بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College of Graduate Studies

Application Frequency of the Alimentary Tract Contrast Study

تردد تطبيق فحوصات القناة الهضمية الملونة

A thesis submitted for partial fulfillment of requirements of M.Sc. degree in Diagnostic Radiological Technology

Prepared by: Hind Mohammed Elhassan Ali

Supervisor: Dr. Caroline Edward Ayad

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الآية

﴿وَاللَّهُ أَخْرَجَكُمْ مِنْ بُطُونِ أُمَّهَاتِكُمْ لَا تَعْلَمُونَ شَيْئًا وَجَعَلَ لَكُمُ السَّمْعَ وَالْأَبْصَارَ وَالْأَفْئِدَةَ ۙ لَعَلَّكُمْ تَشْكُرُونَ﴾ (78)

صدق الله العظيم

سورة النحل

Abstract

The main aim of this study is to evaluate the application frequency of barium studies in relation to the other contrast examinations.

This study was conducted at radiology departments of some of centers at Khartoum state in the period from March to December.Random sample of 400 patients, who had been examined by different types of contrast studies, using fluoroscopy or computed radiography in order to compare the application frequency of barium studies in relation to other contrast enhanced examinations.

In this study, the barium examinations were more occurrences (29%) than IVU (27.5%), HSG (23%), urethrogram (9.5%), MCUG (4.5%), fistulogram (2.5%), T-Tube cholecystogram (1.5%), cystogram (1%), nephrostogrm (0.5%), and sinogram (0.1%). The most using of barium studies was in diagnosis of dysphagia, chronic constipation in children and post operative patients. The study revealed that barium swallow had the highest frequency (55.2%) in comparison with barium enema(33.6%), barium meal(8.6%) and barium follow-through (2.6%). The study elaborated that, barium sulfate was used in most of the cases (61.2%) and water soluble contrast was used in a certain cases with about (38.8%). The study found that, the barium studies were conducted more in Fideel Hospital (50.9%).

The study concluded that; despite the presence of the recent new modalities, alimentary tract contrast enhanced study has a high application frequency and is

still of great value as a first line diagnostic exam for diagnosing a wide range of GIT abnormalities.

ملخص البحث

تهدف هذه الدراسة إلى تقييم تردد فحوصات القناة الهضمية باستخدام وسيط التباين.أجريت هذه الدراسة في أقسام الأشعة التشخيصية لبعض المراكز بولاية الخرطوم في الفترة من مارس وحتى ديسمبر، وكانت العينة المأخوذة عينة عشوائية تتألف من 400 مريض أجريت لهم فحوصات إشعاعية باستخدام وسيط التباين، ولقد تمت الفحوصات باستخدام الأشعة المرئية أو الأشعة الرقمية لمقارنة تردد استخدام فحوصات الباريوم بالمقارنة مع الفحوصات الأخرى التي تستخدم وسائط تباين مختلفة.

توصلت الدراسة إلى أن فحوصات القناة الهضمية التي تستخدم وسيط تباين تمثل أعلى تردد (29%) بالمقارنة مع فحص المسالك البولية الملون(27.5%) ،وفحص الرحم والانابيب الملون (23%) ، وفحص الإحليل الملون (9.5%) ، وفحص المثانة الملون أثناء عملية التبول (4.5%) وفحص الناسور الملون (2.5%) وفحص الحويصلة الصفراوية الملون باستخدام أنبوبة ت ، وفحص المثانة الملون (1%) ،وفحص النيفرونات الملون (0.5%) ، وفحص الجيب الملون (0.1%). كما وجدت الدراسة أن أكثر استخدام لفحوصات الباريوم في تشخيص صعوبة البلع ، الإمساك المزمن لدى الأطفال وفي تقييم المرضى بعد العمليات.وعند مقارنة تردد فحوصات الباريوم توصلت الدراسة إلي أن فحص المرئ الملون يمثل أعلي تردد (55.2%) بالمقارنة مع الفحص الملون للمعدة (8.6%) وفحص االأمعاء الدقيقة الملون (2.6%) والفحص الملون للأمعاء الغليظة (33.6%).توصلت الدراسة إلى أن الباريوم هو وسيط التباين الأكثر استخداما" في تصوير القناة الهضمية(61.2%) بينما يستخدم وسيط التباين القابل للذوبان في الماء في حالات معينة (38.8%).

وخلصت الدراسة إلي أنه علي الرغم من وجود أجهزة تشخيصية ذات تقنية متقدمة إلا أن فحوصات القناة الهضمية الملونة مازالت ذات تردد عالي ولها قيمة عظيمة كوسيلة فحص أولية في تشخيص أمراض وإضطرابات القناة الهضمية المختلفة.

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Dedication

"If you see scientists at the gates of the Kings, say evil kings and evil scientists, and if you see the Kings at the gates of scientists, say yes and yes, scientists Kings."

Ali bin Abi Talib

I dedicate this research work to my father soul.

To my mother, who taught me that even the largest task can be accomplished if it was done step by step.

Acknowledgement

My special thanks and appreciation to my supervisor **Dr. Caroline Edward** for her great and sincere support and guidance through this work from inception to the end.

I owe a great many thanks to a great many people who helped and supported us during the writing of this Thesis. Special thanks is to **Dr. Mohammed Alzain**, without his knowledge and assistance this study would not have been successful.

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Abbreviations

S. No	Abbreviation	Meaning
1	ACR	American college of radiology
2	AP	Anteroposterior
3	CR	Computed radiography
4	CT	Computed tomography
5	CTC	Computerize tomographic colonography
6	EGD	Esophagogastroduodenoscopy
7	EMS	Esophageal motility study
8	ERCP	Endoscopic retrograde cholangiopancreatography
9	GERD	Gastroesophageal reflux disease
10	GIT	Gastrointestinal tract
11	HD	Hirschsprung disease
12	HH	Hiatal hernia
13	HSG	Hystrosalpingography
14	IBS	Idiopathic bowel syndrome
15	IVU	Intravenous urography
16	Kvp	Peak kilovoltage
17	LAO	Left anterior oblaque
18	L1-L2	First and second lumber vertebrae
19	mAS	Milliemampere second
20	MCUG	Micturatingcystourethrogram
21	MRI	Magnetic resonance imaging
22	NPO	Nothings by mouth
23	PA	Posteroanterior
24	pH	Power of hydrogen
25	PTC	Percutaneous transhepatic cholangiography

26	RAO	Right anterior oblaque
27	TOF	Tracheosophageal fistula
28	T5-T6	Fifth and sixth thoracic vertebrae
29	UES	Upper esophageal sphincter
30	VC	Virtual colonography
31	VCE	Video capsule endoscopy

Chapter one:

Introduction

Chapter One

1.1 Introduction:

Digestive disorders and diseases significantly affect millions of persons worldwide inducing highly significant economic impact comprising healthcare costs and work absenteeism, in addition to patient's decreased quality of life. The gastrointestinal tract (GIT) is a long tubular structure extending from the pharynx to the anal canal. There are many ways in which this can be imaged. Gas in the bowel is visible on the plain radiographs, while the examinations using a suspension of barium sulfate to coat or fill the lumen demonstrate the anatomy and details of the bowel wall. Computed tomography (CT) and magnetic resonance (MR)can be used to study the cross-sectional anatomy and the surrounding anatomical structures whereas the endoscopy is a valuable test for assessing mucosal diseases in the GI tract and it is possible to perform mucosal biopsy. Less commonly, nuclear medicine techniques investigate functional anatomy, and particularly in the infant, ultrasound has a role in the studying the gut.Endoluminal ultrasound showed detailed wall structure and is used particularly in the assessment of tumors (Butler et al. 2007).
Barium study is a useful test for the work-up of a host of GI diseases. It is a safe, non-invasive, relatively inexpensive global examination, also has an important role in the evaluation of patients after GI surgery, and has clear advantages over endoscopy for evaluating submucosal and extrinsic mass lesion and for assessing GI function and motility from the pharynx to anorectal junction(Levine et al. 2009).

The previous researches that study the application frequency of barium studies revealed that there has been a slow but steady decline in the volume of barium studies performed worldwide. This trend is related to a variety of factors, including the availability of endoscopy and advanced cross-sectional imaging

modalities such as CT and MRI. Economic factors have also acted as powerful disincentive for performing GI fluoroscopy in most radiology practices because radiologists whose practices include a large volume of GI fluoroscopic studies may receive less compensation than their colleagues who mainly perform cross-sectional imaging studies.

1.2 Research Problem:

There has been a slow and steady decline in the application frequency of barium studies performed worldwide, this study mainly aims to show if there is a decline in the application frequency of barium studies performed nationwide.

1.3 General Objectives of the Study:

To evaluate the presence and frequency of barium studies in relation to the other contrast examinations.

1.4 Specific Objectives of the Study:

- To evaluate the application frequencies of the different types of barium study examinations.
- To determine how often barium studies has been used as a first line investigation.
- To determine the pathological indications for barium studies.
- To determine types of contrast media used in main GIT contrast examinations.
- To evaluate in general terms other modalities which are used in diagnosis of GIT abnormalities and their availability.
- To compare the costs of barium studies with other GIT examinations.

1.5 Thesis Outline:

The thesis outlined in to five chapters as follows: *chapter one* general introduction to digestive disorders and different modalities of diagnostic tools that are important in the assessment of the GIT abnormalities, the problem and objectives of the study. *Chapter two* is devoted to the literature review and the previous international studies. Material and methods in *chapter three* including techniques used for four types of barium studies, imaging modalities fluoroscopy and computed radiography (CR). *Chapter four*: the results of the study. *Chapter five* present the discussion to all results of the study, conclusion, and recommendations.

Chapter Two:

Literature review

Chapter Two

2.1 Alimentary Tract:

The alimentary tract is a musculomembranous tube that passes through the thoracic and abdominal cavities and extends from the mouth to the anus. It consists of the oral cavity, pharynx, esophagus, stomach, small intestine and large intestine. The regions of the alimentary tract vary in diameter according to functional requirements (McPhee and Ganong 2006). The overall function of alimentary tract is to take in nutrients and process them to a form that can be used by the body and to eliminate wastes. The major physiological processes that occur in the alimentary tract are digestion, secretion, motility, and absorption (McPhee and Ganong 2006).

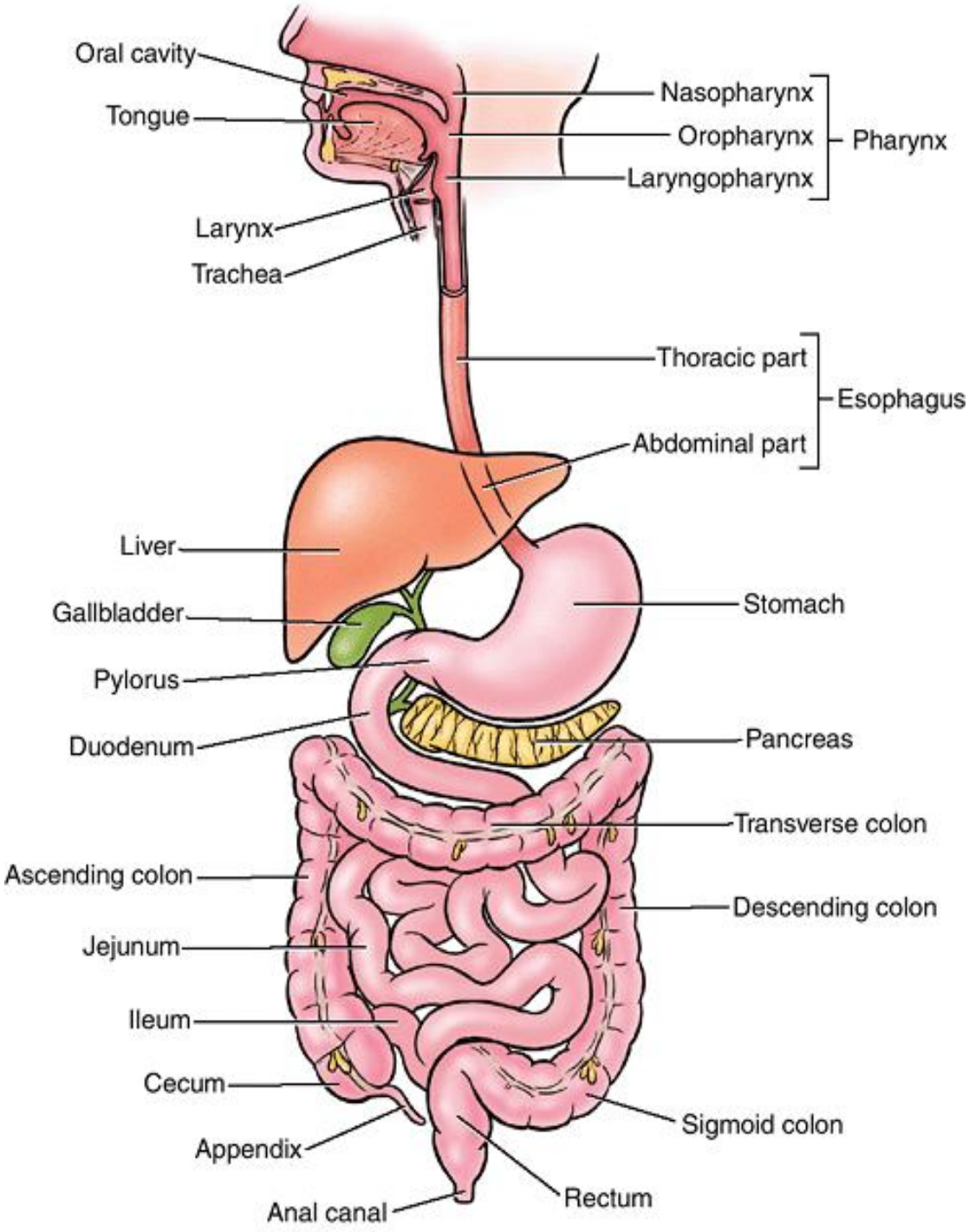

Fig (2.1): Anterior View of the Alimentary Tract

(Moree and Agur2007)

2.2 Disorders of the Alimentary Tract:

Gastrointestinal diseases most often present with one or more of four common classes of symptoms and signs: abdominal or chest pain, altered ingestion of food (e.g. resulting from nausea, vomiting, disphagia, odynophagia or anorexia), altered bowel movements (e.g. diarrhea or constipation)and GI bleeding (McPhee and Ganong 2006).

