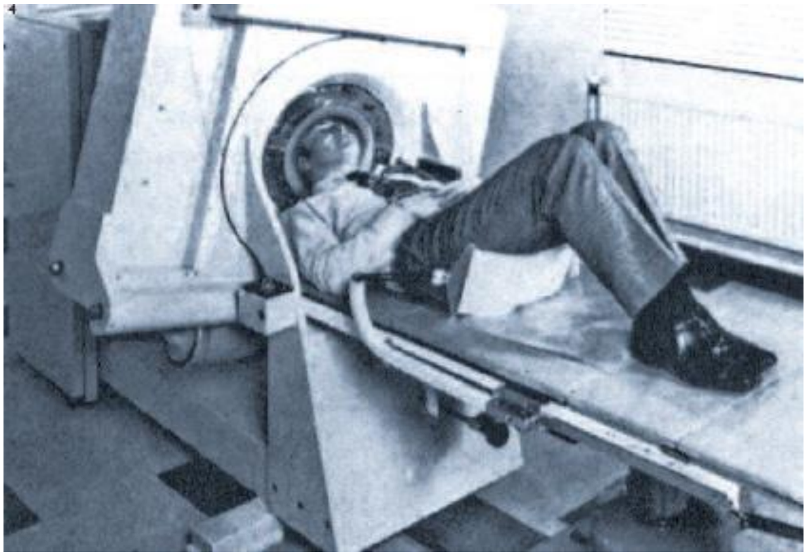
Appendix A

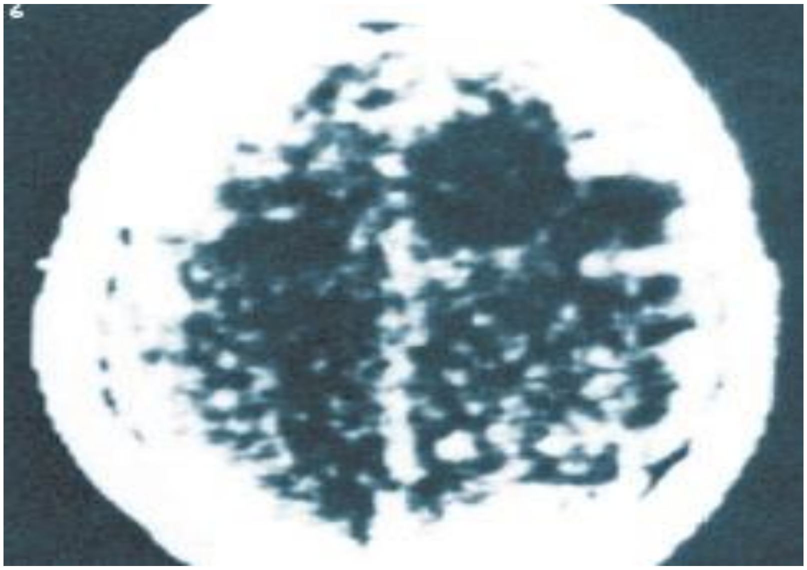
Toshiba Aquilion™ 64 MDCT scanner. Monitor, Gantry and Table

