Sudan University of Sciences and Technology
College of Graduate Studies

Application of MRI in Diagnosis of Gastrointestinal Tract Diseases

تطبيقات تقنية الرنيين المغناطيسي في تشخيص امراض القناة الهضمية

A Thesis Submitted in Partial Fulfillment for the Requirements of Master Degree of Science in diagnostic Radiological Technology

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الآية

قال تعالى:

(إنَّ في خلْق السَّمواتِ والأرض واختلافِ اللَّيل والنَّهار لآياتٍ لأولي الألباب الَّذين يَذْكُرونَ الله قياماً وقعوداً وعلى جُنوبهم ويتفَكَّرونَ في خلْق السَّمواتِ والأرض ربَّنا ما خلقْت هذا باطلاً سبحانَك فَقِنَا عذابَ النَّار)

آل عمران آية 190-191

Dedication

To my mother, father, teachers, brothers, sister,

to soul of my brother, and my friends.

ACKNOWLEDGMENT

First of all thank to almighty Allah for giving me the knowledge and strength to complete this dissertation.

I would like to express my deep gratitude to my supervisor **Dr.Asma Ibrahim Ahmed** for her keen supervision, encouragement and support through this work, and also deeply thanks to my brother and teacher **Abd Alrahman Mohammed Noor** for his helped during this work.

Thanks are extended to the staff of **Alribat university hospital**.

ABBREVIATION

2D	TWO Dimensions.
3D	Three Dimensions.
BH	Breath Hold .
CAT	Computed Axial Tomography.
CT	Computed Tomography.
GIT	Gastrointestinal Tract.
IA	Image Amplifier**.**
IBD	Inflammatory Bowel Disease.
IMA	Inferior Mesenteric Artery.
MBH	Multiple Breath Hold**.**
MRI	Magnetic Resonance Imaging.
NMR	Nuclear Magnetic Resonance.
PID	Pelvic Inflammatory Disease.
SMA	Superior Mesenteric Artery.
T	Tesla.
T1	T1 weighted.
T2	T2 weighted.
TrueFISP	Fast imaging with steady-state free precession.
Trufi	True fast imaging with steady-state free precession.
UC	Ulcerative colitis.
US	Ultrasound.

ABSTRACT

This study, carried out during the period from December 2014 to February 2015 .the aim of this study was to applied of MRI protocol in diagnosis the GIT diseases specially the inflammatory bowel diseases.

The 30 random cases of patient came to the MRI department with request for MRI Enterology examination .MRI machine used in this study were: alribat university hospital used closed magnet ,sign high definition with magnetic field strength (1.5 t) (Magnetom Sonata, Siemens Medical Systems, Erlangen, Germany).

From this study result the best protocol to visualize, detection and diagnose the gastrointestinal tract diseases specially the inflammatory bowel disease by using MR Enterology protocol, used 2D (Sagittal, axial) T2 Trufi BH, 2D coronal T2 True FISP BH,. axial T2 Tse MBH, 3D coronal T1 FS, Gadolinium enhanced T1, and the oral contrast is mannitol 2.5% with 1500ml of water

All patients scanned by MRI 16 (53.3%) were male and 14 (46.7%) female. The age of the subject ranged from 24 to 60 years.

The study concluded that MR Enterology protocol best in detection and diagnose the gastrointestinal tract diseases specially the inflammatory bowel disease and the communally sequence use is 2D coronal a fast T2-weighted steady state precession sequence (True FISP).26.7% male more affected inflammatory bowel disease than female 10%.

الملخص

هذه الدراسه أجريت خلال الفترة من ديسمبر 2014 إلى فبراير 2015. وكان الهدف من الدراسة هو تطبيق بروتوكول الرنين المغناطيسي في تشخيص أمراض الجهاز الهضمي خصوصا امراض التهابات الامعاء.

30 مريض قدموا إلى قسم التصوير بالرنين المغناطيسي لتصوير الامعاء بفورمات مختلفه,جهاز الرنين المغناطيسي المستخدم في هذه الدراسة في مستشفى الرباط الجامعي نوع الجهاز مجال مغناطيسي مغلق عالي الوضوح معشدة مجال مغناطيسي 1.5 تسلا (سيمنز) (صنع في ألمانيا).

من هذه النتيجه أفضل بروتوكول لتصور وكشف وتشخيص أمراض الجهاز الهضمي وخاصة مرض التهاب الأمعاء باستخدام الرنين المغناطيسي للامعاء مع المانيتول 2.5%ممزوج في1500مل من الماءكوسيط تباين فمي للامعاء باستخدام المقاطع ذات البعدين (سهمي، محوري) وخلاله يتحكم المريض بالتنفس, والمقاطع ثلاثية الابعاد مع اضافة الجادولينيوم بحقنه كوسيط تباين محقون وريديا.

30من المرضى تم فحصهم بواسطة الرنين المغناطيسي 16 (53.3٪) من الذكور و 14 (46.7٪) للإناث تراوحت اعمارهم من 24 الي 60 عاما.

خلصت الدراسة إلى أن البروتوكول باستخدام المقاطع ذات البعدين الأفضل في كشف وتشخيص أمراض الجهاز الهضمي وخاصة مرض التهاب الأمعاء ,نسبة الذكور المعرضين للمرض من الرجال 26.7% اكثر من النساء 10%.

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Chapter one

Introduction

1-1 Introduction

Magnetic resonance imaging (MRI) is an imaging modality that uses non-ionizing radiation to create diagnostic useful images. MRI was initially called Nuclear Magnetic Resonance Imaging after its early use for chemical analysis. The "Nuclear" was dropped off about 25 years ago because of fears that people would think there was something radioactive involved, which there is not. (Jeremy et al 2015)

NMR was discovered simultaneously by two physicists, Felix Bloch and Edward Mills Purcell, just after the end of World War II. Bloch trained in quantum mechanics and was involved with atomic energy and then radar counter-measures. At the end of the war he returned to his earlier work in the magnetic moment of neutron. Purcell was involved with development of microwave radar during the War then pursued radio waves for evaluation of molecular and nuclear properties. They received the Nobel Prize in Physics in 1952 for this discovery. (Jeremy et al 2015)

MRI, the use of NMR to produce 2D images was accomplished by Paul Lauterbur, imaging water and Sir Peter Mansfield who imaged fingers of a research student, Dr Andrew Maudsley in 1976. Maudsley continues to make a significant contribution to MRI R&D. Raymond Damadian obtained human images a year later in 1977. Lauterbur and Mansfield received the Nobel Prize in Physiology or Medicine in 2003 for their development of MRI. (Jeremy et al 2015)

Hydrogen atoms have an inherent magnetic moment as a result of their nuclear spin. When placed in a strong magnetic field, the magnetic moments of these hydrogen nuclei tend to align. Simplistically, one can think of the hydrogen nuclei in a static magnetic field as a string under tension. The nuclei have a resonant or "Larmor" frequency determined by their localized magnetic field strength, just as a string has a resonant

frequency determined by the tension on it. For hydrogen nuclei in a typical 1.5T MRI field, the resonant frequency is approximately 64MHz. (Johns et al 2015)

The magnets and radio waves create cross-sectional images of the abdomen, which allow checking for abnormalities in the tissues and organs without making an incision, the technology used in an MRI allows examining the soft tissues without bones obstructing the view. (Brian Krans, 2012)

So that, abdominal MRI scans are used for a variety of reasons, include blocked blood vessels, cancer, and disease affecting the organs, pregnancy complications, injury, and pain. (Brian Krans, 2012)

Examinations with visualization of the anatomy and pathology of the gastrointestinal (GI) tract are often mandatory in the diagnosis of GI diseases. For this purpose, traditional radiological techniques played a leading role for a long time. However, improvements in endoscopic examinations, the latest including wireless capsule endoscopy, have radically changed the possibilities for direct visualization and intervention in the GI tract. The introduction and advances in non-invasive imaging modalities including ultrasound (US), computed tomography (CT), and magnetic resonance imaging (MRI) have in the last decades revolutionized the way in which the GI tract is studied. (Camilleri, 2006)

MRI provides several notable advantages over US and CT in the assessment of abdominal pathologies. The first is its lack of ionizing radiation. This feature is of particular benefit to pediatric patients and, by extension, to pregnant women. Another subset of patients who undergo numerous CT scans for recurring abdominal pain are patients with inflammatory bowel disease. A second advantage of MRI is the ability to image patients who have allergies to CT contrast agents. Third, MRI can delineate certain disease entities better than US or CT, such as choledocholithiasis, where bowel gas and patient body habitus can obscure acoustic windows on US exams and many stones can go undetected on CT. Last, MRI provides superior contrast resolution and excellent characterization of pathologic tissue. (Christina et al 2015)

Acceptance of the use of MR in abdominal imaging has been limited in part by difficulty in distinguishing bowel from intra abdominal masses and normal organs. (Runge et al 1983)

Michael Dam Jensen 2010 sought to determine the frequency and clinical impact of incidental findings detected with magnetic resonance imaging (MRI)-enterography in patients with suspected or known Crohn's disease. (Michael et al 2010)

W. Ajaj1 2003 colleagues sought to was to compare different osmotic carbohydrate solutions (2.5% mannitol, 2.5% / 2.0% / 1.5% sorbitol) for small bowel MR imaging regarding image quality and patient acceptance. (W. Ajaj1 et al 2003)

1.2. Research problems

The MRI in abdominal imaging has been limited in part by difficulty in distinguishing bowel from intra abdominal masses and normal organs.

Limitation of CT abdomen to diagnosis the GIT diseases specially the inflammatory bowel disease in some times because the CT provides low contrast resolution of the tissue than the MRI.

1. 3. Research objectives

1.3.1. General objectives

To applied of MRI protocol in diagnosis the GIT diseases specially the inflammatory bowel diseases.

1.3.2 Specific objectives

To applied the protocol (MR Enterology protocol).

To applied the MR Enterology in diagnosis the GIT diseases specially the inflammatory bowel disease.

To alter from CT modalities to MRI in imaging the gastrointestinal tract.

1.4 Thesis outline

Chapter one: consist of introduction, statement of the problem, objectives of the study, and thesis outline).

Chapter two: the literature review (Anatomy, Physiology, Pathology of the brain, previous studies).

Chapter three: methodomatriel and method.

Chapter four: result.

Chapter five: Discussion, Conclusions and Recommendation.

References.

Appendix.

Chapter two

Literature review

2.1. Theoretical Background

2.1.1. Anatomy of The gastrointestinal tract

The gastrointestinal (GI) tract, or alimentary canal (alimentary = nourishment), is a continuous tube that extends from the mouth to the auns through the thoracic and abdominopelvic cavities. (Gerard et al 2008) Is divided into the upper and lower gastrointestinal tracts. (From Wikipedia, Dorland's Medical Dictionary) However, by the broadest definition, the GI tract includes all structures between the mouth and the anus.(From Wikipedia, Medical Subject Headings) On the other hand, the digestive system is a broader term that includes other structures, including the digestive organs and their accessories. (From Wikipedia, Dorland's Medical Dictionary) include the teeth, tongue, salivary glands, liver, gallbladder, and pancreas. (Gerard et al 2008) The length of GI tract is about 5-7 meters (16.5-23 feet). The tract may also be divided into foregut, midgut, and hindgut, reflecting the embryological origin of each segment(From Wikipedia, Dorland's Medical Dictionary) The mouth includes : the tongue, teeth, and the hard and soft palates also there are the parotid glands in front of the ears, the sublingual glands embedded under the sides of the tongue, and the submaxillary glands near the rear of the jawbone. The esophagus is about twenty-five to thirty centimeters long that begins at the pharynx and descending through the mediastinum and diaphragm into the stomach. (Margaret Matt et al 1982)

2.1.1.1. Upper gastrointestinal tract

The upper gastrointestinal tract consists of the esophagus, stomach, and duodenum.(From Wikipedia, Medical Subject Headings) The exact demarcation between the upper and lower tracts is the suspensory ligament of the duodenum (also known as the Ligament of Treitz). This delineates the embryonic borders between the foregut and

midgut. (David et al 2005) The duodenum may appear to be a unified organ, but it is divided into four segments based upon function, location, and internal anatomy. The four segments of the duodenum are as follows (starting at the stomach, and moving toward the jejunum): bulb, descending, horizontal, and ascending. The suspensory ligament attaches the superior border of the ascending duodenum to the diaphragm. The suspensory muscle of duodenum is an important anatomical landmark which shows the formal division between the duodenum and the jejunum, the first and second parts of the small intestine, respectively. This is a thin muscle which is derived from the embryonic mesoderm. (David et al 2005)