2.2.1 Disorders of the Esophagus:

The esophagus can be affected by many diseases that can drive from congenital conditions, or they can be acquired later in life (Snell, 2004).

2.2.1.1 Achalasia:

Also termed cardiospasm, is a motor disorder of the esophagus generally occurring in the 35-50 year age group. Primary and secondary peristalsis initially fails, tertiary contraction develops and there is a failure of relaxation of the lower esophageal sphincter. Unlike strictures of the esophagus, which initially cause dysphasia for solids but allow liquids to pass. A barium swallow will show the gastro-esophageal junction failing to open fully and tapering to a rat tail or bird beak appearance (Sutton, 2003).

Fig (2.2): Barium swallow showing achalasia (Sutton, 2003)

2.2.1.2 Barrett's Esophagus:

Barrett's esophagus is the replacement of the normal squamous epithelium with columnar-lined epithelium. This replacement may produce a stricture in the distal esophagus. It is a complication of long-standing gastroesophageal reflux. The esophagram may demonstrate subtle tissue changes in the esophagus, but nuclear medicine is the modality of choice (Bontrager and Lampignano 2001, p.459).

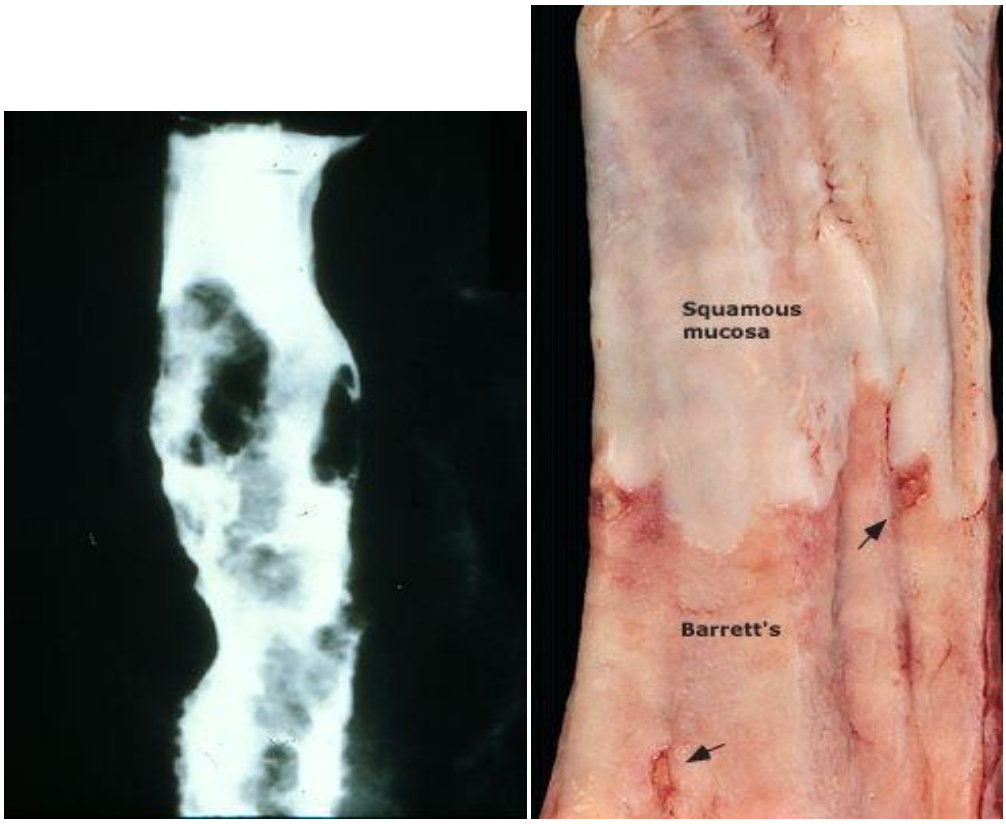

Fig (2.3): Barrett's esophagus(Sutton, 2003)

2.2.1.3Reflux Esophagitis:

Reflux can be a normal phenomenon, but esophagitis is results if reflux is excessive or particularly damaging to the mucosa. Excessive reflux results from an increase in number or duration of episodes of relaxation of the lower esophageal sphincter, as may be induce by fatty meals, drinking alcohol or coffee, or from cigarette smoking. The definitive test for esophageal reflux is 24 hour pH recording, where a drop in pH below 4 defines a reflux event. The earliest changes of esophagitis are seen at endoscopy (Sutton, 2003).

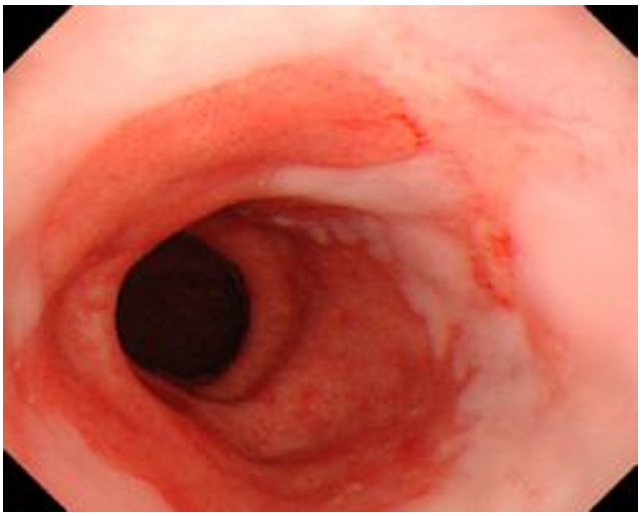

Fig (2.4): The upper endoscopy showed the erythema and erosions to the distal esophagus caused by GERD
(http://www.nature.com/gimo/contents/pt1/images/gimo44-f1.jpg)

2.2.1.4 Carcinoma of the Esophagus:

Cancer of the esophagus is often associated with anorexia, significant weight loss, and rapidly progressive dysphagia, initially for solids and later for liquids. There are two main histologic types ofesophageal carcinoma: adenocarcinoma and squamous cell carcinoma.Esophagram and endoscopy are performed to detect these tumors. The CT maybe performed in staging tumor and whether it has extended beyond the inner layer of the esophageal mucosa (Bontrager and Lampignano2001, p.459).

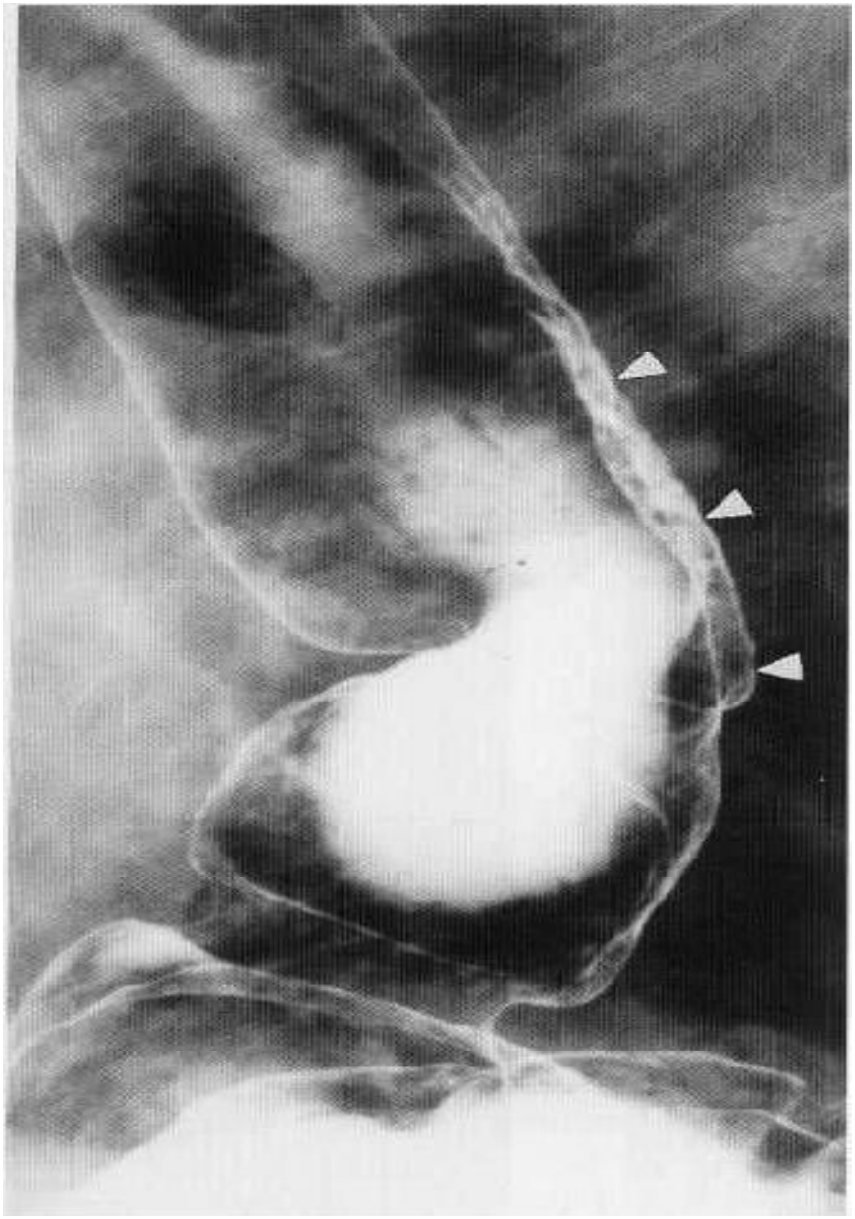

Fig (2.5): Barium-swallow demonstrated early esophageal carcinoma (Sutton,2003)

2.2.1.5 Esophageal Web:

Esophageal web refers to a thin mucosal fold that protrudes into the lumen and is covered with squamous epithelium. Webs most commonly occur anteriorly in the cervical esophagus, causing focal narrowing in the postcricoidaerea.(Sutton, 2003).

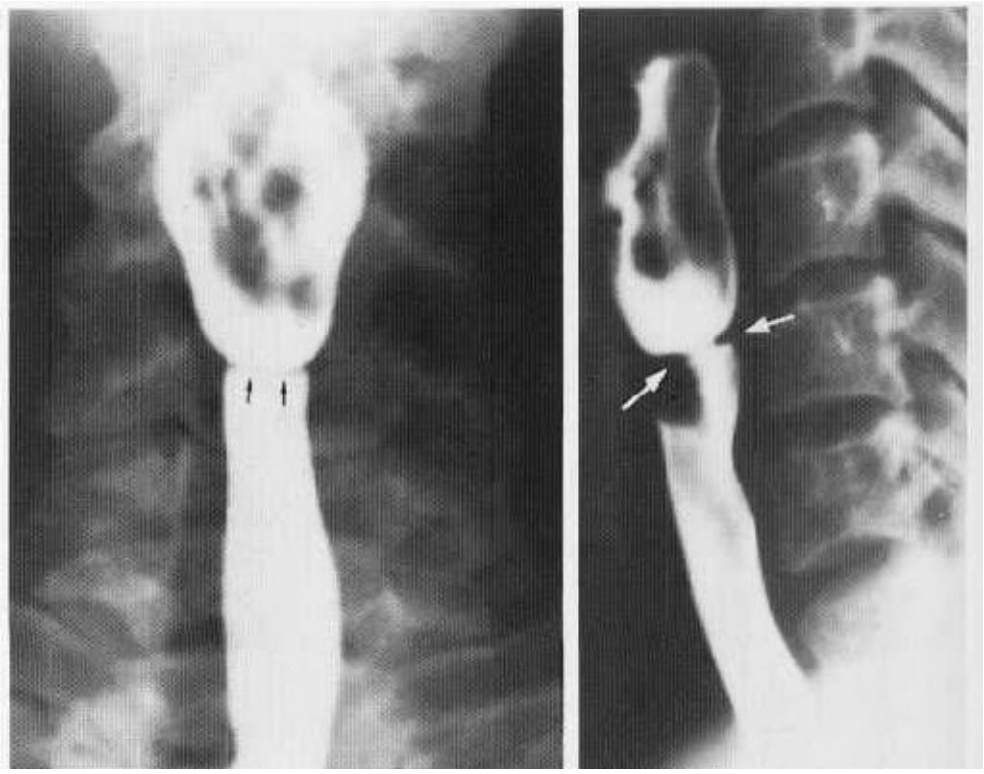

Fig (2.6): Upper esophageal web in both the frontal and lateral projections (arrows) (Sutton, 2003)

2.2.1.6Schatzki'sRings:

Schatzki's ring is defined as a pathological annual narrowing at the esophagastric junction causing dysphagia. In some it may be congenital, in others there is inflammation and fibrosis(Sutton, 2003).