Monitor

Gantry and Table

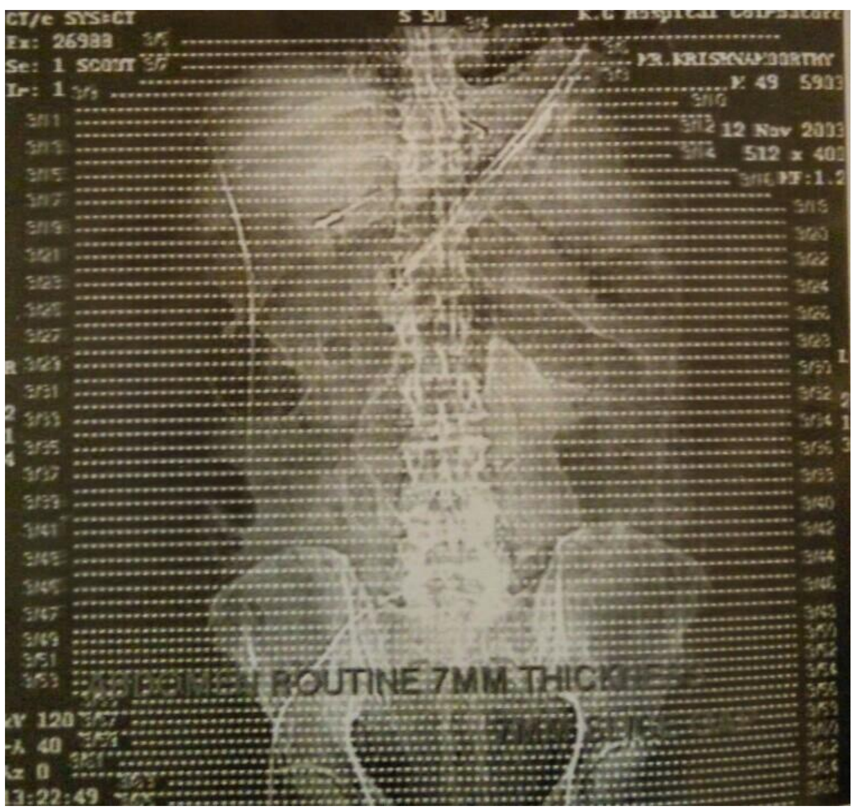
Appendix C





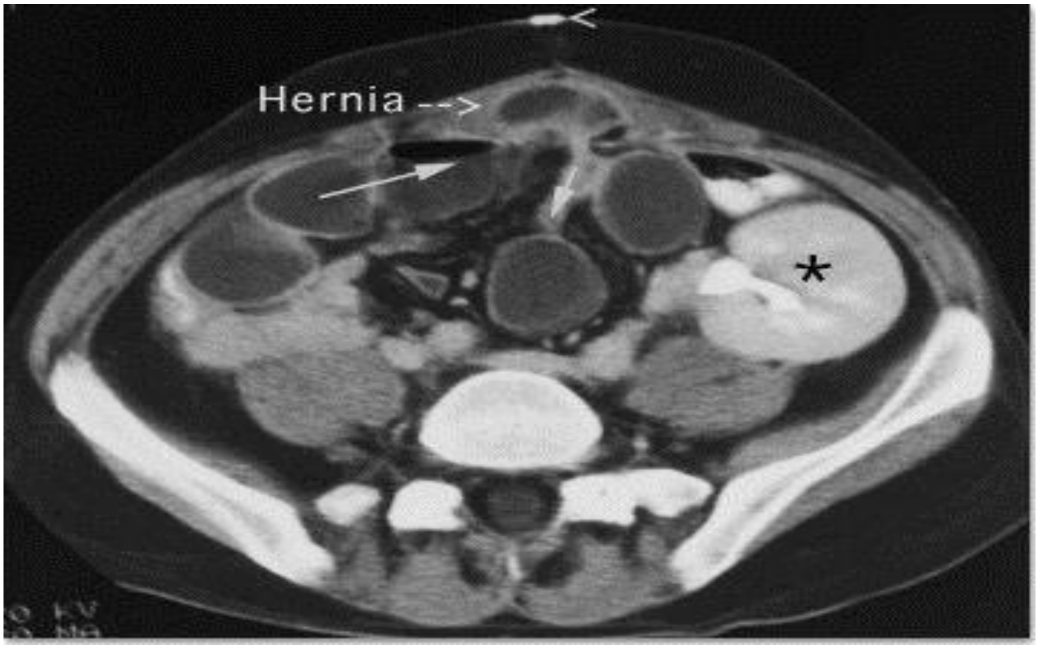
First clinical prototype EMI brain scanner and First clinical image obtained from EMI prototype unit.