2.1.1.2. Lower gastrointestinal tract

2.1.1.2.1. The small intestine

The lower gastrointestinal tract includes most of the small intestine and all of the large intestine. (From Wikipedia, Medical Subject Headings) In human anatomy, the intestine (or bowel, hose or gut) is the segment of the gastrointestinal tract extending from the pyloric sphincter of the stomach to the anus, the small intestine is further subdivided into the duodenum, jejunum and ileum while the large intestine is subdivided into the cecum, colon, rectum, and anal canal.(Kapoor et al 2011)

The small intestine begins at the duodenum, It is a tubular structure, usually between 6 and 7 m long. (Drake et al 2005) The area of the human, adult small intestinal mucosa is about 30 m2. (Helander et al 2014) It has three major divisions: the duodenum a short structure (about 20-25 cm long (Drake et al 2005)). The jejunum is the midsection of the small intestine, connecting the duodenum to the ileum. It is about 2.5 m long, and contains the plicae circulares, and villi that increase its surface area. The ileum is the final section of the small intestine. It is about 3 m long, and contains villi similar to the jejunum. (Drake et al 2005)

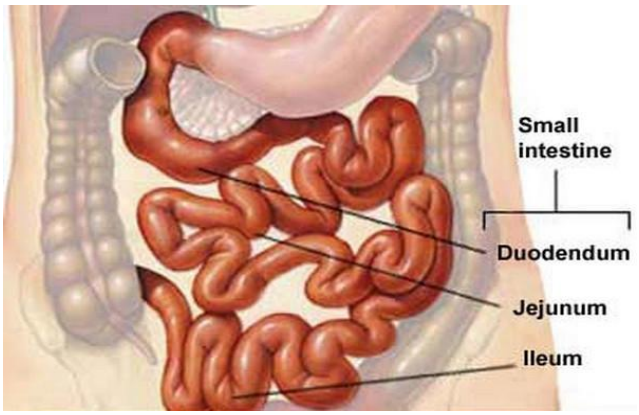

Figure (2.1) Small intestine and its parts (duodenum, jejunum and ileum). http://healthfixit.com/wp-content/uploads/2013/03/small-intestine-location-and-anatomy.jpg

2.1.1.2.2. The large Intestine

The large Intestine consists of the cecum, colon, rectum, and anal canal. It also includes the vermiform appendix, which is attached to the cecum. The colon is further divided into: Ascending colon (ascending in the back wall of the abdomen), transverse colon (passing across the back wall), descending colon (descending down the left side of the abdomen), and the Sigmoid Flexure. The gut during fetal life can be divided into three segments: foregut from the esophagus to first 2 sections of the duodenum , midgut from the lower duodenum, to the first two-thirds of the transverse colon, and hindgut from the last third of the transverse colon, to the upper part of the anal canal. (Helander et al 2014)

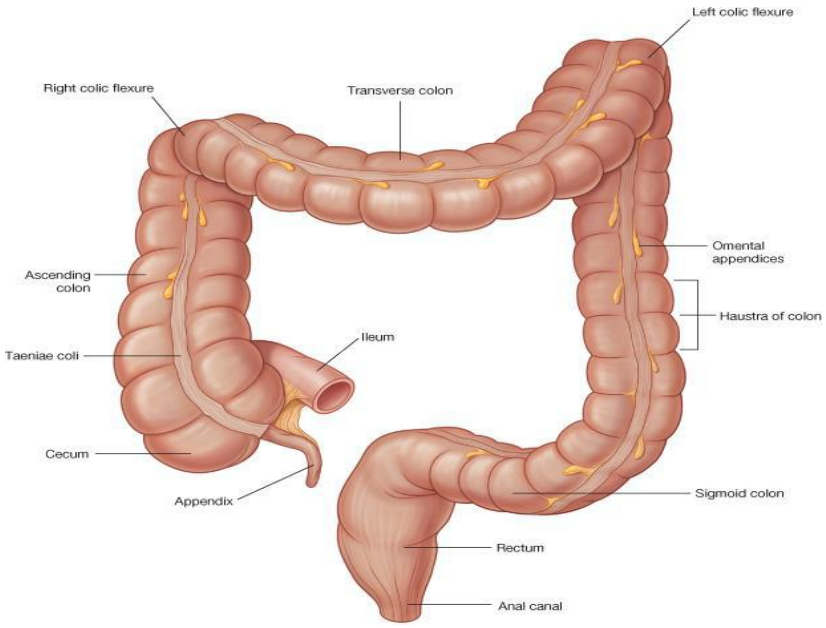

Figure (2.2) Large intestine with its parts. (Drake et al 2006)

2.1.1.3. The gastrointestinal tract layers

The gastrointestinal tract has four concentric layers: the mucosa (oral mucosa and gastric mucosa is the innermost layer of the gastrointestinal tract. that is surrounding the lumen, the submucosa consists of a dense irregular layer of connective tissue with large blood vessels, lymphatics, and nerves branching into the mucosa and muscularis externa , the muscularis externa consists of an inner circular layer and a longitudinal outer muscular layer, serous membrane and adventitia are the outermost layer of the gastrointestinal tract consists of several layers of connective tissue, intraperitoneal parts of the GI tract are covered with serosa. These include most of the stomach, first part of the duodenum, all of the small intestine, caecum and appendix, transverse colon, sigmoid colon and rectum, retroperitoneal parts are covered with adventitia these include the esophagus, pylorus of the stomach, distal duodenum, ascending colon, descending colon, anal canal, and the oral cavity. (Abraham et al 2002)

2.1.1.4. Accessory organs

2.1.1.4.1. The pancreas

The pancreas is a major as an accessory digestive gland in the digestive system, the pancreas lies below and at the back of the stomach. It connects to the duodenum via the pancreatic duct, there is a nearby connection of the common bile duct to the duodenum. (Ahrens et al 1998)

2.1.1.4.2. The liver

The liver is the largest organ (after the skin) and is an accessory digestive gland, The liver is located in the upper right quadrant of the abdomen and below the diaphragm to which it is attached at one part, This is to the right of the stomach and it overlies the gall bladder. (From Wikipedia. Black's Medical Dictionary)

2.1.1.4.3. The gallbladder

The gallbladder is a hollow part of the biliary system that sits just beneath the liver. It is a small organ, it is divided into three sections: fundus, body and neck. The neck tapers and connects to the biliary tree via the cystic duct, which then joins the common hepatic duct to become the common bile duct. (From Wikipedia, Black's Medical Dictionary)

2.1.1.4.4. The biliary tree

The biliary drainage system consists of the right hepatic duct and the left hepatic duct exists from the liver, the right hepatic duct attaches to the left hepatic duct to form the common hepatic duct, the thin and tortuous cystic duct measures between 2-4cm in length and usually empties into the common hepatic duct, originating the common bile duct. It connects the gallbladder to the extrahepatic biliary tree. (J. Ressurreição1et al 2014)

2.1.2. Physiology of the gastrointestinal tract

The GI tract contains food from the time it is eaten until it is digested and absorbed or eliminated. The muscular contractions in the wall of the GI tract physically break down the food by churning it and propel the food along the tract, from the esophagus to the anus. The contractions also help to dissolve foods by the mixing them with fluids secreted into the tract. Enzymes secreted by accessory digestive organs and cell that line the tract break down the food chemically. The digestive system performs six basic process. (Gerard et al 2008)

2.1.2.1. Ingestion and secretion

Ingestion, this process involves taking food and liquid into the mouth (eating). Secretion, each day, cells within the wall of GI tract and accessory organs secreted total of about 7 liters of water, acid, buffers and enzymes into the lumen (interior space) of the tract. (Gerard et al 2008)

2.1.2.2. Mixing and propulsion

Mixing and propulsion , altering contractions and relaxations of smooth muscle in the walls of GI tract mix food and secretions and propel them toward the anus , this capability of GI tract to mix and move material along its length is called motility. Digestion is mechanical and chemical processes break down ingestion food into small molecules, in mechanical digestion the teeth cut and grind food before it is swallowed, and then smooth muscle of the stomach and small intestine churn the food. As a result, food molecules become dissolved and thoroughly mixed with digestive enzymes, in chemical digestion the large carbohydrate, lipids, proteins, and nucleic acid molecules in food are split into smaller molecules by the hydrolysis. (Gerard et al 2008)

2.1.2.3. Digestion and absorption

Digestion enzymes produced by the salivary glands, tongue, stomach, and small intestine catalyze these catabolic reactions. A few substances in food can be absorbed without chemical digestion, these include vitamins, ions, cholesterol, and water.

Absorption is the entrance the ingestion and secreted fluid, ions, and the products of the digestion into the epithelial cells lining the lumen of GI tract is called absorption, the absorbed substances pass into blood or lymph and circulate to cell throughout the body. (Gerard et al 2008)

2.1.2.4. Defecation

Defecation, west, indigestible substances, bacteria, cells sloughed from the lining of GI tract, and digested materials that were not absorbed in their journey through the digestive tract leave the body through the anus in a process called defecation. The eliminate materials is termed feces. (Gerard et al 2008)

The main function of the small intestine is to absorb the products of digestion (including carbohydrates, proteins, lipids, and vitamins) into the bloodstream, as the following: the Duodenum receives gastric chyme from the stomach, together with digestive juices from the pancreas (digestive enzymes) and the gall bladder (bile). The digestive enzymes break down proteins and bile and emulsify fats into micelles. The duodenum contains Brunner's glands, which produce a mucus-rich alkaline secretion containing bicarbonate. These secretions, in combination with bicarbonate from the pancreas, neutralize the stomach acids contained in gastric chyme. The Jejunum where Products of digestion (sugars, amino acids, and fatty acids) are absorbed into the bloodstream. The ileum absorbs mainly vitamin B12 and bile acids, as well as any other remaining nutrients.

The main function of the large intestine is to absorb water. (From Wikipedia, Human gastrointestinal tract)

2.1.2.5. The blood supply

2.1.2.5.1. Celiac trunk

Just below to the aortic hiatus, the celiac trunk branched from the abdominal aorta and give rises to branches that supply organs derived from foregut. Three major branches that

come from celiac trunk are left gastric artery is the smallest branch among three arteries from celiac trunk. This artery supplies superior part of stomach. It also gives rises to small esophageal branch that supplies gastroesophageal junction, splenic artery that is the largest branch of celiac trunk. This artery courses toward left side of abdomen by locates onto superior border of pancreas before enters spleen through its hilum, also this artery supplies body and tail of pancreas, the body of stomach and greater omentum and the fundus of stomach, common hepatic artery is another large branch that courses toward the porta hepatis of liver, and supplies parts of stomach, duodenum and liver. (Bien Nillos et al 2010)

2.1.2.5.1.1. Superior mesenteric artery

The superior mesenteric artery (SMA) give rises to branches that supply parts of GI tract derived from midgut; from third part of duodenum to proximal 2/3 of transverse colon. This artery branched from the abdominal aorta at the level of L1 vertebral body, and it is supplies head and uncinated process of pancreas and distal part of duodenum, jejunal and ileal parts of small intestine, transverse colon, ascending colon, terminal ileum, colon and vermiform appendix. (Bien Nillos et al 2010)

2.1.2.5.1.2. Inferior mesenteric artery

The inferior mesenteric artery (IMA) is responsible for blood supply to the GI tract derived from hindgut, which ranged from distal 1/3 of transverse colon to superior part of rectum. This artery is branched from the abdominal aorta at the level of L3 vertebral body, and supplies descending colon, sigmoid colon, rectum and anal canal. (Bien Nillos et al 2010)

2.1.2.5.1.3. Hepatic portal vein

Virtually all blood that returns from the gastrointestinal tract is drained back to liver via the hepatic portal vein, this vein has two major tributaries: splenic vein receives blood

drainage from spleen, pancreas and stomach, distal part of transverse colon, descending colon, sigmoid colon and rectum, superior mesenteric vein receives blood from small intestine, cecum, ascending colon and proximal part of transverse colon. (Bien Nillos et al 2010)