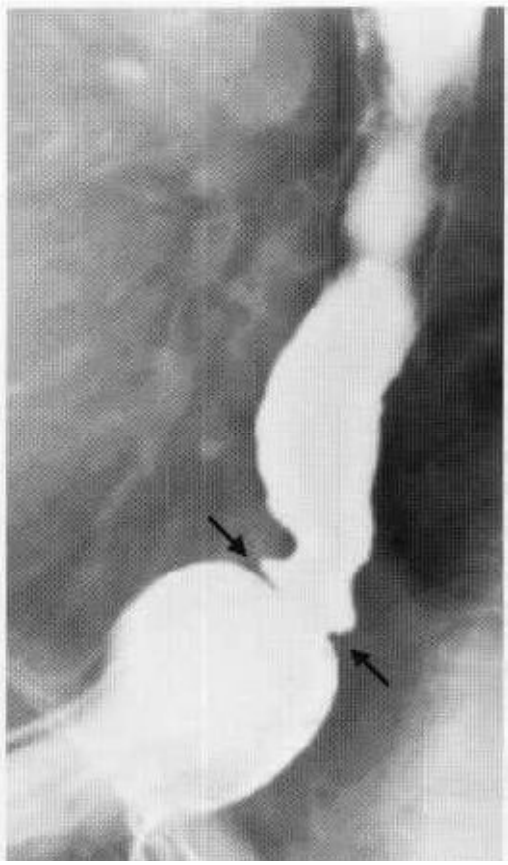

Fig (2.7): Schatzki's ring (between the arrows) demonstrating by barium swallow (Sutton, 2003)

2.2.1.7Zenker'sDiverticulum:

Zenker's diverticulum is characterized by a large, out pouching of the esophagus just above the upper esophageal sphincter, which occur due to a weakening of the muscles wall. Because of its size, the patient may experience dysphagia, aspiration, and regurgitation of food eaten hours earlier(Bontrager and Lampiqnano 2001, p.460).

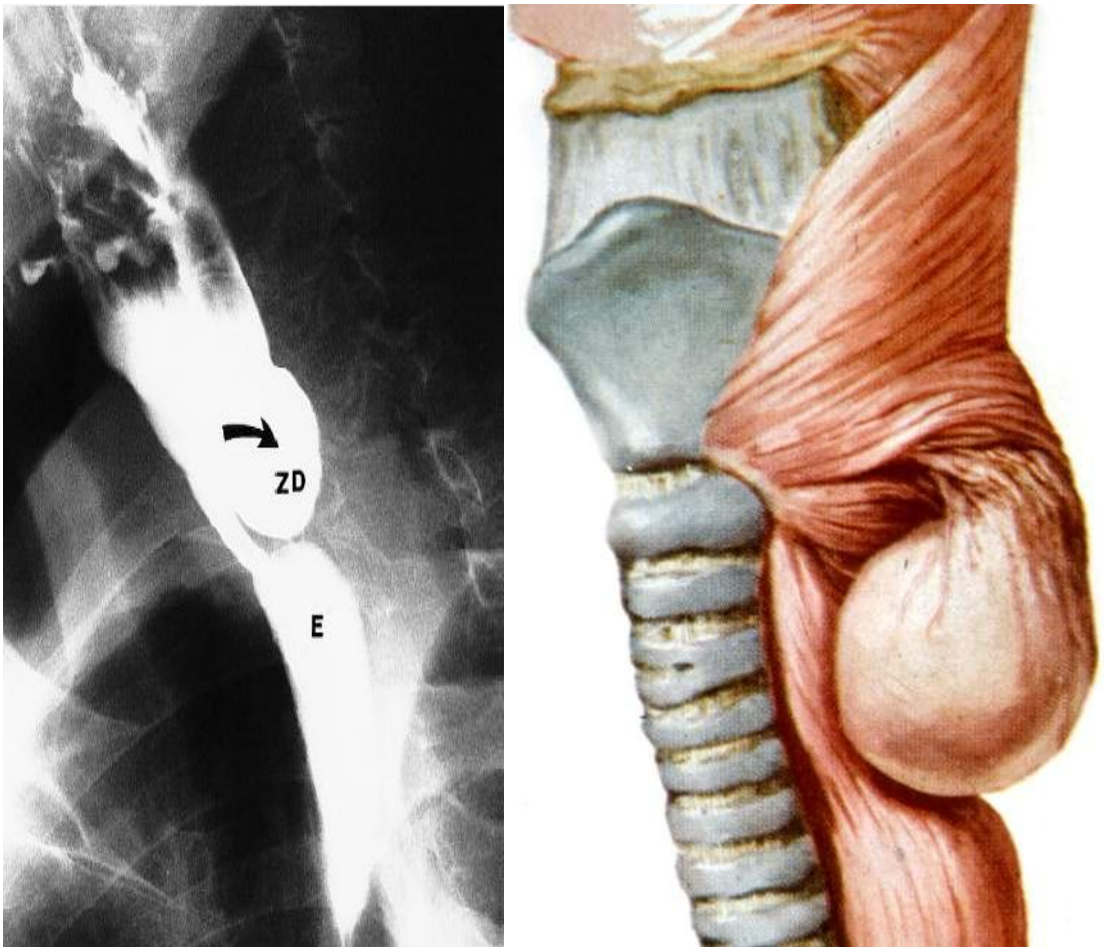

Fig (2.8):Zenker's diverticulum(Mettler, 2005)

2.2.1.8 Esophageal Varices:

Esophageal varices are characterized by dilatation of the veins in the distal esophagus, and occur chiefly as a consequence of portal hypertension in cirrhosis of the liver. They present with narrowing of the distal one third of the esophagus and a wormlike or cobblestone appearance due to the enlarged veins. (Bontrager and Lampignano 2001, p.460)

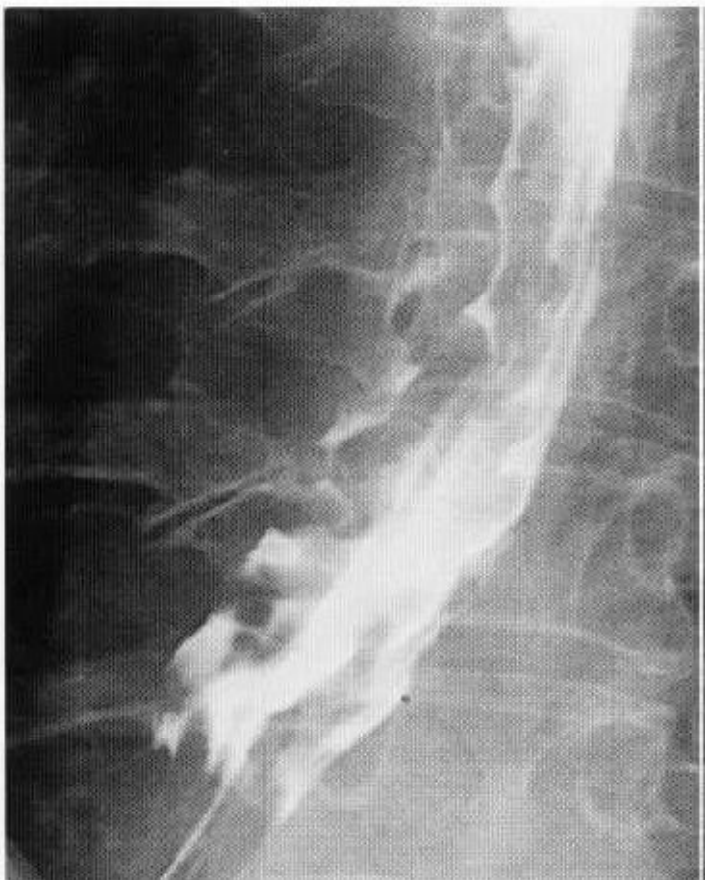

Fig (2.9):Esophageal varices (Typical warm-like filling defects)
(Sutton, 2003)

2.2.2 Disorders of the Stomach:

2.2.2.1 Pyloric Stenosis:

Pyloric stenosis means that the opening of the pyloric sphincter is narrowed, and emptying of thestomach is impaired. This is most often a congenital disorder caused by hypertrophy of pyloric sphincter (Snell, 2004).

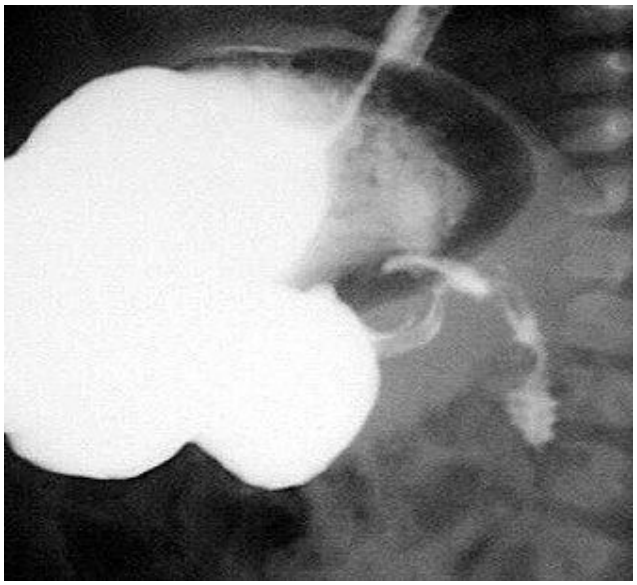

Fig (2.10): Upper GI of pyloric stenosis, show (apple-core sign)
(Brandt, 2011)

2.2.2.2 Gastritis:

Gastritis is an inflammation of the mucosa of the stomach which may develop in response to various physiologic and environmental conditions. Gastritis is best seen with a double-contrast GI series and endoscopy may also be performed to visually inspect themucosa for signs of gastritis (Bontrager and Lampignano2001, p.464).

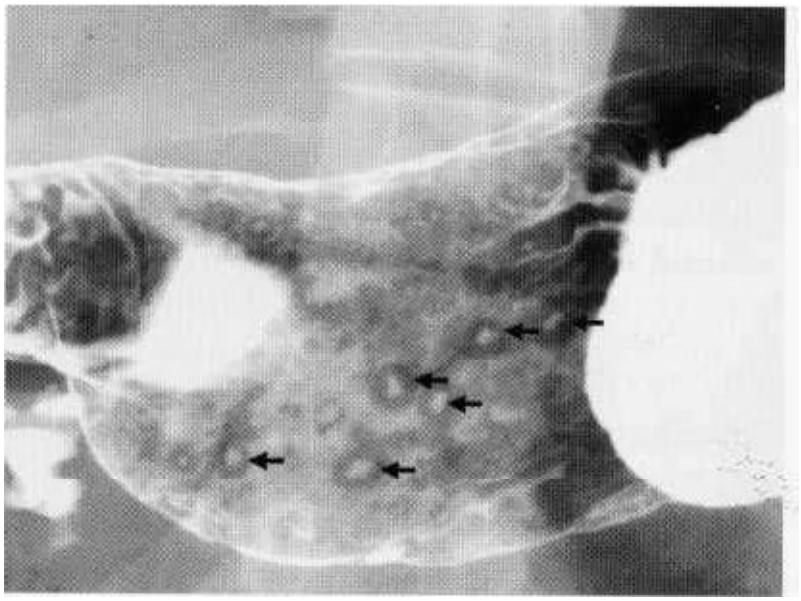

Fig (2.11): Double-contrast barium meal showed acute erosive gastritis (arrows)(Sutton,2003)

2.2.2.3 Hiatus Hernia (HH):

Hiatus hernia is a condition in which a portion of the stomach herniates through the diaphragmatic opening. The herniation may be slight, but in severe cases a majority of the stomach is found within the thoracic cavity. A hiatal hernia may be due to congenitally short esophagus or a weakening of the muscles that surrounds the diaphragmatic opening, sliding hiatal hernia is a second type of hiatal hernia which may produce a radiographic sign termed Schatzke' s ring (Bontrager and Lampignano 2001, p.464).