Appendix D

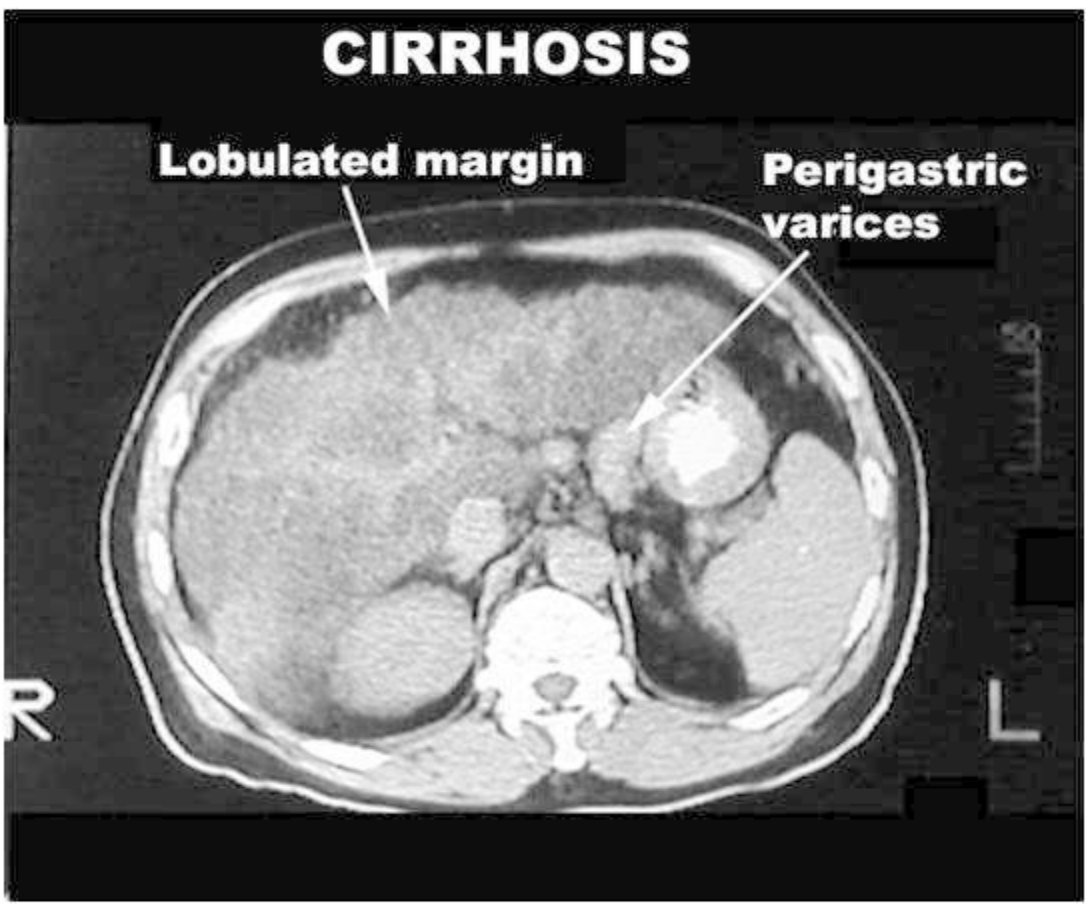


Scan plane for abdomen

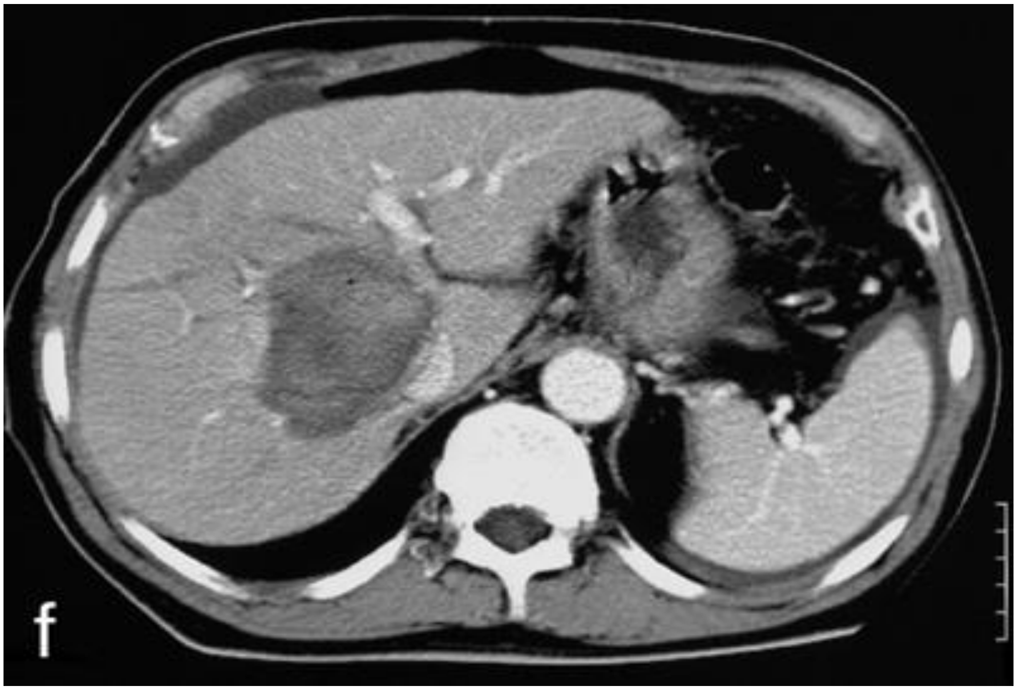
Appendix E



Female, 37 years - Abdominal hernia



Male 72 years - Liver cirrhosis



Female, 48years - Hepatocellular carcinoma