2.1.3. Pathology of gastrointestinal tract

2.1.3.1. The inflammatory bowel disease

The inflammatory bowel disease (IBD) is a group of inflammatory conditions of the colon and small intestine. Crohn's disease and ulcerative colitis are the principal types of inflammatory bowel disease. (Baumgart et al 2007)The chief types of inflammatory bowel disease are Crohn's disease and ulcerative colitis (UC). Inflammatory bowel diseases fall into the class of autoimmune diseases, in which the body's own immune system attacks elements of the digestive system. (From Wikipedia,"Crohn's & Colitis Foundation of America")

2.1.3.1.1. Crohn's disease

Crohn's disease, also known as Crohn’s syndrome and regional enteritis, is a type of inflammatory bowel disease (IBD) that may affect any part of the gastrointestinal tract from mouth to anus. Symptoms often include abdominal pain, diarrhea (which may be bloody if inflammation is severe), fever, and weight loss. (Baumgart et al 2012) Other complications may occur outside the gastrointestinal tract and include anemia, skin rashes, arthritis, inflammation of the eye, and tiredness. The skin rashes may be due to infections as well as pyoderma gangrenosum or erythema nodosum. Bowel obstruction also commonly occurs and those with the disease are at greater risk of bowel cancer. (Baumgart al 2012)

Crohn's disease is caused by a combination of environmental, immune and bacterial factors in genetically susceptible individuals.(Stefanelli et al 2008) It results in a chronic inflammatory disorder, in which the body's immune system attacks the gastrointestinal

tract possibly directed at microbial antigens. (Dessein et al 2008) While Crohn's is an immune related disease, it does not appear to be an autoimmune disease (in that the immune system is not being triggered by the body itself). (Casanova et al 2009) The exact underlying immune problem is not clear; however, it may be an immunodeficiency state. (Lalande et al 2010) About half of the overall risk is related to genetics with more than 70 genes found to be involved. (Baumgart et al 2012) Tobacco smokers are two times more likely to develop Crohn's disease than nonsmokers. (Cosnes et al 2004) It also often begins after gastroenteritis. Diagnosis is based on a number of findings including biopsy and appearance of the bowel wall, medical imaging and description of the disease. Other conditions that can present similarly include irritable bowel syndrome and Behcet's disease. (Baumgart et al 2012)

2.1.3.1.2. Ulcerative colitis

Ulcerative colitis (Colitis ulcerosa, UC) is a form of inflammatory bowel disease (IBD). Ulcerative colitis is a form of colitis, a disease of the colon (the largest portion of the large intestine), that includes characteristic ulcers, or open sores. The main symptom of active disease is usually constant diarrhea mixed with blood, of gradual onset. IBD is often confused with irritable bowel syndrome (IBS).

Ulcerative colitis shares much in common with Crohn's disease, another form of IBD, but Crohn's disease can affect the whole gastrointestinal tract while ulcerative colitis only attacks the large intestine, and while ulcerative colitis can be treated by performing a total colectomy (i.e., removing the entire large intestine), surgery for Crohn's disease involves removing the damaged parts of the intestine and reconnecting the healthy parts, which does not cure Crohn's, as it can recur after surgery, mostly at the site of the intestinal anastomosis (connection) or in other areas. Ulcerative colitis is an intermittent disease, with periods of exacerbated symptoms, and periods that are relatively symptom-free. (Danese et al 2011)

2.1.3.2. Bowel abscess

A bowel abscess is a medical condition in which swelling is present in the colon as a result of pus which has collected in that area of the body. Infection is the most common reason an abscess develops. Diverticulitis is a relatively widespread disorder and is the most prevalent source of the infection responsible for the formation and accumulation of the pus in a bowel abscess. Other sources include Crohn's disease, peritonitis and Pelvic Inflammatory Disease (PID). Abdominal pain accompanied by fever and a general feeling of weakness should be reported to a medical professional right away. If a bowel abscess is present, an early diagnosis can often prevent some of the more serious complications, including sepsis, from arising due to the formation of a bowel abscess. (From Wikipedia)

2.1.3.3. Bowel obstruction

Bowel obstruction (or intestinal obstruction) is a mechanical or functional obstruction of the intestines, preventing the normal transit of the products of digestion. It can occur at any level distal to the duodenum of the small intestine and is a medical emergency. The condition is often treated conservatively over a period of 2–5 days with the patient's progress regularly monitored by an assigned physician. Surgical procedures are performed on occasion however, in life-threatening cases, such as when the root cause is a fully lodged foreign object or malignant tumor. Depending on the level of obstruction, bowel obstruction can present with abdominal pain, swollen abdomen, abdominal distension, vomiting, fecal vomiting, and constipation. (Vann al 2010) Bowel obstruction may be complicated by dehydration and electrolyte abnormalities due to vomiting, respiratory compromise from pressure on the diaphragm by a distended abdomen, or aspiration of vomitus, bowel ischaemia or perforation from prolonged distension or pressure from a foreign body. In small bowel obstruction the pain tends to be colicky (cramping and intermittent) in nature, with spasms lasting a few minutes. The pain tends to be central and mid-abdominal. Vomiting occurs before constipation [citation needed]. In large bowel obstruction, the pain is felt lower in the abdomen and the spasms last longer. Constipation occurs earlier and vomiting may be less prominent. Proximal

obstruction of the large bowel may present as small bowel obstruction. Causes of small bowel obstruction include: Adhesions from previous abdominal surgery (most common cause), Pseudo obstruction, Hernias containing bowel, Crohn's disease causing adhesions or inflammatory strictures. Causes of large bowel obstruction include: Neoplasm's ,Diverticulitis / Diverticulosis ,Hernias ,Inflammatory bowel disease Colonic volvulus (sigmoid, caecal, transverse colon) ,Adhesions. (Wexner et al 2010)

2.1.3.4. Bowel tumors

Tumors of the small intestine offer a unique challenge. As a result of their infrequent occurrence, they invariably present difficult problems in diagnosis and management. Although the prognosis for benign lesions is excellent, malignant small bowel tumors are perhaps the most devastating GI malignancies, at the time of diagnosis, only approximately 50% of these lesions are completely resectable for cure. Symptoms are often absent until the tumor has progressed to produce a complication. Even then, the presentation is often vague and nonspecific, intermittent pain, obstruction, and chronic anemia.

Colorectal tumors usually form inside the lining of the large intestine. Benign tumors are non-cancerous include: Neoplastic epithelial polyps (premalignant), Adenomas, Non-neoplastic epithelial polyps, Hyperplastic polyps, Inflammatory polyps and Lymphoid polyps, while malignant tumors are cancerous and result from abnormal cell growth. (Ashley et al 1988)

2.1.3.5. The fistula

A fistula is an abnormal connection between two hollow spaces (technically, two epithelialized surfaces), such as blood vessels, intestines, or other hollow organs. Fistulas are usually caused by injury or surgery, but they can also result from an infection or inflammation. Fistulas are generally a disease condition. Fistulas can develop in various parts of the body , In the bowel a fistula occurs in many sites such Gastrojejunocolic fistula - after a Billroth II a fistula forms between the transverse colon and the upper

jejunum (which, post Billroth II, is attached to the remainder of the stomach). Fecal matter passes improperly from the colon to the stomach and causes halitosis, enterocutaneous fistula between the intestine and the skin surface, namely from the duodenum or the jejunum or the ileum. This definition excludes the fistulas arising from the colon or the appendix, anorectal fistula (fecal fistula, fistula-in-anal) connecting the rectum or other anorectal area to the skin surface. This results in abnormal discharge of feces through an opening other than the anus, Enteroenteral fistula between two parts of the intestine. (From Wikipedia)

2.1.4. Imaging modalities

2.1.4.1. Radiography

Two forms of radiographic images are in use in medical imaging; projection radiography and fluoroscopy, with the latter being useful for catheter guidance. These 2D techniques are still in wide use despite the advance of 3D tomography due to the low cost, high resolution, and depending on application, lower radiation dosages. This imaging modality utilizes a wide beam of x rays for image acquisition and is the first imaging technique available in modern medicine.(From Wikipedia, Medical imaging)

Figure (2.3) X-ray machine

http://a3ddiagnostics.com/images/XRAY_MACHINE2.jpg

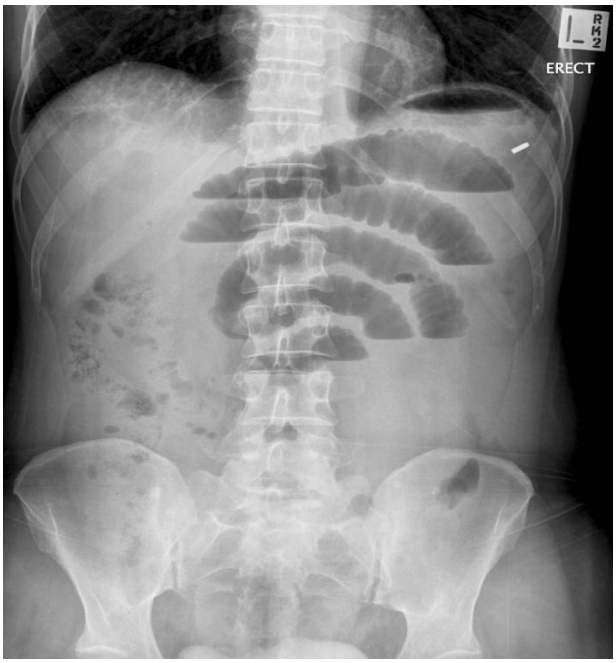

Figure (2.4) X-ray abdominal image.

http://cdn.lifeinthefastlane.com/wp-content/uploads/2010/04/OC_521_AXR_SBO_2-copy.jpg

Fluoroscopy produces real-time images of internal structures of the body in a similar fashion to radiography, but employs a constant input of x-rays, at a lower dose rate. Contrast media, such as barium, iodine, and air are used to visualize internal organs as they work. Fluoroscopy is also used in image-guided procedures when constant feedback during a procedure is required. An image receptor is required to convert the radiation into an image after it has passed through the area of interest. Early on this was a fluorescing screen, which gave way to an Image Amplifier (IA) which was a large vacuum tube that had the receiving end coated with cesium iodide, and a mirror at the opposite end. Eventually the mirror was replaced with a TV camera.

Projectional radiographs, more commonly known as x-rays, are often used to determine the type and extent of a fracture as well as for detecting pathological changes in the lungs. With the use of radio-opaque contrast media, such as barium, they can also be used

to visualize the structure of the stomach and intestines - this can help diagnose ulcers or certain types of colon cancer. (From Wikipedia, Medical imaging)

2.1.4.2. Ultrasound

Medical ultrasonography uses high frequency broadband sound waves in the megahertz range that are reflected by tissue to varying degrees to produce (up to 3D) images. This is commonly associated with imaging the fetus in pregnant women. Uses of ultrasound are much broader, however. Other important uses include imaging the abdominal organs, heart, breast, muscles, tendons, arteries and veins. While it may provide less anatomical detail than techniques such as CT or MRI, it has several advantages which make it ideal in numerous situations, in particular that it studies the function of moving structures in real-time, emits no ionizing radiation, and contains speckle that can be used in elastography. Ultrasound is also used as a popular research tool for capturing raw data, that can be made available through an ultrasound research interface, for the purpose of tissue characterization and implementation of new image processing techniques. The concepts of ultrasound differ from other medical imaging modalities in the fact that it is operated by the transmission and receipt of sound waves. The high frequency sound waves are sent into the tissue and depending on the composition of the different tissues; the signal will be attenuated and returned at separate intervals. A path of reflected sound waves in a multilayered structure can be defined by input acoustic impedance (ultrasound sound wave) and the Reflection and transmission coefficients of the relative structures. (Dhawan P, A. et al 2003) It is very safe to use and does not appear to cause any adverse effects. It is also relatively inexpensive and quick to perform. Ultrasound scanners can be taken to critically ill patients in intensive care units, avoiding the danger caused while moving the patient to the radiology department. The real time moving image obtained can be used to guide drainage and biopsy procedures. Doppler capabilities on modern scanners allow the blood flow in arteries and veins to be assessed. (From Wikipedia, Medical imaging)