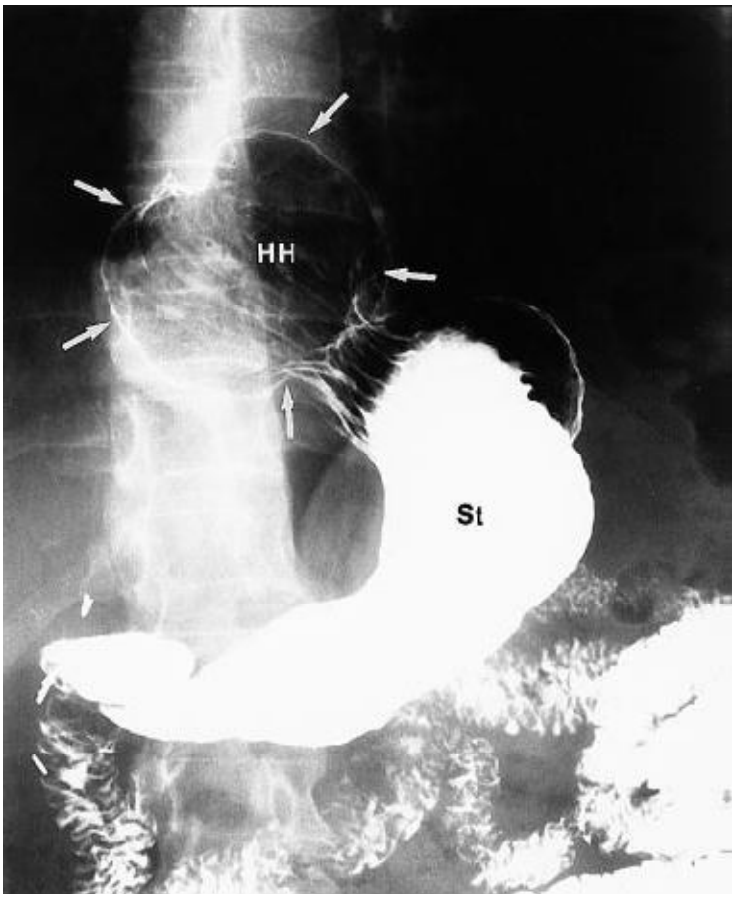

Fig (2.12): Large hiatal hernia, demonstrating in barium meal (Mettler,2005)

2.2.2.4 Gastric Ulcer:

Gastric ulcer is an erosion of the mucosa of the stomach due to various physiologic and environmental conditions, such as excessive gastric secretions, stress, diet and smoking. On the upper GI study the ulcer appears as a punctuate barium collection that may be surrounded by a lucent-halo appearance (Bontrager and Lampignano2001, p.465).

Fig (2.13): Barium-meal demonstrated large ulcer(arrow) along lesser curvature of the stomach (Mettler,2005)

2.2.2.5 Gastric Carcinoma:

Gastric carcinoma comprises 70% of all stomach neoplasms. The double-contrast upper GI study is the gold standard for the detection of gastric carcinoma. CT and/or endoscopy may be performed to determine the degree of invasion of the tumor into tissues surrounding the stomach (Bontrager and Lampignano2001, p.465).

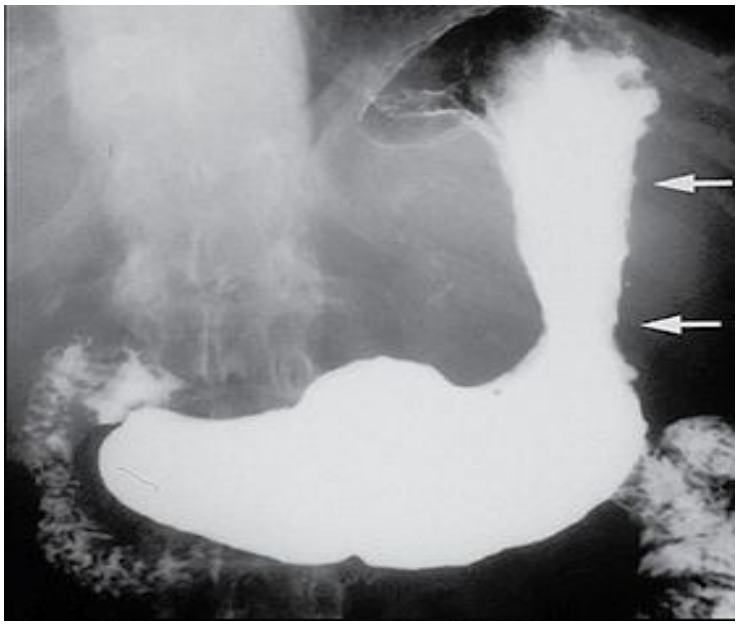

Fig (2.14): Upper gastrointestinal series reveals fixed narrowing of entire proximal stomach (arrows) due to gastric cancer (Sutton,2003)

2.2.2.6 Diverticula:

Diverticula are weakening and blind outpouchings of a portion of the mucosal wall. 70% to 90% of gastric diverticula arise in the posterior aspect of the fundus. A double-contrast upper GI is recommended to diagnose diverticula (Bontrager and Lampignano 2001, p.463).

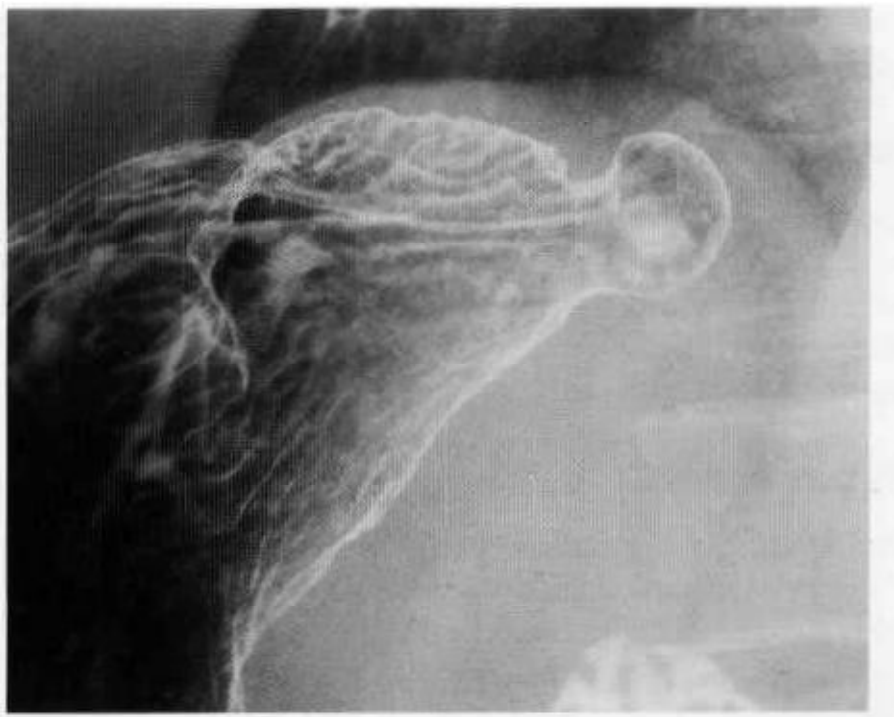

Fig (2.15): Gastric diverticulum arising from the fundus of the stomach (Sutton, 2003)

2.2.3 Small and large Intestines:

These two organs are therefore considered together. Collectively, disorders of the intestines account for a large portion of human diseases (Kumar et al. 2010).

2.2.3.1 Developmental Anomalies:

These defects are uncommon but sometimes result in serious clinical disease (Kumar et al. 2010).

2.2.3.1.1Atresia:

Atresia is a complete failure of development of the intestinal lumen, and stenosis, narrowing of the intestinal lumen with incomplete obstruction, may affect any segment of the small intestine, but duodenal atresia is the most common (Snell, 2004).

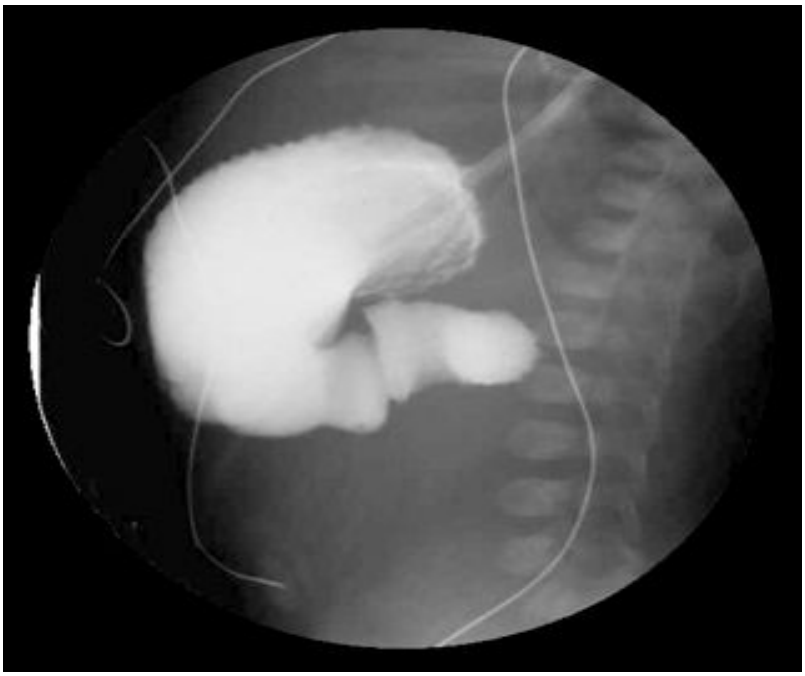

Fig (2.16): Upper GI contrast study demonstrates dilatation of the stomach and proximal duodenum due to duodenal atresia (Mettler,2005)

2.2.3.1.2 Meckel’sDiverticulum:

Meckel’sdiverticlumis a fairly common birth defect found in the ileum of small bowel. Usually it does not cause symptoms unless it becomes inflamed (diverticulitis) or causes bowel obstruction. It is rarely seen on barium studies of the small bowel because of the rapid emptying on a barium study (Bontrager and Lampignano 2001, p.487).

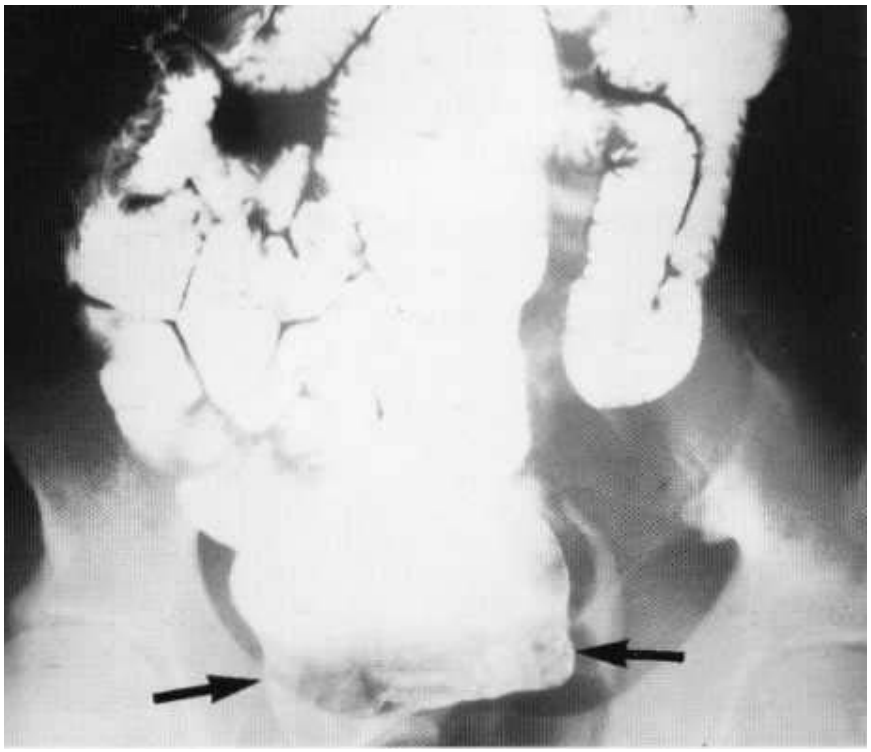

Fig (2.17): Barium follow-through reveals a large Meckel's diverticulum (Sutton, 2003)

2.2.3.1.3HirschsprungDisease (HD):

Hirschsprungdisease is more common in females than females. Symptoms usually appear during the first few days after birth. The child fails to pass meconium, and the abdomen becomes enormously distended. The sigmoid colon greatly distended and hypertrophied, while the rectum and anal canal are constricted(Snell, 2004).

Fig(2.18):HirschsprungDisease (Mettler,2005)

2.2.3.1.4 Imperforate Anus:

About 1 child in 4.000 is born with imperforate anus caused by imperfect fusion of entodermal cloaca with the proctodeum(Snell, 2004).

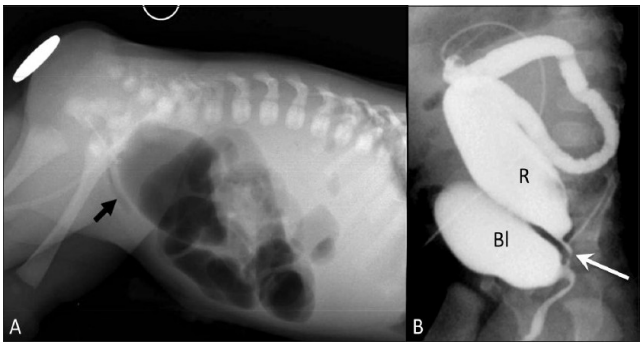

Fig (2.19) A-B Same patient show high perforate anus with recto-urethral fistula(Mettler,2005)

2.2.3.2 Bowel Obstruction:

Any part of the gut may be involved, but the small bowel is most commonly affected because of its narrow lumen. A mechanical obstruction is a physical blockage of the bowel may be due to: hernias, intussusceptions, and volvulus(Kumar et al. 2010).

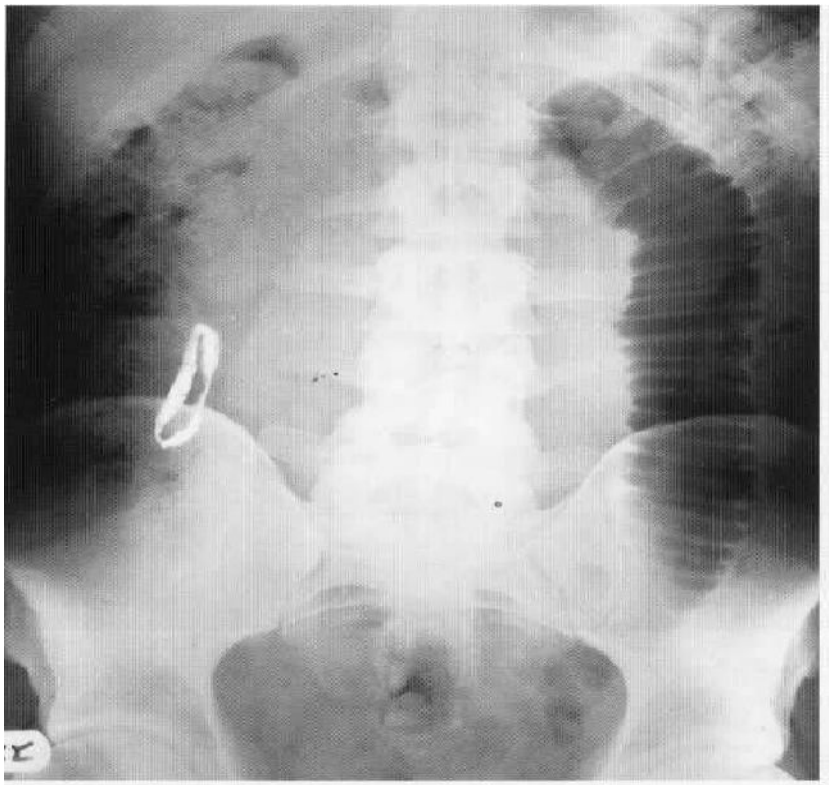

Fig (2.20): Plain abdominal film revealed a dilated jejunal loop due to obstruction secondary to internal hernia (Sutton, 2003)

2.2.3.3 InflammatoryBowelDisease:

Crohn's disease and ulcerative colitis are chronic relapsing inflammatory disorders of unknown origin. Collectively, knownas idiopathic inflammatory bowel diseases (IBD) (Kumar et al. 2010).Crohn's disease may affect any portion of GI tract but most often involves the ileum. Ulcerative colitis is a nongranulomatous disease limited to the colon. It is a severe form of colitis

(inflammatory condition of large intestine) that often leads to coin like ulcer developing within themucosal wall. These ulcers may be seen during the barium enema as multiple ring-shaped filling defects, creating a “cobblestone” appearance along mucosal wall (Bontrager and Lampignano 2001, p.486, 492).

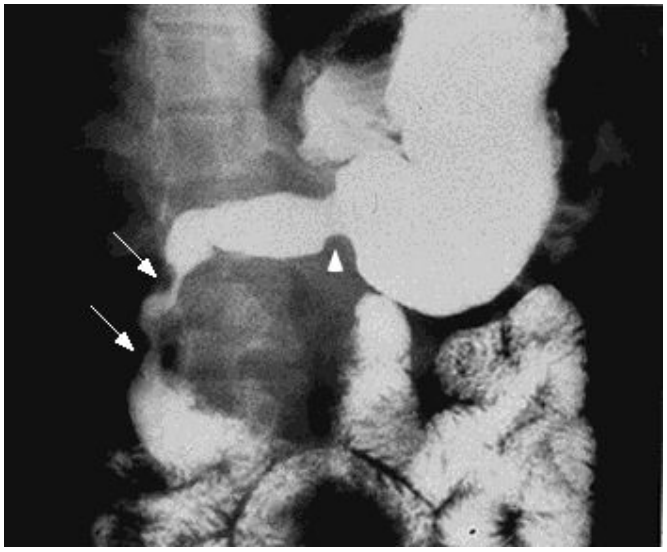

Fig (2.21): Upper GI Series in patient with gastroduodenalcrohn’s disease shows antral narrowing (small arrow) and duodenal strictures (large arrows) (Mettler,2005)

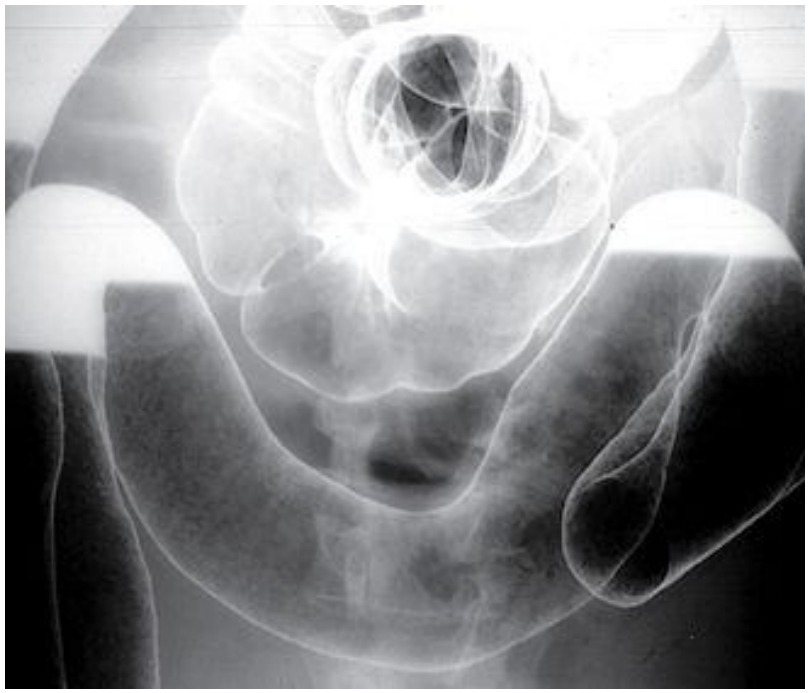

Fig (2.22):Double-contrast barium enema in patient with chronic ulcerative colitis shows a featureless colon with complete loss of folds in sigmoid colon

(Mettler,2005)

2.2.3.4 Tumors of the Small and Large Intestines:

Epithelial tumors of the intestines are a major cause of morbidity and mortality worldwide. Common benigntumors of the small intestineinclude adenomas andliomayomas. The majority of benign tumors are found in the jejunum and ileum. Lymphoma andadenocarcinoma are malignant tumors of the small intestine. Lymphomas are demonstrated during a small bowel series as producing the “stacked coin” sign.Adenocarcinomas produce short and sharp “napkin-ring” defects within the lumen and may lead to complete obstruction. The colon, including the rectum, is host to more primary neoplasms than any other organ in the body. A majority of carcinomas in the large intestine occur in the rectum and sigmoid colon. The radiographic appearance leads to descriptive terms such as “apple-core” or “napkin-ring” lesions. Both benign and malignant

tumors may begin as polyps. Polyps are saclike projections project inward into the lumen (Kumar et al. 2010).

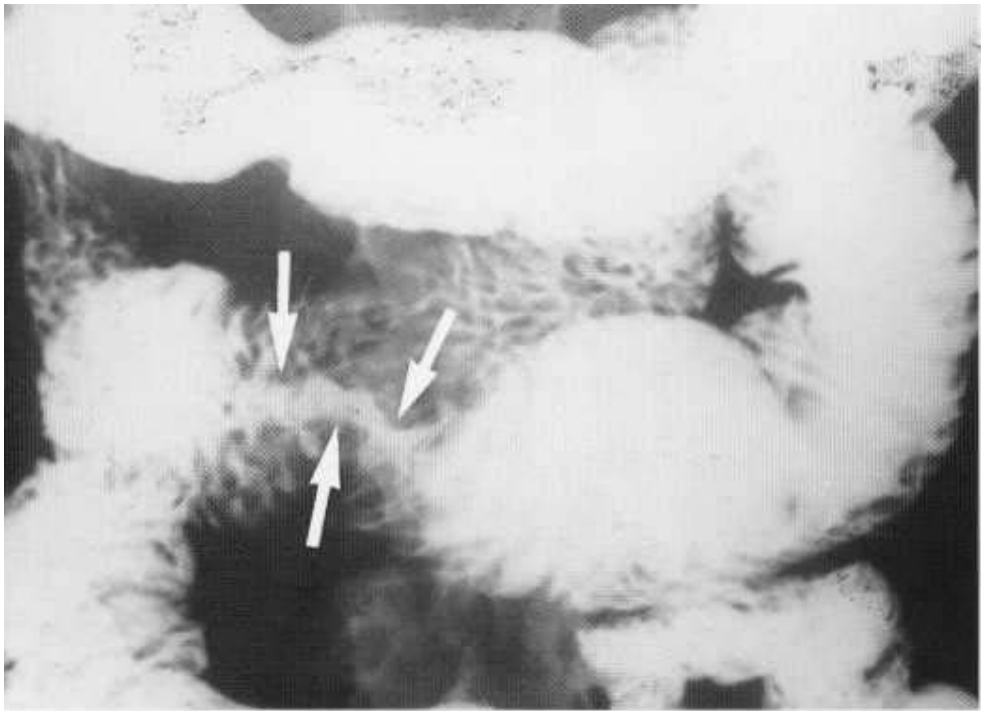

Fig (2.23): Small bowel adenocarcinoma (between arrows) (Sutton,2003)

Table (2.1) Contrast Enhanced Examinations (ACR committee on drugs and contrast media 2013)

Type of Exam	Contrast media used	Type of contrast media
Bariumstudies	Bariumsulfate	Powder
IVU	Omnipaque	Non-ionic water soluble
Angiography	Omnipaque	Non-ionic water soluble
Venography	Omnipaque	Non-ionic water soluble
HSG	Omnipaque	Non-ionic water soluble
CholecystogramOral	Biloptin	Tabs
Urethrogram	Omnipaque	Non-ionic water soluble
Cystogram	Omnipaque	Non-ionic water soluble
Retrograde pyelography	Omnipaque	Non-ionic water soluble
Antigrade pyelography	Omnipaque	Non-ionic water soluble
PTC	Omnipaque	Non-ionic water soluble
ERCP	Omnipaque	Non-ionic water soluble
Vesiclography	Omnipaque	Non-ionic water soluble
Saliography	Omnipaque	Non-ionic water soluble
Lymphography	Lipodol	Oily contrast media
Bronchography	Dylosine	Oily contrast media
Myologram	Myodile	Oily contrast media
T-Tube cholecystogram	Omnipaque	Non-ionic water soluble
Nephrostogram	Omnipaque	Non-ionic water soluble
Sinogram	Omnipaque	Non-ionic water soluble
Fistulogram	Omnipaque	Non-ionic water soluble
MCUG	Omnipaque	Non-ionic water soluble

2.3 Barium Studies:

Barium studies are used to diagnose abnormalities of the gastrointestinal tract. Studies consist of: barium swallow, upper GI series (barium meal,), small bowel series and lower GI series (barium enema).