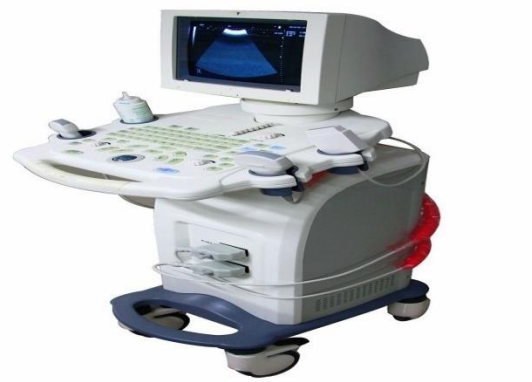

Figure (2.5) Ultrasound machine.

http://www.vietcanmedical.com/yahoo_site_admin/assets/images/ultrasound_machine.26194745_std.jpg

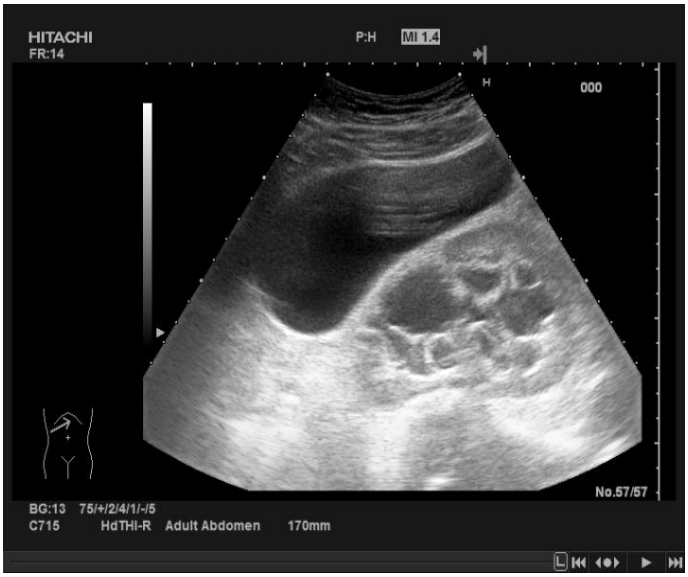

Figure (2.6) Ultrasound abdominal image.

http://api.ning.com/files/V7znx0qsEM34JbOFQfdfQHhw55NVon1XSEwkQKg4mTSuUznhGWSxXotuqvbe0fqFtyVDWilEn4zV5MBMXmTDSXOIITtO4U7A/M_20100513_20100513073740_00002.bmp?width=721

2.1.4.3. Tomography

Tomography is the method of imaging a single plane, or slice, of an object resulting in a tomogram. There are two principal methods of obtaining such images, conventional and computer assisted tomography. Conventional tomography uses mechanical means to record an image directly onto X-ray film, while in computer assisted tomography, a computer processes information fed to it from detectors then constructs a virtual image which can be stored in digital format and can be displayed on a screen, or printed on paper or film. (From Wikipedia, Medical imaging)

2.1.4.3.1. Conventional tomography

In conventional tomography, mechanical movement of an X-ray source and film in unison generates a tomogram using the principles of projective geometry. Synchronizing the movement of the radiation source and detector which are situated in the opposite direction from each other causes structures which are not in the focal plane being studied to blur out. This was the main method of obtaining tomogaphic images until the late-1970s. It is now considered obsolete (except for certain dental applications), having been replaced with computer assisted tomographic techniques. (Littleton et al 2014)

2.1.4.3.2. Computer-assisted tomography

In computer-assisted tomography, a computer processes data received from radiation detectors and computationally constructs an image of the structures being scanned. Imaging techniques using this method are far superior to conventional tomography as they can readily image both soft and hard tissues (while conventional tomography is quite poor at imaging soft tissues). The following techniques exist:

X-ray computed tomography (CT), or Computed Axial Tomography (CAT) scan, is a helical tomography technique (latest generation), which traditionally produces a 2D image of the structures in a thin section of the body. In CT, a beam of X-rays spins around an object being examined and is picked up by sensitive radiation detectors after having penetrated the object from multiple angles. A computer then analyses the

information received from the scanner's detectors and constructs a detailed image of the object and its contents using the mathematical principles laid out in the Radon transform. It has a greater ionizing radiation dose burden than projection radiography; repeated scans must be limited to avoid health effects. CT is based on the same principles as X-Ray projections but in this case, the patient is enclosed in a surrounding ring of detectors assigned with 500-1000 scintillation detectors (fourth-generation X-Ray CT scanner geometry). Previously in older generation scanners, the X-Ray beam was paired by a translating source and detector. (Dhawan et al 2003)

Figure (2.7) computed tomography machine.

http://www.medgadget.com/img/46455ct.jpg

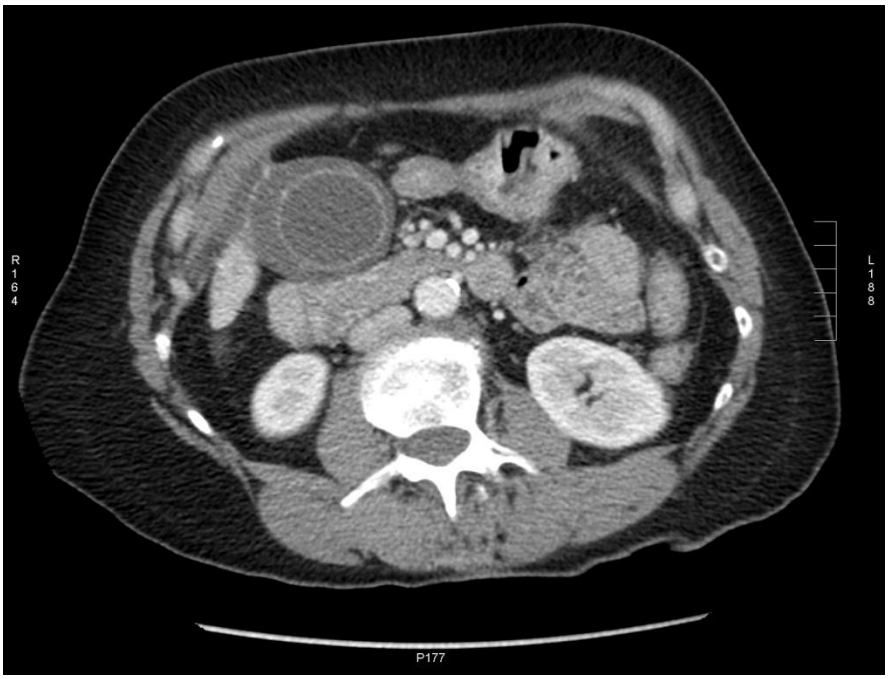

Figure (2.8) CT abdominal image.

http://cdn.lifeinthefastlane.com/wp-content/uploads/2009/11/AAA-GB.jpg

2.1.4.4. Magnetic resonance imaging

A magnetic resonance imaging instrument (MRI scanner), or "nuclear magnetic resonance (NMR) imaging" scanner as it was originally known, uses powerful magnets to polarise and excite hydrogen nuclei (single proton) in water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body. The MRI machine emits a RF (radio frequency) pulse that specifically binds to hydrogen. The system sends the pulse to the area of the body to be examined. The pulse makes the protons in that area absorb the energy needed to make them spin in a different direction. This is the "resonance" part of MRI. The RF pulse makes them (only the one or two extra unmatched protons per million) spin at a specific frequency, in a specific direction. The particular frequency of resonance is called the Larmour frequency and is calculated based on the particular tissue being imaged and the strength of the main magnetic field. MRI uses three electromagnetic fields: a very strong (on the order of units of tesla) static magnetic field to polarize the hydrogen nuclei, called the static field; a weaker time-

varying (on the order of 1 kHz) field(s) for spatial encoding, called the gradient field(s); and a weak radio-frequency (RF) field for manipulation of the hydrogen nuclei to produce measurable signals, collected through an RF antenna. (From Wikipedia, Medical imaging)

Like CT, MRI traditionally creates a two dimensional image of a thin "slice" of the body and is therefore considered a tomographic imaging technique. Modern MRI instruments are capable of producing images in the form of 3D blocks, which may be considered a generalisation of the single-slice, tomographic, concept. Unlike CT, MRI does not involve the use of ionizing radiation and is therefore not associated with the same health hazards. For example, because MRI has only been in use since the early 1980s, there are no known long-term effects of exposure to strong static fields (this is the subject of some debate; see 'Safety' in MRI) and therefore there is no limit to the number of scans to which an individual can be subjected, in contrast with X-ray and CT. However, there are well-identified health risks associated with tissue heating from exposure to the RF field and the presence of implanted devices in the body, such as pace makers. These risks are strictly controlled as part of the design of the instrument and the scanning protocols used.

Because CT and MRI are sensitive to different tissue properties, the appearance of the images obtained with the two techniques differ markedly. In CT, X-rays must be blocked by some form of dense tissue to create an image, so the image quality when looking at soft tissues will be poor. In MRI, while any nucleus with a net nuclear spin can be used, the proton of the hydrogen atom remains the most widely used, especially in the clinical setting, because it is so ubiquitous and returns a large signal. This nucleus, present in water molecules, allows the excellent soft-tissue contrast achievable with MRI. (From Wikipedia, Medical imaging)

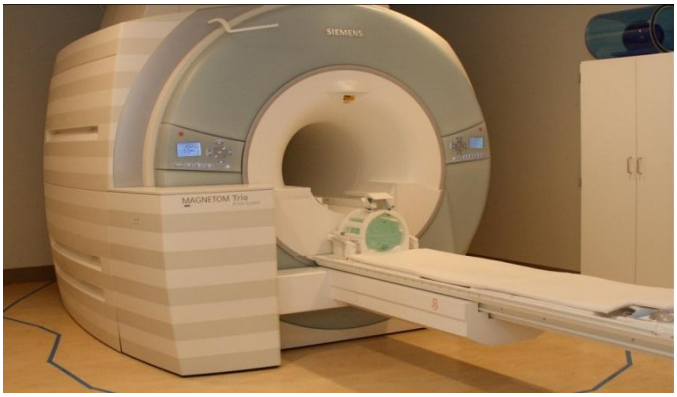

Figure (2.9) MRI machine.

http://www.thenation.com/sites/default/files/user/194882/mri.jpg

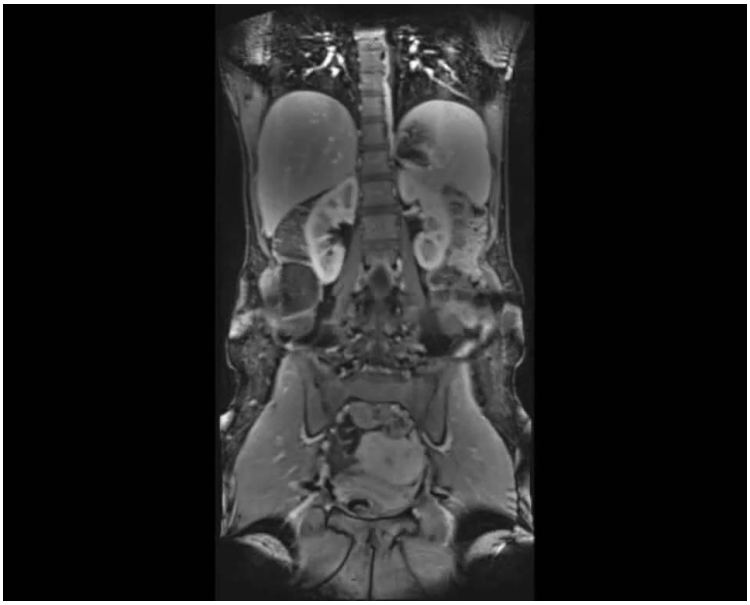

Figure (2.10) MRI abdominal image.

http://i.ytimg.com/vi/cpl333A-A7Q/maxresdefault.jpg

2.1.4.4.1. MR Enterology

MR Enterology is a special type of magnetic resonance imaging (MRI) performed with a contrast material to produce detailed images of the small intestine. Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose

and treat medical conditions. MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. MRI does not use ionizing radiation (x-rays). Detailed MR images allow physicians to evaluate various parts of the body and determine the presence of certain diseases. (From radiologyinfo.org, MR Enterology)

2.1.4.4.2. MRI Safety

MRI scan is a painless and safe procedure. You may find it uncomfortable if you have claustrophobia (fear of enclosed spaces), but most people find this manageable with support from the radiographer. Sometimes going into the scanner feet first may be easier, although this is not always possible.