The alimentary canal has a thin-walled and does not have sufficient density to be demonstrated through the surrounding structures, its radiographic demonstration requires the use of an artificial contrast medium. Barium sulfate, which is a water-insoluble salt of the metallic element barium, is the contrast medium universally used in examinations of alimentary canal. Barium sulfate is available as either a dry powder or a liquid. The powdered barium has different concentrations and is mixed with plain water. The concentration depends on the part to be examined and the preference of the physician.

The alimentary canal is usually examined using a combination of fluoroscopy and radiography. Fluoroscopy makes it possible to observe canal in motion, perform special mucosal studies, and determine the subsequent procedure required for a complete examination. Images are obtained, as indicated, during and after the fluoroscopic examination to provide a permanent record of the findings (Ballinger and Frank 2003).

2.3.1Barium Swallow (Esophagram):

Esophagram is a common radiographic examination of the pharynx and esophagus, utilizing a radiopaque contrast medium. The purpose of an esophagram is to study radiographically the form and function of the swallowing aspects of the pharynx and esophagus.

Because the esophagus is empty most of the time the patients need no preparation for an esophagram. The patient is positioned on an examination table and images are obtained during and after the ingestion of barium sulphate. The views are taken in the different projections depending on the indication of

the examination. The contrast medium filled esophagus should be demonstrated from the lower part of the neck to the esophagastric junction, where the esophagus joins the stomach (Bontrager and Lampignano2001).

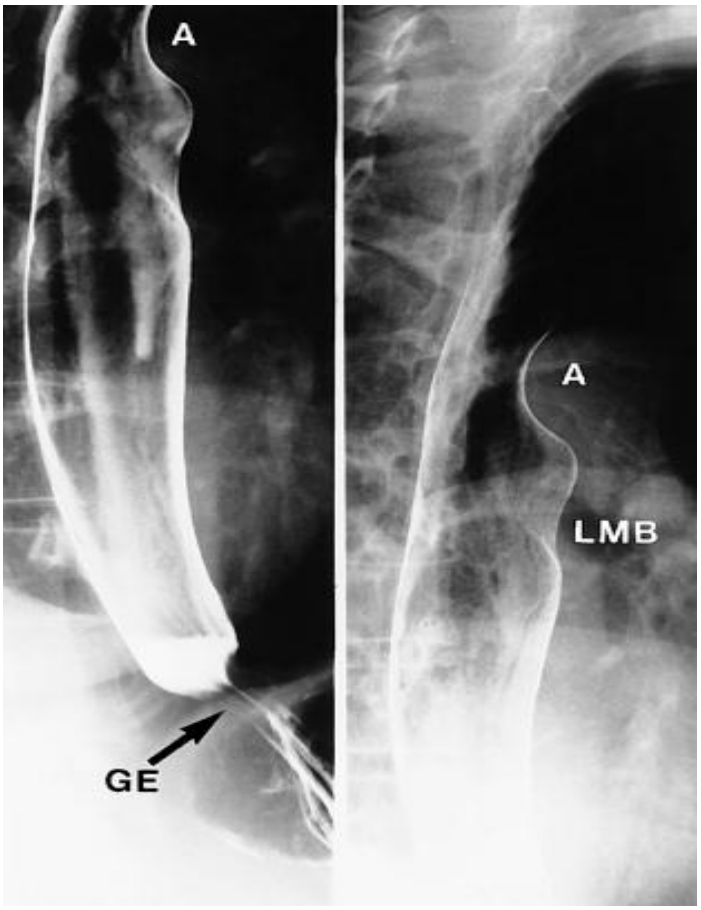

Fig (2.24): Barium swallow, showed the normal indentations of the esophagus

(Mettler, 2005)

2.3.2 Upper Gastrointestinal (GI) Series:

Upper GI radiographs are used to evaluate the distal esophagus, stomach, and some or all of the small intestine. The patient should be NPM (Non PerOs, meaning nothing by mouth) from midnight until time of examination. Foods and fluids should be withheldfor at least 8 hours prior to the exam, and also should not smoke cigarette or chew gum during the NPM period, because this activities

tend to increase gastric secretions and salivation, which prevents proper coating of the barium to the gastric mucosa. A barium meal usually takes less than hour. There are two varieties of barium meal: single and double contrast meals. A single contrast uses only barium where as a double contrast uses barium as well as negative contrast medium such as air, nitrogen, or carbon dioxide. The double contrast meal is more useful as a diagnostic test, demonstrating mucosal details (Bontrager and Lampignano 2001).

Fig (2.25): Stomach on double-contrast barium meal, in supine position(Butler et al. 2007)

2.3.3 SmallBowel Series:

Small bowel series is a radiographic study specifically of the small intestine. The upper GIand small bowl series are most often combined. Under these

circumstances the small bowel portion of the exam may call a small bowel follow-through. The patient should fast at least 8 hours prior to the exam. Radiographs are taken at set intervals as the contrast moves through intestine. The test is completed when the barium reaches the ileocecal valve. The small intestine may also be studied radiographically by enteroclysis, which accomplished by introducing an intestinal tube via the patient mouth through the esophagus and the stomach to reach the end of the duodenum, then both positive and negative contrast media directly injected in the small bowel. This procedure gives better visualization of the small bowel than barium follow-through, but intubation may be unpleasant for the patient and also it is a higher radiation dose to the patient (Bontrager and Lampignano 2001).

Fig (2.26): Small intestine on barium follow-through study

(Butler et al. 2007)

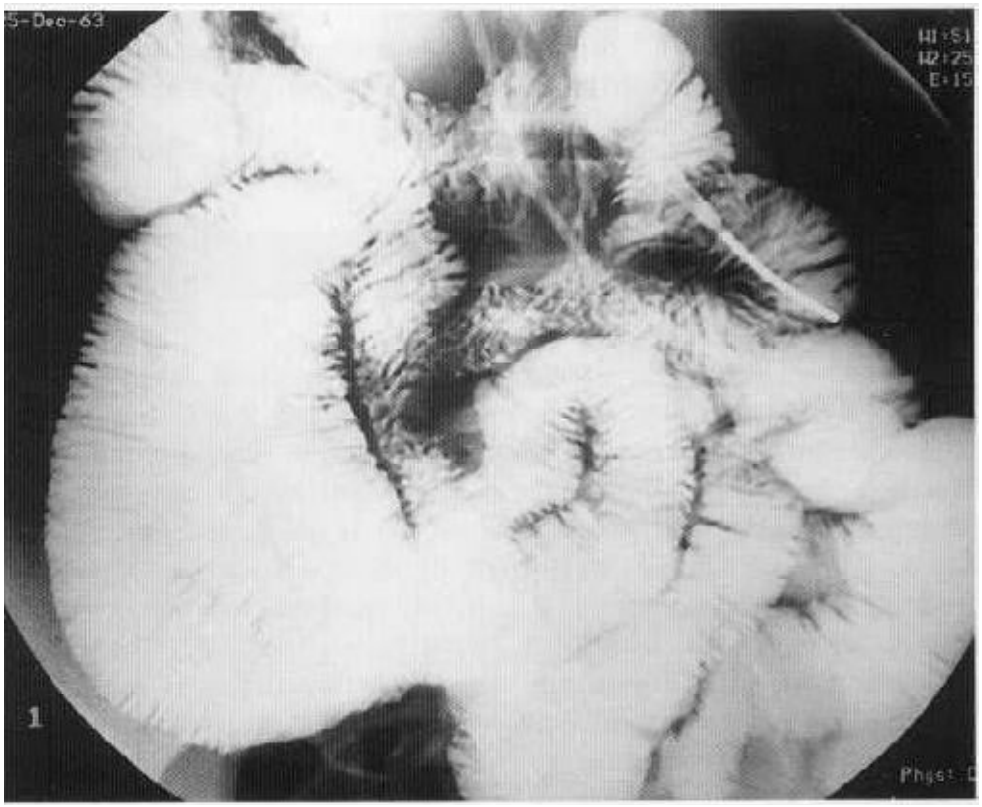

Fig (2.27): Small-bowel enema (enteroclysis) (Sutton, 2003)

2.3.4 Barium Enema (Lower GI Series):

Barium enema is a radiographic study of the large intestine. Both the single-contrast and double-contrast barium enema include a study of entire large intestine. To prevent obscuring of the image, it is necessary for the large bowel to be emptied of faeces prior to the examination. The patient should drink clear fluids during the preceding day, use a laxative and have nil by mouth for some hours prior to the procedure. The patient is positioned on an examination table and the barium liquid introduced per rectum via an enema tube. During double contrast imaging, the colon is also inflated with air through the same rectal tube with a small hand pump. The patient is usually asked to move to different positions and the table is slightly tipped to get different views (Ballinger and Frank 2003).

Fig (2.28): Normal single-contrast Barium Enema (Mettler,2005)

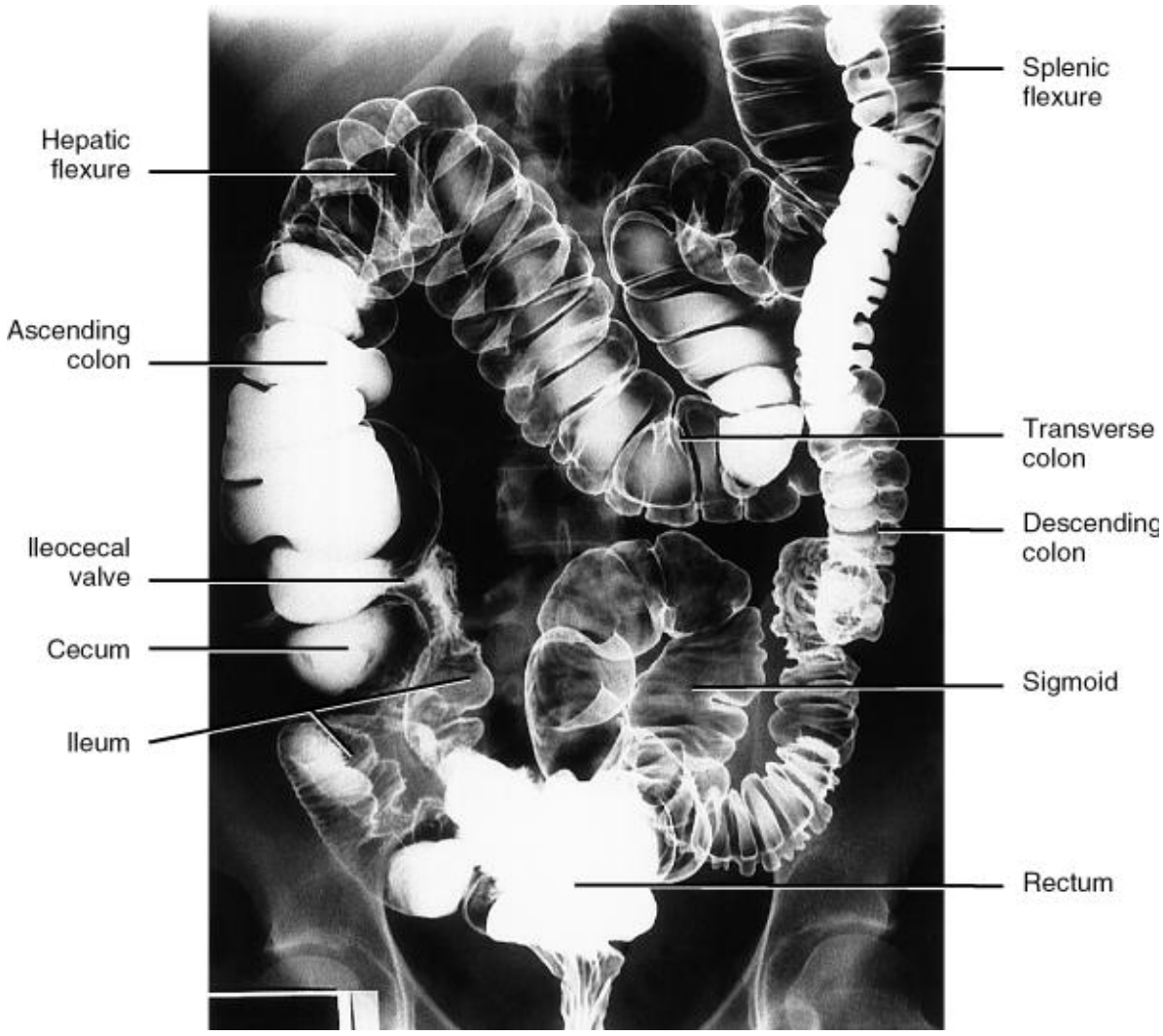

Fig (2.29): Normal double-contrast barium Enema (Mettler,2005)

2.4.5 Contraindications of Barium Studies:

Hypersensitivity to barium or any component of the formulation, suspected colonic obstruction because of risk of dehydration of barium and secondary colonic impaction, suspected GI tract perforation, suspected tracheoesophageal fistula (TOF), and toxic mega colon (Chung et al. 2002).