MRI scans do not involve exposing the body to X-ray radiation. This means people who may be particularly vulnerable to the effects of radiation, such as pregnant women and babies, can use them if necessary. However, not everyone can have an MRI scan. For example, they are not always possible for people who have certain types of implants fitted, such as a pacemaker (a battery-operated device that helps control an irregular heartbeat). Extensive research has been carried out into whether the magnetic fields and radio waves used during MRI scans could pose a risk to the human body. No evidence has been found to suggest that there is a risk, which means that MRI is one of the safest medical procedures currently available. (Slichter et al 1978)

2.1.4.4.3. Coils

A coil consists of one or more loops of conductive wire, looped around the core of the coil. Coils are part of the hardware of MRI machines and are used to create a magnetic field or to detect a changing magnetic field by voltage induced in the wire.A coil is usually a physically small antenna.

The perfect coil produces a uniform magnetic field without significant radiation. Different types of MRI coils are used in MR systems: Gradient coils are used

to produce controlled variations in the main magnetic field (B0) to provide spatial localization of the signals and to apply reversal pulses in some imaging techniques. MR imaging radio frequency coils to receive and/or transmit the RF signal. Shim coils provide auxiliary magnetic fields in order to compensate for inhomogeneities in the main magnetic field of the MRI machine. (Nitz et al 1999)

The body coil is a permanent part of the scanner, and surrounds the patient. It is important, as it is the transmitter for all types of examinations. It also receives the signal when larger parts of the body are imaged. (Prof. Dr. Hans 1990)

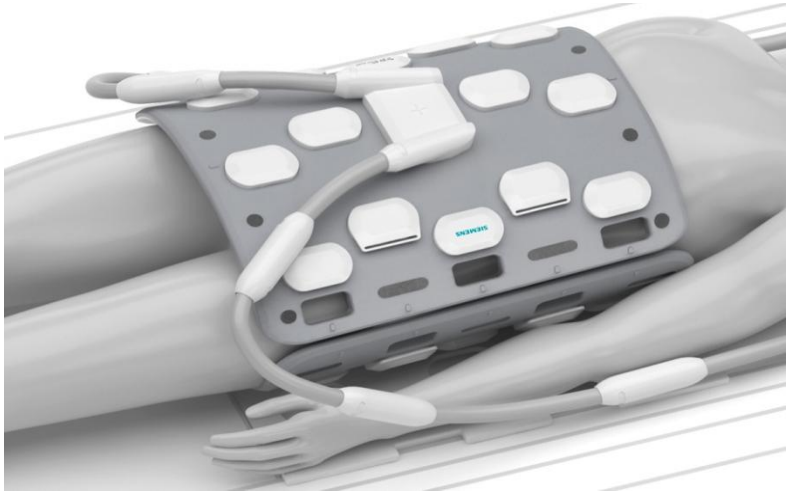

Figure (2.11) MRI abdomen coil.

https://www.healthcare.siemens.com/magnetic-resonance-imaging/options-and-upgrades/coils/body-60-body-30

2.1.4.4.4. MRI contrast agents

Gastrointestinal MRI contrast agents are varied either to positive contrast agents can be divided into paramagnetic agents, short T1-relaxation agents, and combination agents containing both, or negative contrast agents can be divided into diamagnetic agents, super paramagnetic agents, and perfluorochemicals. Paramagnetic, positive GI contrast agents include ferric chloride, ferric ammonium citrate, and gadolinium-DTPA (with and

without mannitol). Paramagnetic materials cause both T1 and T2 shortening. (Dr Jeremy et al 1996)

Mannitol is a carbohydrate classified as sugar alcohol. Its underlying chemical structure prevents intestinal absorption. Its inherent osmotic property leads to increased bowel distention. (Thomas et al 2003)

2.2. Previous studies

Michael Dam Jensen et al 2010 sought to determine the frequency and clinical impact of incidental findings detected with magnetic resonance imaging (MRI)-enterography in patients with suspected or known Crohn's disease. : Incidental findings were defined as unexpected lesions outside the small intestine, not previously known or suspected at the time of referral, and not related to inflammatory bowel disease. Through a systematic review of medical charts we analyzed the clinical impact of incidental findings, and compared the MRI findings with subsequent diagnostic procedures. A total of 283 patients were included in the analysis, and MRI detected active CD in 31%, fistula in 1.4% and abscess in 0.7%. Extra-intestinal findings not related to CD were recorded in 72 patients (25%), of which 58 patients (20%) had 74 previously unknown lesions. Important or incompletely characterized findings were detected in 17 patients (6.0%). Incidental findings led to 12 further interventions in 9 patients (3.2%) revealing previously unknown pathological conditions in 5 (1.8%). One patient (0.4%) underwent surgery and one patient was diagnosed with a malignant disease. MRI detected incidental colonic lesions in 16 patients of which additional work-up in 4 revealed normal anatomy. Two patients (0.7%) benefitted from the additional examinations, whereas incidental findings led to unnecessary examinations in 9 (3.2%). (Michael et al 2010)

W. Ajaj1, S. C. Goehde1, et al 2003 sought to compare different osmotic carbohydrate solutions (2.5% mannitol, 2.5% / 2.0% / 1.5% sorbitol) for small bowel MR imaging regarding image quality and patient acceptance. 12 healthy volunteers underwent each four MR examination after ingesting 1500ml of the different contrast solutions. Coronal 2D images were collected by using a fast T2-weighted steady state precession sequence

(TrueFISP). While best distension values were observed after both the administration of 2.5% mannitol and 2.0% sorbitol, the use of sorbitol led to less side-effects and should therefore be recommended for small bowel MR imaging. Twelve healthy volunteers (eight female and four male age range 31 to 55 years. They ingested in a randomized order 1500ml of a solution containing 2.5% mannitol, 2.5%, 2.0% or 1.5% sorbitol. The interval between two single examinations amounted to a minimum of 48 hours. MR examinations were performed on a 1.5 T system (Magnetom Sonata, Siemens Medical Systems, Erlangen, Germany) equipped with high-performance gradient systems. MR Imaging was performed under breath-hold conditions. The quantitative comparison of all contrast agents revealed the highest small bowel distension for the 2.5% mannitol solution the administration of a 2.5% mannitol solution resulted in a mean small bowel diameter of 19.8mm, compared to 18.8mm for 2.0% sorbitol, 18.2mm for 2.5% sorbitol. (W. Ajaj1 et al 2003)

Dorota Mankowska-Wierzbicka et al 2009 sought to assess the clinical value of magnetic resonance imaging (MRI) of the small intestine as a method for detection of abnormalities typical in Crohn's disease. Of a total of 130 patients who underwent MRI, 73 patients had known Crohn's disease and 57 patients had clinical suspicion of the disease. All patients underwent MRI at 1.5 Tesla following oral ingestion of a 6% mannitol solution for contrast. They were classified according to Disease Activity Index score and inflammation of the small intestine was documented in terms of bowel wall thickness, contrast enhancement, presence of perienteric vessels, fatty infiltration, and focal lymph nodes. Wall thickness ranged from 4 to 12 mm in 53 patients with Crohn's disease and in 25 patients with suspected disease. Researchers detected wall enhancement in 73 patients. Fibrofatty infiltrations were found in 30 and 22 patients, respectively. A comb sign was seen in 18 and 22 patients, respectively. Mesenteric lymph nodes were seen in 48 and 21 patients, respectively. "We diagnosed 78 patients with active disease and 52 patients with inactive disease," the researchers reported. (Dorota et al 2009)

Chapter three

Materials and Methods

3.1 Materials

3.1.1 Patients (Study sample)

This study will be a practical study will be include a samples of 30 patients 16male and 14female underwent to MRI department for MR Enterology examination suspected GIT diseases specially inflammatory bowel disease in different genders and in range of age from 20 to 80 years old. whom will be referred to the radiology department in modern medical centers in Khartoum with a suspected case of GIT diseases specially inflammatory bowel disease, undergone MRI examination, to applied of MRI protocol in diagnose the GIT diseases specially inflammatory bowel disease, all patients will informed to obtain their consent before the exam and their information's will be used in this study, the data will be collected and interpreted by radiologist reports.

3.1.2. Machine used

Machine used in this study closed magnet, sign high definition with magnetic field strength 1.5T (Magnetom Sonata, Siemens Medical Systems, Erlangen, Germany),in alribat university hospital. Coil used abdomen coil, ear plug, immobilization bad and the respiratory gaiting inner the MRI device.

3.2. Methods

3.2.1. Technique used

The following MRI technique was used:

Field Strength: 1.5 T.

Sequences: 2D (Sagittal, axial) T2 Trufi BH.

2D Coronal T2 True FISP BH.

Axial T2 Tse MBH.

3D (Coronal, axial) T1 FS.

Gadolinium enhanced T1.

Mannitol 2.5% with 1500ml of water (oral contrast).

Gadolinium-DTPA (IV contrast).

Patient preparation:

Patient fasting 4 hours.

The oral contrast taken by the patient during 45 minute before the exam.

Patient position:

Patient supine head first.

The Sagittal laser beam localizer parallel to the midline of the body and the axial laser beam localizer perpendicular to the midline of the body.

The center point in

3.2.2 Data Interpretation

The data result collected from the result of MRI scan finding and supported the result by radiologist reports. Determine by wall thickened, intraluminal enhancement, and other contrast enhancement lesion additional to previous CT finding.

3.2.3. Data collection:

Data will be collected from findings which appear in different MRI cuts and the data will be represented in tables and graphs.

The data's will include the general patients data (Age, genders and weight) and will be accompanied by the related to the symptoms of GIT diseases specially the inflammatory bowel disease, previous CT finding.

The patient's history (inflammatory bowel disease, other GIT diseases).

3.2.4. Data analysis

All data wered entered and analysed using Microsoft Excel and statistical package for social sciences(SPSS) version 30 statistical analysis included description statistic of frequency tables, graphs, cross tabulation.

Chapter four

Results

This results from 30 patients have rang of age from 20 to 80 years old, suspected bowel disease according to the history of patient, previous CT finding and request of MR Enterology received in Radiology department, this study in Sudanese population and was done at alribat university hospital.

We were analyzed the data and the result showing as following:

Table (4.1) illustrates the frequency of patients according to the gender.

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

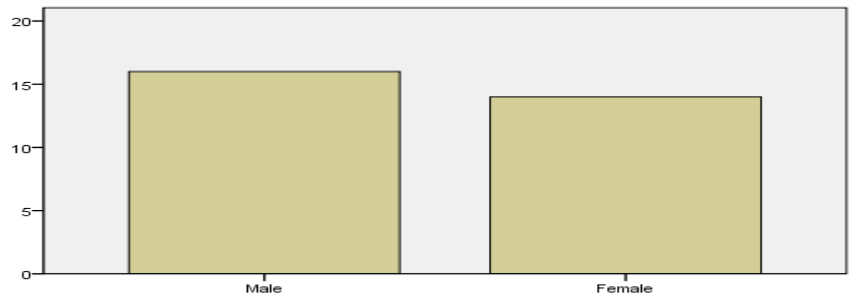

Figure (4.1) illustrate the frequency of patients according to the gender.

Table (4.2) illustrates the frequency of MR Enterology finding according to the gender.