2.4.6 Water-Soluble Studies:

Water-soluble contrast is an ultranative to the barium, when the barium suspensions are contraindicated .There are essentially two choices, which will

be determine by the clinical situation. Ionic agent such as gastrographine is widely used and generally safe (unless there is a possibility of pulmonary aspiration). Non-ionic agents such as iohexol suffer less from dilution and provide better radiographic contrast (Sutton, 2003).

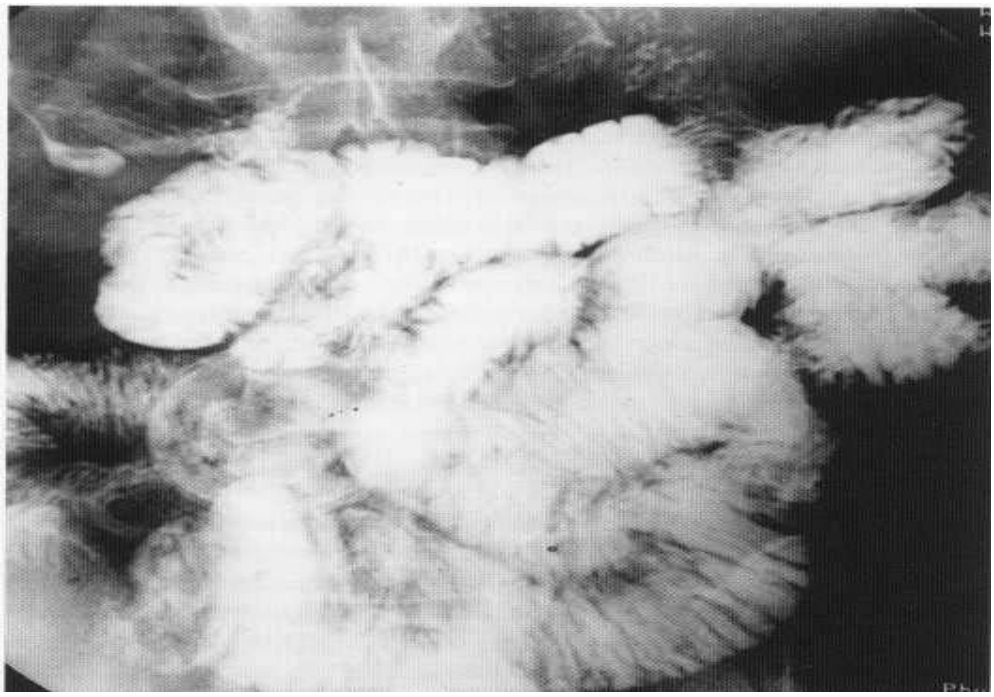

Fig (2.30): Non-ionic, water-soluble follow-through in post-operative patient (Sutton, 2003)

2.5 Other Modalities:

2.5.1. Endoscopy:

There are many types of endoscopy that are used to diagnose or monitor some digestive problem such as: nausea, vomiting, dysphagia, abdominal pain, and GIT bleeding (Snell,2004).

2.5.1.1 Upper Gastrointestinal Endoscopy:

Upper gastrointestinal endoscopy, also called esophagogastroduodenoscopy (EGD) is the direct visualization of the mucous membrane of the oropharynx, esophagus, stomach, and proximal duodenum, with real time assessment and interpretations of the findings encountered through an illuminated tube fittedwith a lens system. It is possible to perform mucosal biopsy(Snell,2004).

2.5.1.2 Wireless Video Endoscopy:

Wireless video endoscopy or video capsule endoscopy (VCE) is a noninvasive technology designed primarily to provide diagnostic imaging of the small intestine, an anatomic site that has proven peculiarly difficult to visualize. Limited views to excellent resolution, and higher magnifications than that of conventional endoscopy. The capsule moves passively and, does not inflate the bowel, and images the mucosa in the collapsed state. More recently, double-ended wireless video capsules have been developed for the examination of the esophagus and colon (Gong et al. 2000).

2.5.1.3Colonoscopy:

Colonoscopy is the direct visualization of the mucous membrane of the colon through an elongated flexible tube, or endoscope. The patient is sedated, and the tube is gently inserted into the anal canal. The interior of the large bowel can be observed from the anus to the cecum. The procedure generally takes between 20 minutes and one hour(Snell, 2004).

2.5.1.4 Sigmoidoscopy:

The sigmoid colon lies only a short distance from the anus, so that it is possible to examine the mucus membrane under direct vision. A flexible tube fitted with lenses and illuminated internally is introduced through the anus and carefully passed up through the anal canal, rectum, sigmoid colon, and descending colon. Sigmoidoscopy can be carried out without an anesthetic in an outpatient clinic.

Biopsy specimens of the mucus membrane can be obtained through this instrument(Snell, 2004).

2.5.1.5 Complications and Contraindications of Endoscopy:

Endoscopy is a safe procedure and complications are rare but can occur. Complications may occur including: bleeding from biopsies and removal polyps, complications due to sedation, and endoscope can cause perforation, tear or hole in the viscus.

The contraindications of endoscopy include the inability of patient to cooperate with the procedure, an inability to obtain informed consent, or the presence of a known or suspected perforatedviscus(Eisen andBaron2002).

2.5.2 Computed Tomography (CT):

CT is an excellent modality used to demonstrate tumorsof the GI tract. With the use of dilutedoral contrast media, CT can demonstrate diverticula, and hiatal hernia. CT has become the modality of choice to demonstrate trauma to the GI tract and accessory organs (Bontrager and Lampignano2001).

2.5.2.1 CTEnterography:

CT enterography is an ultranative to enteroclysis that does not require placement of a nasogastric tube for contrast administration; it is better tolerated by patients. It involves ingestion of a neutral contrast agent to distend the small bowel, followed by CT imaging of the abdomen. Using of neutral contrast agent allows for better evaluations of the wall of the small bowel, which is difficult to see when standard barium solutions are used (Fletcher, 2009).

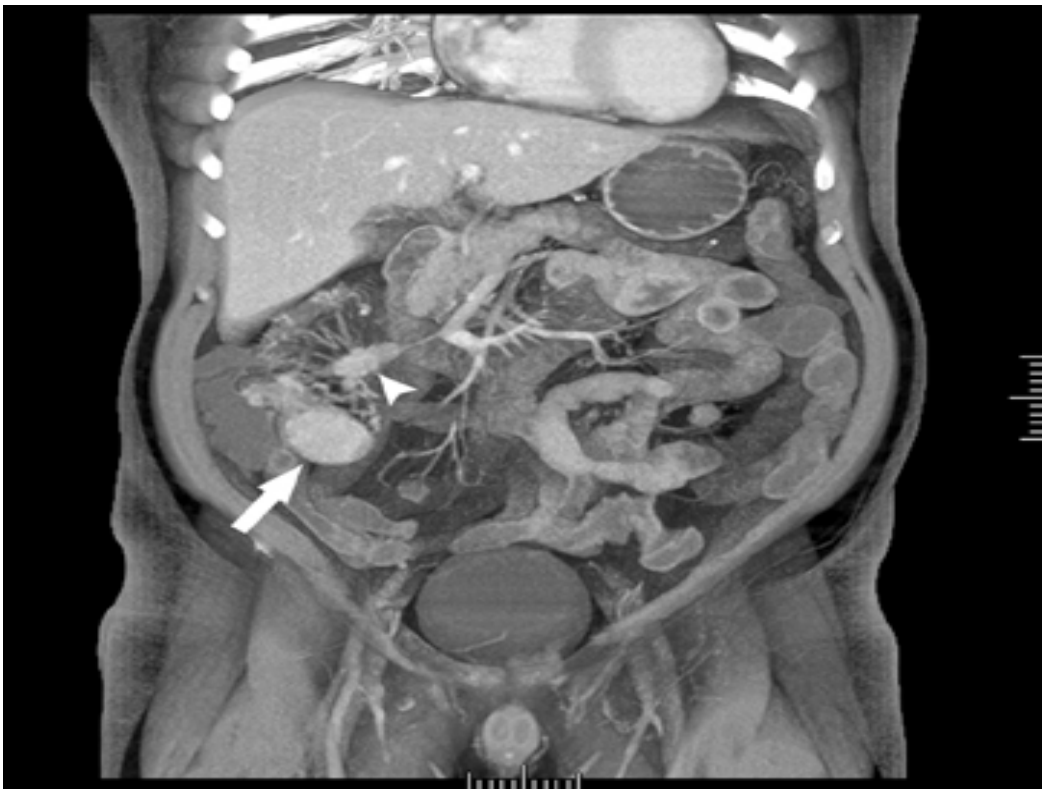

Fig (2.31): Volume- rendered image from a CT enterography (Fletcher, 2009)

2.5.2.2 Virtual Colonoscopy(VC): Virtual colonography also called virtual colonoscopy or CT colonography, is a medical imaging procedure which uses the computed tomography to produce two- and three-dimensional images of colon. The procedure takes 15 minutes. The colon is filled with carbon dioxide or air with tube introduced into the rectum. The patient is asked to roll over into several different positions. Then CT scans are acquired in both prone and supine positions and images of the colon are obtained (Mulhall et al. 2005).

2.5.2.2.1 Advantages and Disadvantages of Virtual Colonography (VC):

VC is more comfortable than conventional colonoscopy because it does not use a colon scope. As a result no sedation is needed. VC provides clearer, more detailed images than lower GI series (barium enema). It also takes less time than

either a conventional colonoscopy or a lower GI series.The main disadvantages of VC the radiologist cannot take biopsy or remove polyp during procedure, so a conventional colonoscopy must be performed if abnormalities are found. Also VC does not show as much detail as a conventional colonoscopy, so polyps smaller than between 2 and 10 millimeters in diameter may be missed on the image. Furthermore, virtual colonoscopy performed with CT exposes the patient to ionizing radiation (Mulhall et al. 2005).

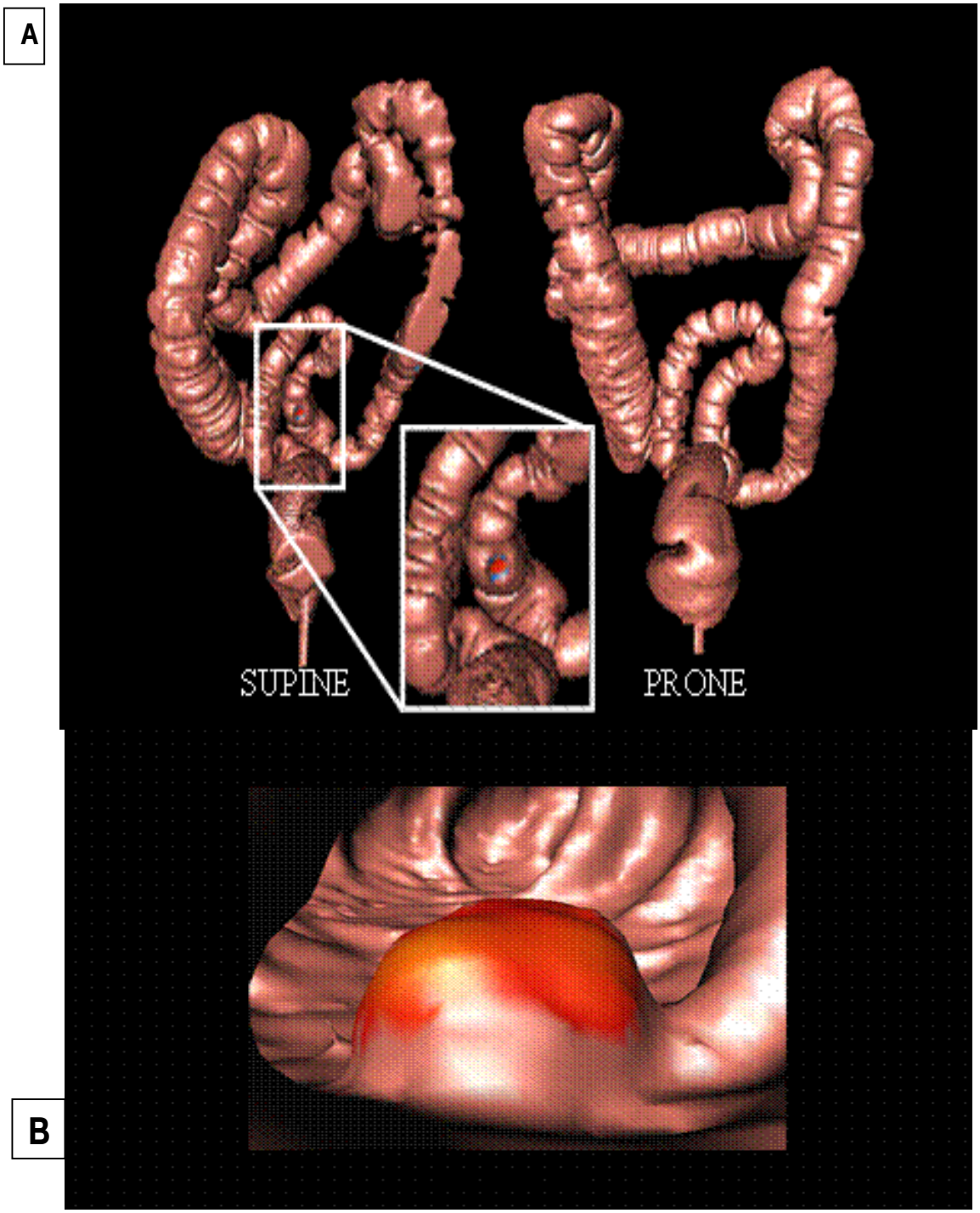

Fig (2.32): (A) Computerized tomographic colonography (CTC), (B) The red color area indicated a polyp, Images inside the colon (Mulhallet al. 2005)

2.5.3 Magnetic Resonance Imaging (MRI):

Although MRI is not the gold standard for imaging of the GI tract, it has been used in limited applications. MRI cannot detect mucosal lesions, but it can demonstrate primary tumors of the bowel and adjacent structure. It can assist with the planning for surgical excision of these tumors. Abscesses in the mesentery or retroperitoneum can be easily demonstrated on T2 MRI (Bontrager and Lampignano 2001).