MR Enterology protocol finding	Frequency	Percent
Crohn's disease	6	20.0
Ulcerative Colitis	5	16.7
Fistula	4	13.3
Rectal mass	3	10.0
Bowel abscess	2	6.7
Bowel obstruction	3	10.0
Adrenal gland mass	2	6.7
Aortic aneurysm	3	10.0
Lymph nodes disease	2	6.7
Total	30	100.0

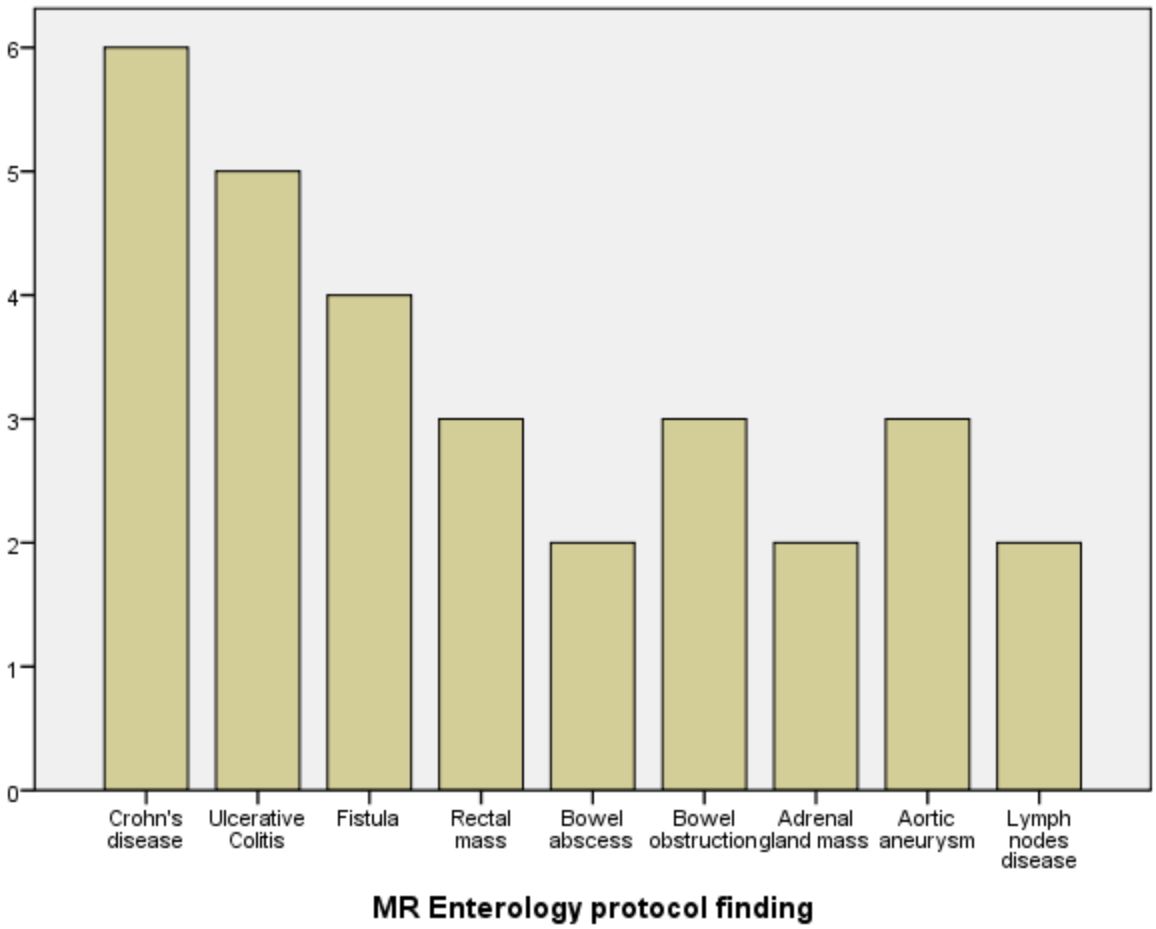

Figure (4.2) illustrates the frequency of MR Enterology finding according to the gender.

Table (4.3) illustrates the cross tabulation between MR Enterology finding and the CT finding.

MR Enterology finding \ CT finding	Wall thickening	Obstruction	Lesion	Adrenal gland mass	Aortic aneurysm	Large lymph node size and number	Mucosal edema	Intracolonic attenuation	Intra luminal opining	Lymph adenopathy	mass	Extra luminal lesion	Normal	Total
Crohn's disease	4	0	0	0	0	2	0	0	0	0	0	0	0	6
Ulcerative Colitis	2	0	0	0	0	0	2	1	0	0	0	0	0	5
Fistula	0	0	0	0	0	0	0	0	2	2	0	0	0	4
Rectal mass	0	0	0	0	0	0	0	0	0	0	3	0	0	3
Bowel abscess	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Bowel obstruction	0	1	0	0	0	0	0	0	0	0	0	0	2	3
Adrenal gland mass	0	0	1	1	0	0	0	0	0	0	0	0	0	2
Aortic aneurysm	0	0	0	0	1	0	0	0	0	0	0	0	2	3
lymph nodes disease	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Total	6	1	1	1	1	4	2	1	2	2	3	2	4	30

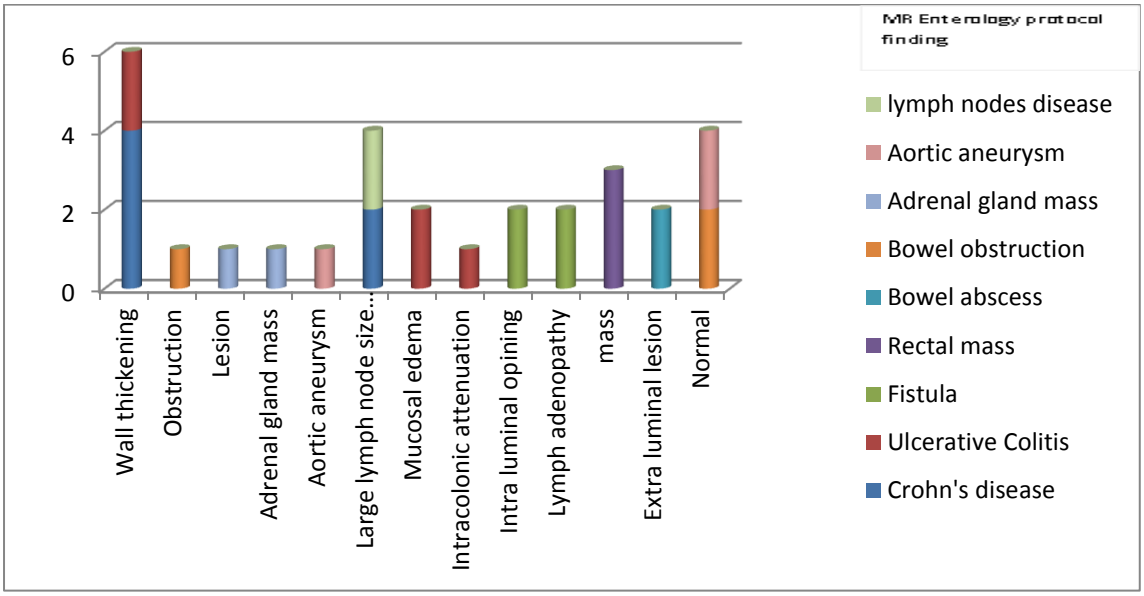

Figure (4.3) illustrates the MR Enterology protocol finding according to the CT finding.

CHAPTER FIVE

Discussion, Conclusions and Recommendations

5.1 Discussion

In the table (4.1) we observed, the male is about (53.3%) and female is about (46.7%) from the study, the frequency of male is 16 and the female 14 from the total sample size and figure (4.1) illustrate the frequency of patients according to the gender.

In the table (4.2) the researcher found, the active crohn's disease in 6patients (20.0%), ulcerative colitis in 5 patients (16.7%), fistula in 4 patients (13.3%), bowel mass in 3 patients (10.0%), bowel abscess in 2 patients (6.7%), bowel obstruction in 3 (10.0%), adrenal gland mass in 2 patients (6.7%) and aortic aneurysm in 3 patients (10.0%) unrelated to bowel diseases, lymph nodes disease in 2 patients (6.7%), from total of 30 patients were included in the analysis and figure (4.2) illustrates the frequency of MR Enterology finding according to the gender, this results disagree with Michael Dam Jensen results because he was used large number sample.

In Crosstabs (4.3) the researcher found that MREnterology superior than CT in diagnose the GIT diseases specially the inflammatory bowel diseases and other diseases (crohn's disease, ulcerative colitis, bowel obstruction and aortic aneurysm) and confirms result of CT, also MREnterology confirms result of CT in other diseases (fistula, bowel mass, bowel abscess, adrenal gland mass and lymph nodes disease) and figure (4.3) illustrates the MR Enterology protocol finding according to the CT finding.

The researcher study agree with Michael Dam Jensen study in use the MR Enterology protocols to detect the inflammatory bowel diseases, all patients selected randomly also there is Incidental findings, but disagree in the number of the patients, Michael Dam select large number of patients and he is concerned on the crohn's disease mainly, and the regions of small intestine, as it present in chapter two, but this study was concerned on all inflammatory bowel diseases in the bowel.

Also the study was agree with W. Ajaj1, S. C. Goehde1 study in use MRI with mannitol 2.5% as oral contrast, that provide good distention of the bowel, the examination were performed on a 1.5 T Siemens Medical Systems and used a fast T2-weighted steady state precession sequence (TrueFISP). as it present in chapter two, the study was disagree with W. Ajaj1, S. C. Goehde1 study because the study concerned about detect the oral contrast make good bowel distention, as it present in chapter two, while this study concerned on role of MR Enterology in bowel diseases.

Also the study was agree with Dorota Mankowska-Wierzbicka study in use the MRI with mannitol 2.5% as oral contrast, Dorota Mankowska-Wierzbicka study concerned on the crohn's disease in small bowel region, as it present in chapter two, but this study was concerned on the inflammatory bowel diseases.

5.2 Conclusions

The study conclude that the MR Enterology protocol improved the ability to detect and diagnose the GIT diseases specially the inflammatory bowel disease and make the distinguishing bowel from intra abdominal masses and normal organs by use the mannitol 2.5% mixed with water 1500ml that provide highest bowel distention, MR Enterology of the GIT plays a prominent role in establishing the diagnosis of inflammatory bowel disease. Moreover, it allows an earlier and accurate diagnosis of the disease, as it can support or even replace the CT modalities because the MRI provide highly detailed image to the tissue and high contrast resolution of tissue than CT and disadvantage of CT in use the ionizing radiation, accurate diagnosis is essential to allow earlier therapeutic intervention that appears to be beneficial on delaying the accumulation of irreversible GIT damage.

Through the study found that the communally sequence in MR Enterology protocol is Coronal 2D a fast T2-weighted steady state precession sequence (True FISP).

5.3 Recommendations

- Farther study with large sample of patient.
- Training for technologist and radiologist for MR Enterology protocol and sequence.
- All GIT surgeons and consultants and physicians should be awarded with MR Enterology protocol.
- Acceptance of the use of MR in abdominal imaging has been limited in part by difficulty in distinguishing bowel from intra abdominal masses and normal organs so using mannitol 2.5% is very important adding in MR Enterology protocol.
- All patient with GIT abnormalities must do MR Enterology.

REFERENCES

Abraham L. Kierszenbaum (2002). Histology and cell biology: an introduction to pathology. St. Louis: Mosby. ISBN 0-323-01639-1.

Ahrens, Thomas; Prentice, Donna (1998). Critical care certification: preparation, review & practice exams. Norwalk, CT: Appleton & Lange. p. 265. ISBN 0-8385-1474-X. Black's Medical Dictionary 39th Ed.1999.

Ashley SW1, Wells SA Jr. Department of Surgery, Washington University School of Medicine, St. Louis, MO 63110, 1988 Apr;15(2):116-28.

Baumgart DC, Carding SR (2007). "Inflammatory bowel disease: cause and immunobiology.". The Lancet 369 (9573): 1627–40. doi:10.1016/S0140-6736(07)60750-8. PMID 17499605.

Baumgart DC, Sandborn WJ; Sandborn (2012). "Crohn's disease". The Lancet 380 (9853): 1590–605. doi:10.1016/S0140-6736(12)60026-9. PMID 22914295.

Camilleri M. New imaging in neurogastroenterology: an overview. Neurogastroenterol Motil. 2006;18:805–812.

Casanova JL, Abel L (Aug 31, 2009). "Revisiting Crohn's disease as a primary immunodeficiency of macrophages.". The Journal of experimental medicine 206 (9): 1839–43. doi:10.1084/jem.20091683. PMID 19687225.

Cosnes J (2004). "Tobacco and IBD: Relevance in the understanding of disease mechanisms and clinical practice". Best Practice & Research Clinical Gastroenterology 18 (3): 481–96. doi:10.1016/j.bpg.2003.12.003. PMID 15157822.

Danese, S. & Fiocci, C. (2011). Ulcerative colitis. The New England Journal of Medicine, 365:1713-1725.

David A. Warrell (2005). Oxford textbook of medicine: Sections 18-33. Oxford University Press. pp. 511–. ISBN 978-0-19-856978-7. Retrieved 1 July 2010.

Dessein R, Chamaillard M, Danese S (2008). "Innate Immunity in Crohn’ s Disease". Journal of Clinical Gastroenterology 42: S144–7. doi:10.1097/MCG.0b013e3181662c90. PMID 18806708.

Dhawan P, A. (2003). Medical Imaging Analysis. Hoboken, NJ: Wiley-Interscience Publication.

Dorota Mankowska-Wierzbicka, MD, Gastroenterology Clinic, University Medical

Dr Jeremy Jones and Dr J. Ray Ballinger, Gastrointestinal MRI contrast agents et al March 5, 1996.

Drake RL, Wayne V, Mitchell AWM, Tibbits R and Richardson R. Gray’s Atlas of Anatomy. 1st edition. Churchill Livingstone. 2007; 156-172.

Drake, Richard L.; Vogl, Wayne; Tibbitts, Adam W.M. Mitchell; illustrations by Richard; Richardson, Paul (2005). Gray's anatomy for students. Philadelphia: Elsevier/Churchill Livingstone. p. 273. ISBN 978-0-8089-2306-0.

Gerard J. Tortora, Bryan H. Derrickson Principles of anatomy and physiology 12th edition, page 922 – 2008.

Helander HF, Fändriks L., "Surface area of the digestive tract – revisited", Scand J Gastroenterol 49: 681-9, 2014.

http://a3ddiagnostics.com/images/XRAY_MACHINE2.jpg.

http://api.ning.com/files/V7znx0qsEM34JbOFQfdfQHhw55NVon1XSEwkQKg4mTSuUznhGWSxXotuqvbe0fqFtyVDWilEn4zV5MBMXmTDSXOIITtO4U7A/M_20100513_20100513073740_00002.bmp?width=721.

http://cdn.lifeinthefastlane.com/wp-content/uploads/2009/11/AAA-GB.jpg.

http://cdn.lifeinthefastlane.com/wp-content/uploads/2010/04/OC_521_AXR_SBO_2-copy.jpg.

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT "gastrointestinal tract" at Dorland's Medical Dictionary.

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT,gastrointestinal tract at the US National Library of Medicine Medical Subject Headings .

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT "gastrointestinal tract" at Dorland's Medical Dictionary.

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT, upper Gastrointestinal Tract at the US National Library of Medicine Medical Subject Headings .

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT, lower Gastrointestinal Tract at the US National Library of Medicine Medical Subject Headings .

http://en.wikipedia.org/wiki/Human_gastrointestinal_tract. It is a snapshot of the page as it appeared on 3 Apr 2015 16:30:31 GMT.

http://en.wikipedia.org/wiki/Inflammatory_bowel_disease. It is a snapshot of the page as it appeared on 8 Apr 2015 02:44:50 GMT, "Crohn's & Colitis Foundation of America".

http://en.wikipedia.org/wiki/Medical_imaging. It is a snapshot of the page as it appeared on 7 Apr 2015 10:47:16 GMT.

http://healthfixit.com/wp-content/uploads/2013/03/small-intestine-location-and-anatomy.jpg.

http://i.ytimg.com/vi/cpl333A-A7Q/maxresdefault.jpg.

http://radiopaedia.org/articles/mri-introduction. It is a snapshot of the page as it appeared on 3 Apr 2015 06:24:45 GMT .Dr Jeremy Jones.

http://www.healthline.com/health/abdominal-mri-scan. It is a snapshot of the page as it appeared on 18 Apr 2015 22:13:04 GMT.

http://www.maximintegrated.com/en/app-notes/index.mvp/id/4681. It is a snapshot of the page as it appeared on 3 Apr 2015 07:57:58 GMT. Dr John Scampini, Executive Director in the Industrial Communications and Ultrasound Business .

http://www.medgadget.com/img/46455ct.jpg.

http://www.medscape.com/viewarticle/774257. It is a snapshot of the page as it appeared on 31 Mar 2015 03:48:50 GMT. Christina A. LeBedis, MD, David R. Penn, MD, Jennifer C. Broder, MD, Avneesh Gupta, MD, Jaroslaw N. Tkacz, MD, Jorge A. Soto, MD.

http://www.nlm.nih.gov/medlineplus/ency/article/002365.htm. It is a snapshot of the page as it appeared on 7 Apr 2015 09:01:02 GMT.

http://www.radiologyinfo.org/en/info.cfm?pg=mrenterography. It is a snapshot of the page as it appeared on 2 Apr 2015 00:38:07 GMT.

http://www.slideshare.net/bayenMD/gastrointestinal-tract-blood-supply-and-accessory-organs. It is a snapshot of the page as it appeared on 5 Apr 2015 09:53:26 GMT, Bien Nillos Professor at University of Saint La Salle, Published on Sep 30, 2010.

http://www.thenation.com/sites/default/files/user/194882/mri.jpg.

http://www.vietcanmedical.com/yahoo_site_admin/assets/images/ultrasound_machine.26194745_std.jpg.

http://www.wisegeekhealth.com/what-is-a-bowel-abscess.htm. It is a snapshot of the page as it appeared on 13 Mar 2015 21:40:40 GMT.

https://www.healthcare.siemens.com/magnetic-resonance-imaging/options-and-upgrades/coils/body-60-body-30

J. Ressurreição1, L. Batista1, J. T. Soares1, I. Marques2, E. Matos1, L. Andrade3, A. Almeida1, P. Madaleno Ferreira Alves1, P. Portugal1; 1Vila Nova de Gaia/PT, 2Vila Nova de Gaia, Porto/PT, 3Coimbra/PT et al Normal anatomy and anatomic variants of

the biliary tree and pancreatic ductal system at MRCP - what the clinicians want to know -2014.

Johann-Gutenberg-Universität,MRI made easy , Germany by Nationales Druckhaus Berlin, schering AG Berlin/Bergkamen 1990.

Kapoor, Vinay Kumar (13 Jul 2011). Gest, Thomas R., ed. "Large Intestine Anatomy". Medscape. WebMD LLC. Retrieved 2013-08-20.

Lalande JD, Behr MA (2010). "Mycobacteria in Crohn's disease: How innate immune deficiency may result in chronic inflammation". Expert review of clinical immunology 6 (4): 633–41. doi:10.1586/eci.10.29. PMID 20594136.

Littleton, J.T. "Conventional Tomography". A History of the Radiological Sciences. American Roentgen Ray Society. Retrieved 11 January 2014.

Margaret Matt and Joe Ziemian et al Human anatomy coloring book, green edition, page 31, in 1982.

Michael Dam Jensen, Torben Nathan, et al Incidental findings at MRI-enterography in patients with suspected or known Crohn's disease-2010 .

Nitz, W. R. 1999. MR Imaging: Acronyms and Clinical Applications. European Radiology 9, 979–997.

Prof. Dr. Hans H. Schild Lt. et al MRI made easy ISBN 3-921817-41-2, page 99-1990.

Runge VM, Clanton JA, Lukehart CM et-al. Paramagnetic agents for contrast-enhanced NMR imaging: a review. AJR Am J Roentgenol. 1983;141 (6): 1209-15.

Stefanelli T, Malesci A, Repici A, Vetrano S, Danese S"New et al Insights into Inflammatory Bowel Disease Pathophysiology: Paving the Way for Novel Therapeutic Targets". Current Drug Targets 9 (5): 413–8 (2008).

Thomas C. Lauenstein, MD Herbert Schneemann, PhD Florian M.Vogt, MD Christoph U. Herborn, MD Stefan G. Ru¨hm, MD Jo¨rg F. Debatin, MD Optimization of Oral contrast Agents for MR Imaging of the Small Bowel1 et al 2003.

Vann, MPH, Madeline; (Medically reviewed by) Pat F. Bass III, MD, MPH (July 26, 2010). "Diagnosing and Treating Bowel Obstruction". Everyday Health. Retrieved August 28, 2013.

W. Ajaj1, S. C. Goehde1, R. Jeyrani1, H. Schneemann2, S. G. Ruehm1, J. F. Debatin1, T. Lauenstein1 ORAL CONTRAST AGENTS FOR SMALL BOWEL MRI: COMPARISON OF DIFFERENT ADDITIVES TO OPTIMIZEBOWEL DISTENSION et al 2003.

Wexner, edited by Andrew P. Zbar, Steven D. (2010). Coloproctology. New York: Springer. p. 140. ISBN 978-1-84882-755-4.

APPENDIX1

Number	Gander	Age	Weight	MR Enterology finding	CT finding

APPENDIX2

IMAGE 1. RSPIEATORY GAITING, IMMOBILIZATION BAD SIEMENS MRI MACHINE (GERMANY), (ALRIBAT UNIVERSITY HOSPITAL).

IMAGE 2. RSPIEATORY GAITING SIEMENS MRI MACHINE (GERMANY), (ALRIBAT UNIVERSITY HOSPITAL).

IMAGE 3. ABDOMEN COIL SIEMENS MRI MACHINE (GERMANY), (ALRIBAT UNIVERSITY HOSPITAL).

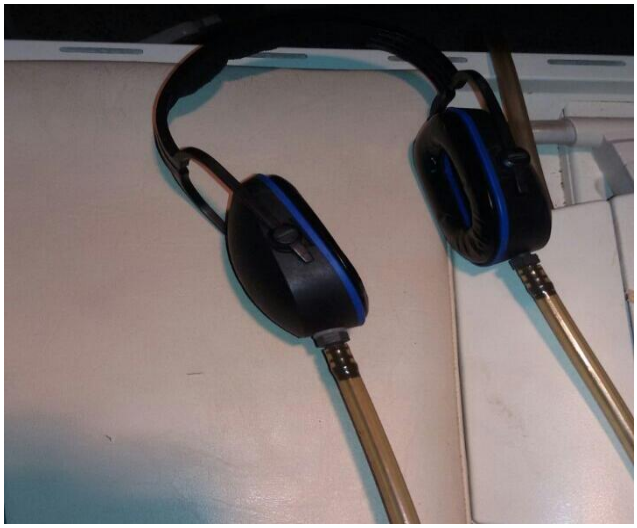

IMAGE 4. EAR PLUG SIEMENS MRI MACHINE (GERMANY), (ALRIBAT UNIVERSITY HOSPITAL).

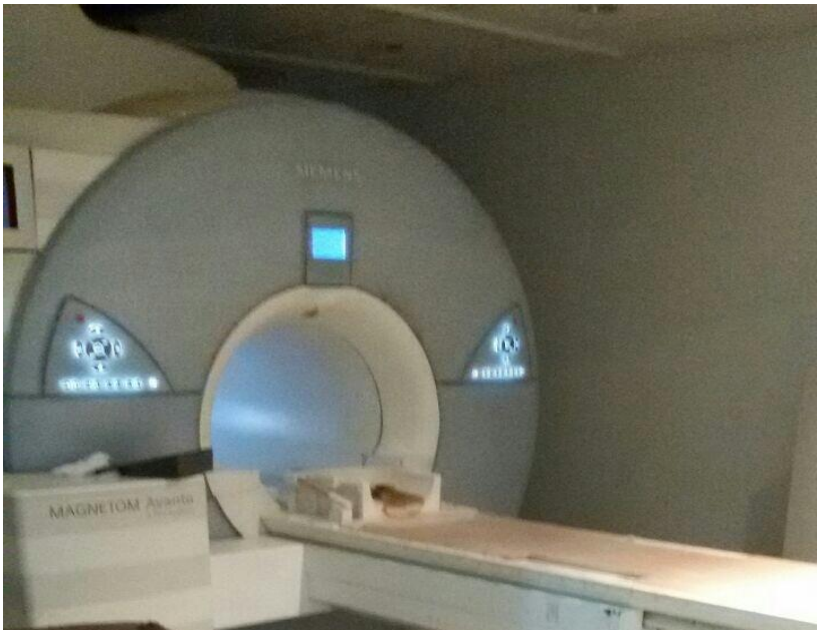

IMAGE 5. CLOSED SIEMENS MRI MACHINE 1.5 TESLA (GERMANY), (ALRIBAT UNIVERSITY HOSPITAL).

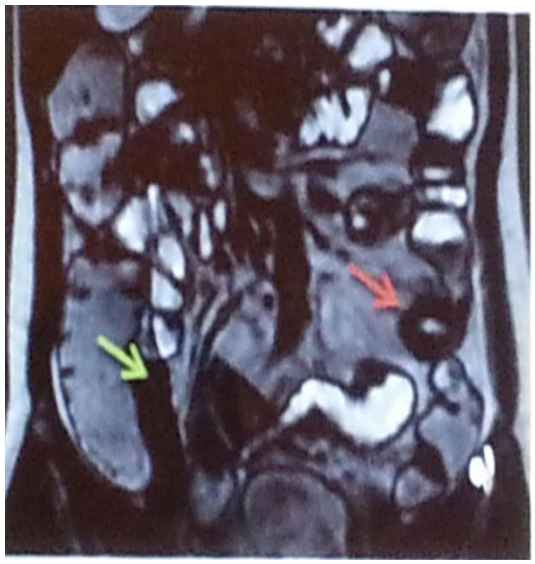

IMAGE 6. Coronal T2 weighted image 35 years old male patient with Crohn's disease MR Enterology found that.

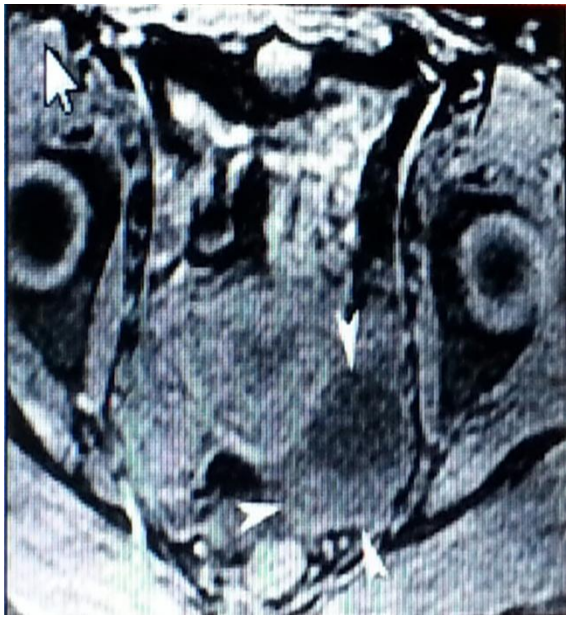

IMAGE 7. Axial T2 weighted image 41 years old male patient with Ulcerative Colitis MR Enterology found that.

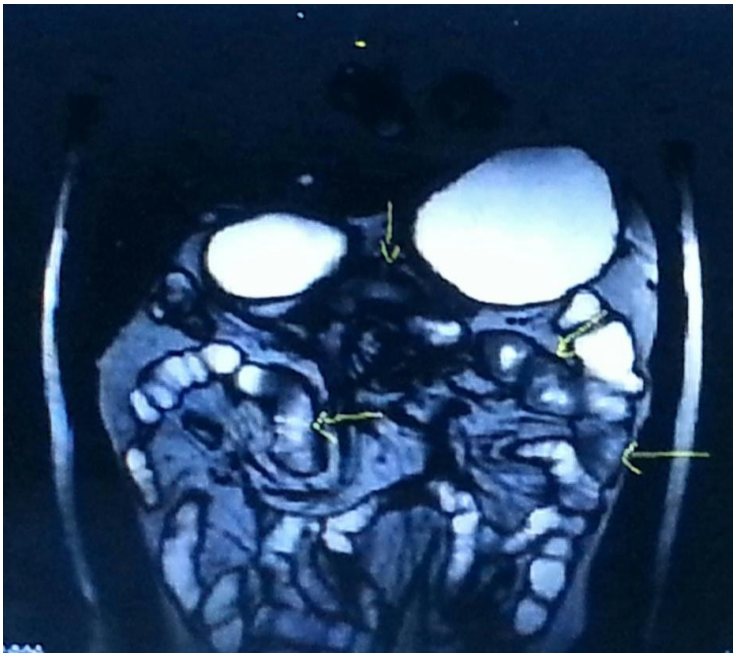

IMAGE 8. Coronal T2 weighted image 57years old female patient with Bowel abscess MR Enterology found that.

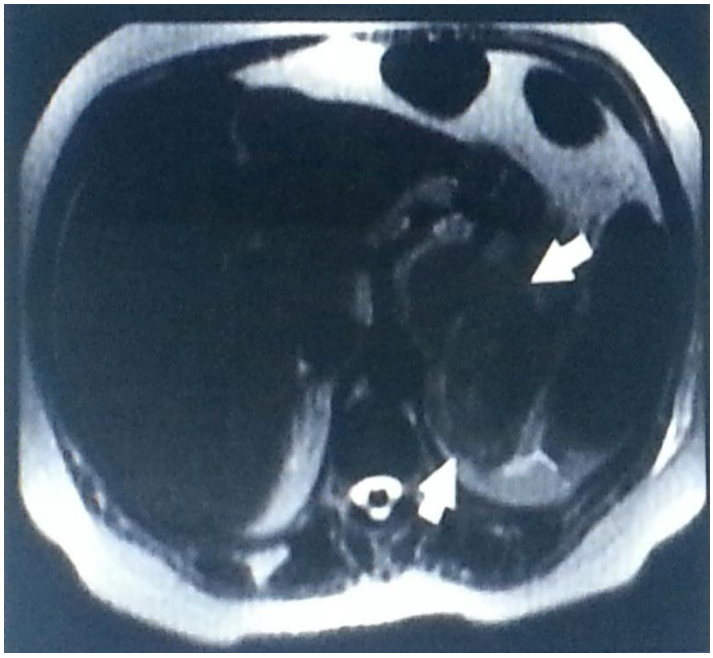

IMAGE 9. Axial T2 weighted image 29years old male patient with Adrenal gland mass MR Enterology found that.

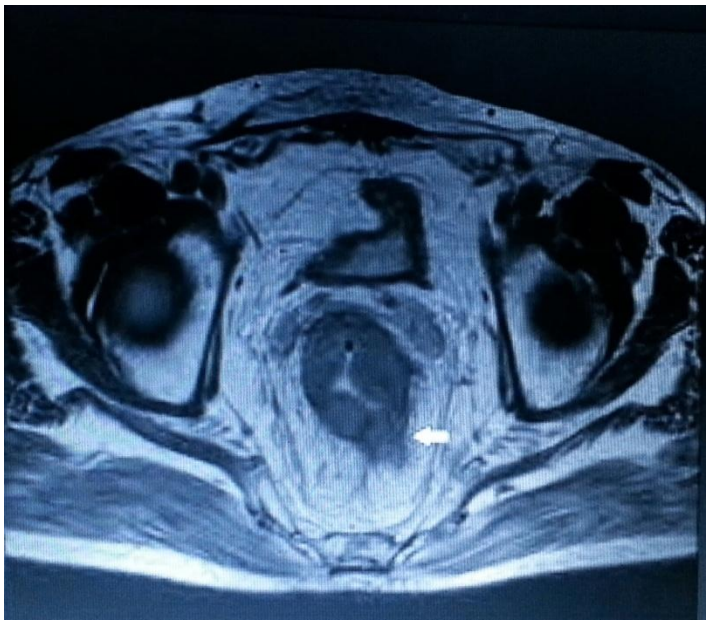

IMAGE 10. Axial T2 weighted image 46years old male patient with Rectal mass MR Enterology found that.

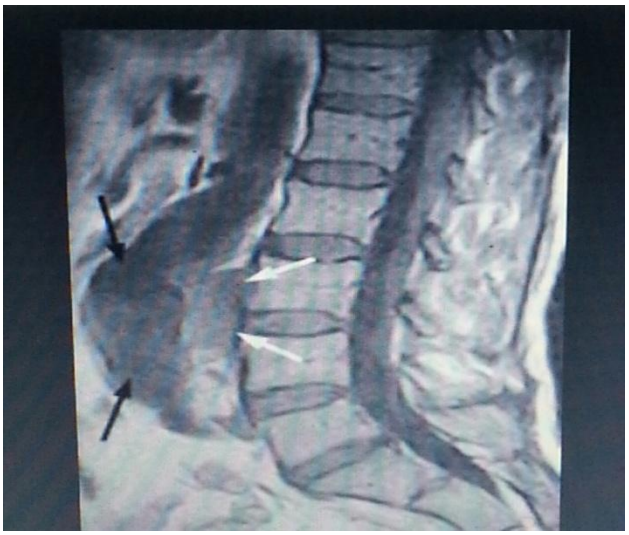

IMAGE 11. Sagittal T1 weighted image 38 old male patient with Aortic aneurysm MR Enterology found that.

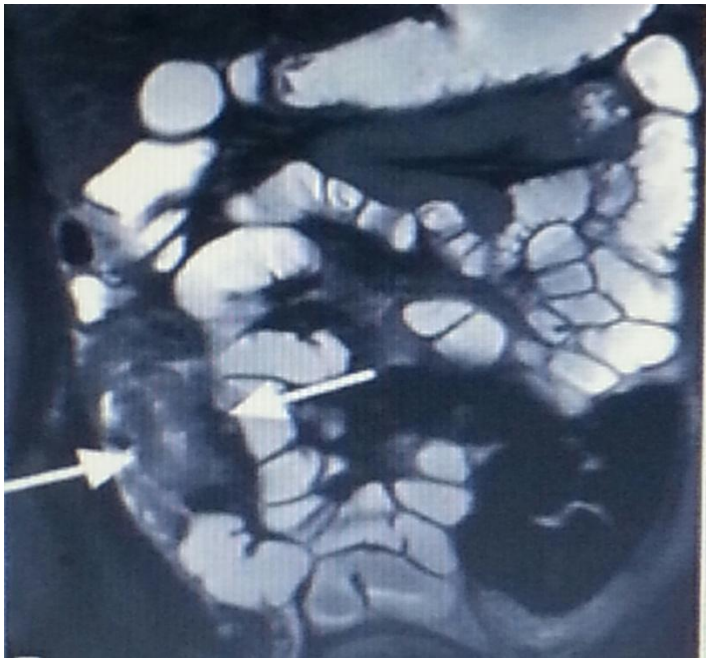

IMAGE 12. Coronal T2 weighted image 52 old male patient with lymph nodes disease MR Enterology found that.

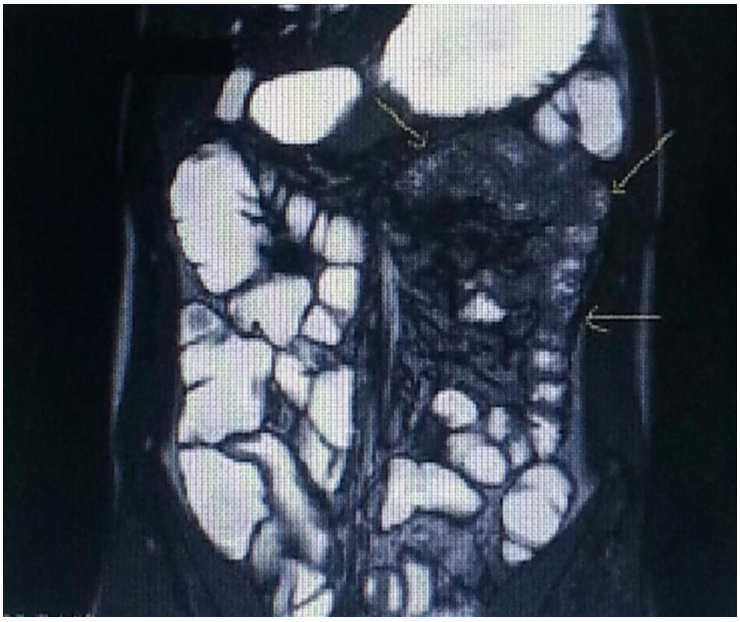

IMAGE 13. Coronal T2 weighted image 52 old male patient with Bowel obstruction MR Enterology found that.