2.5.4 Nuclear Medicine:

A number of nuclear-medicine procedures can be performed for various GI conditions and diseases. The use of radionuclide imaging can assist in the diagnosis of GI bleeding, gastric emptying studies, bowel motility studies, Michel's diverticulum, and esophageal reflux (Bontrager and Lampignano 2001).

2.5.5 Sonography (Ultrasound):

Intraesophagealsonography for esophageal varices and carcinoma of the esophagus is becoming an ultranative to the esophagram. A filled urinary bladder provides an acoustic window to study structures and regions that surround the large intestine. Ultrasound with graded compression may be useful for diagnosis appendicitis (Bontrager and Lampignano 2001).

2.5.6 Manometry:

Manometry refers to evaluation of pressure, including esophageal motility study, and anorectalmanometry.

Esophageal motility study (EMS) or esophageal manometry is a test to assess motor function of the upper esophageal sphincter (UES), esophageal body, and lower esophageal sphincter. The EMS is done to evaluate suspected disorder of

motility peristalsis of the esophagus such as achalasia, diffuse esophageal spasm, nutcraker esophagus, and hypertensive lower esophageal sphincter. Anorectalmanometry is a technique used to measure contractility in the anus and rectum. This technique uses a balloon in the rectum to distend the rectum and a pressure sensor at the internal anal sphincter to measure the presence or absence of therectosphincteric reflux. It may be used to assist in the diagnosis of hirschsprung disease.Gastric manometry is a test measures electrical and muscular activity in the stomach, through a thin tube passes down from patient's throat into the stomach. This tube contains a wire that takes measurements of electrical and muscular activity of the stomach as it digests foods and liquids(http://en.wikipedia.org/wiki/Manometry).

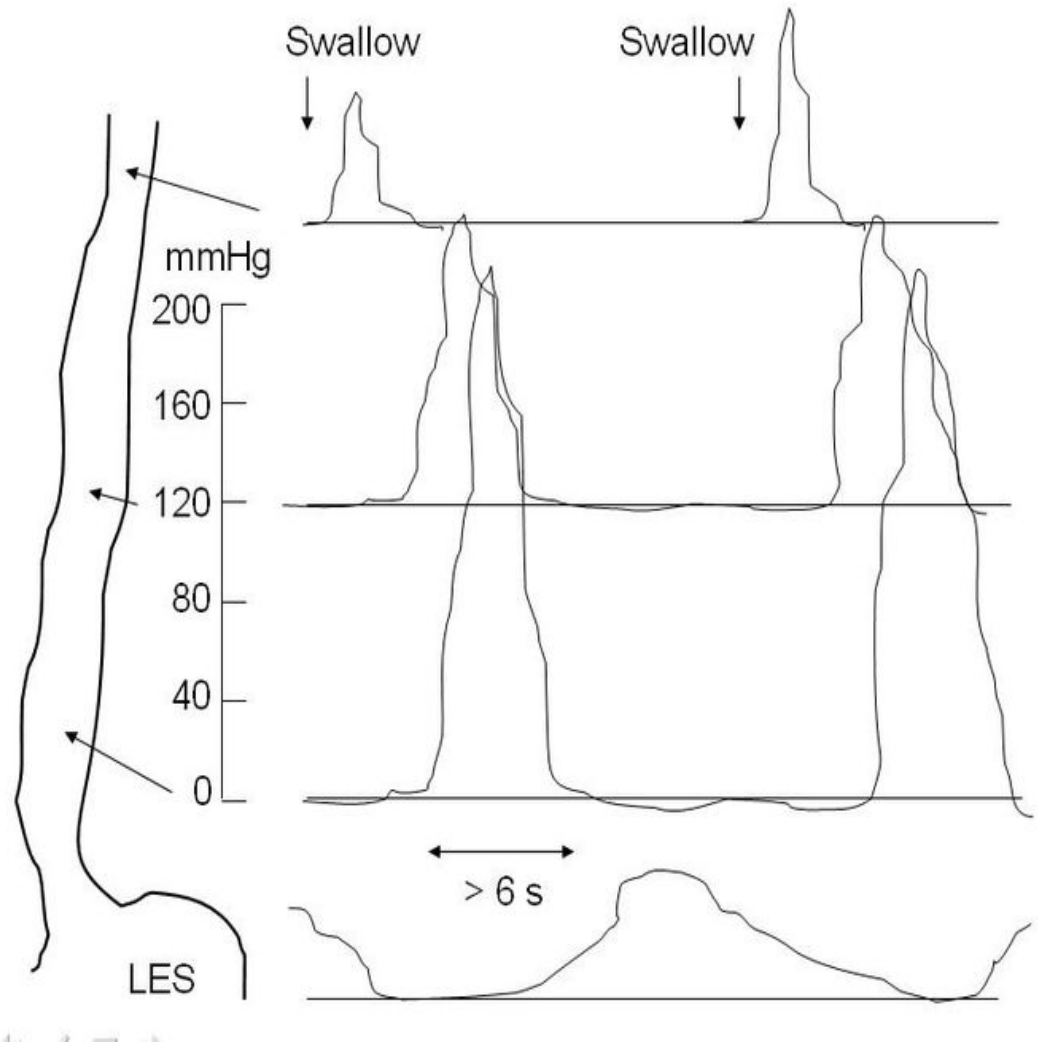

Fig (2.33): Diagram of esophageal study motility study for nutcracker (http://en.wikipedia.org/er esophagus)

2.6 Previous Studies:

A study was conducted in November-2008 by David J. DiSantis, evaluating current usage of gastrointestinal studies, revealed that the volumes of barium enema and upper gastrointestinal studies suffered a steep drop, but the numbers of esophagograms and swallowing studies actually increased.

Another study was published in January- 2009 by Marc. S. Levine et al, on the role of barium studies in modern radiology; revealed that the role of the barium studies has been progressively declining in modern radiology practice. The overall barium studies performed in the United States decreased from 5416000 studies in 2001 to 4481000 in 2005 with largest decrease in the number of barium enema and upper GI examinations. The barium studies have been replaced to a large degree by a myriad of competing endoscopic and imaging test. Endoscopy, manometry, and 24-hour esophageal pH monitoring are some of the diagnostic procedures that have supplanted barium esophagography for evaluating patients with dysphagia or reflux symptoms. Other patients with epigastric pain or dyspepsia are diagnosed by endoscopy rather than a double-contrast upper GI study. The dedicated small bowel follow-through has been replaced to a lesser degree by abdominal CT, and more recently, by CT and MRI enetrography and capsule endoscopy. The double-contrast barium enema has increasingly been discarded in favor of colonoscopy, abdominal CT, and most recently, CT colonogarphy for lower GIT symptoms and colon cancer screening.

(Marc. S. Levine, and Igor Laufer, 1993)also conducted a study on The Upper Gastrointestinal Series.They concluded that surveys of radiology departments have shown a gradual decline in the total number of upper gastrointestinal studies done annually in the past decade. Patients with abdominal symptoms have been examined with increasing frequency with cross-sectional imaging

techniques such as sonography, CT and MRI imaging. The major factor in the declining number of fluoroscopic examinations is the increasing use of endoscopy as the first diagnostic test in patients with suspected disease of upper gastrointestinal tract.

The volume of gastrointestinal fluoroscopy continues to decline. This decline has been accelerated by technologic advances in cross-sectional imaging. With advances in CT colonography and increased utilizations of endoscopy, the screening barium enema has seen the most precipitous decline. Fluoroscopic studies are used more for problem-solving situations than for primary screening. Patients referred to fluoroscopy tend to be more debilitated, less mobile, limited in their ability to be cooperate, morbidly obese, and postoperative. Several specific areas of fluoroscopic imaging including, esophagocography, modified barium swallow studies, proctography, and evaluation of postoperative patient have increased in relationship with other fluoroscopic procedures. In postoperative patient it provides a quick and cost–effective means to asses postoperative leaks. (Benjamin M. Yeh and, Laura R. Carucci, 2011)

Gelfand and Ott,in June-1987, also performed a survey of the volume of gastrointestinal fluoroscopies at 18 hospitals, which suggested a decline in number of these examinations performed over the past five years. Data were acquired on three types of examinations: upper gastrointestinal series, small bowel studies, and barium enemas. Modest decreases of 8.4%, 10.3%, and 2.0% were noted in the numbers of upper GI examinations, small bowel examinations, and barium enemas, respectively.

Chapter three

Methodology

Chapter Three

Materials and Methods

3.1 Study Design:

This study adopts the analytical descriptive design.

3.2 Study Area:

The study was conducted at Radiology departments at Military hospital, Fideel Hospital, Alnileen Medical Center and Modern Medical Centre.

3.3 Study Duration:

This study was conducted in the period of 9 months from March 2013 to December 2013.

3.4 Study Population:

3.4.1 Inclusion Criteria: A random sample which was 400 patients; males and females of different ages within the period of the study whohad been examined by different types of GIT contrast examinations.

3.4.2Exclusion Criteria: Patients that didn't undergo conventional contrast enhanced studies.

3.5 Machines Used:

- Digital fluoroscopy, Shimatzu flex vision, with 150 Kvp, 800 mAsatFideel Hospital.
- Digital fluoroscopy, Toshiba, with 150 Kvp, 1000 mAsatMilitiray Hospital,

- Computed radiography, Shimatzu, 150 Kvp, 110 mASat Alnileen Medical Centre.

3.6Techniques Used:

3.6.1 Barium Swallow:

The patient didn't need a preparation, thick barium contrast medium was used, but in certain cases water soluble contrast (Omnipaque) had been used. The patient position was recumbent or erect, center ray to center of cassette at level of T5 or T6 (in conventional x-ray machine),in fluoroscopy the esophagus was divided in to two parts upper and lower due to limitation of field of view.Views which were taken: antroposterior (AP), right anterior oblique (RAO) and lateral. Breathing technique: the patient suspended respiration and exposed on expiration.

3.6.2 Barium Meal:

The patient had been fasted 8 hours prior to the exam, thin barium contrast was used.The patient position was supine, and the central ray for the stomach and duodenum at the midway between xiphoid process and the lower ribs margin (L1-L2).Views are taken: supine, right lateral, right anterior oblique (RAO), prone, and left posterior oblique (LPO).

Breathing technique: respiration was suspended and exposed on expiration.

3.6.3. Barium Follow-through:

Thepatient had been fasted 8 hours prior to the exam, thin barium contrast medium was used, the patient position was prone and radiographswere taken: routine upper GIT, 30 minute posteroanterior (PA) radiograph, half-hour interval radiographs until barium reaches large bowel (usually 2 hours).

3.6.4 Barium Enema:

Patient preparation: The patient needed to bowel preparation and had been fasted for some hours prior to the exam, contrast was used either single-contrast or double-contrast (barium + air),the patient position was lateral to introduce catheter, then lied in supine position in single-contrast but in double contrast radiograph was taken in the right lateral decubitus position .The patient was asked to rotate several time to distribute the barium and air better with the double- contrast procedure , radiographs were taken: plain film, PA film, Right or Left decubitus, PA post evacuative radiograph.

3.7 Data Collection:

As in this study data about different types of contrast examinations was collected from the request forms and reports of patients with normal and abnormal results, and was putted in a data collecting sheet. Also the study evaluated the numbers of staff (technologists, radiologists, and nurses), equipments (Ultrasound, CT, MRI, fluoroscopy and conventional) and protecting shields in the radiology departments of the study centers.

3.8 Data Collection Tool:

- Data collection sheet was used to collect study sample.
- Radiology contrast enhanced investigations, requests and reports.

3.9 Data Analysis:

- Data was analyzed using SPSS program; relations were demonstrated in Pie Graphs, Tables, histograms and Bar Graphs.

Chapter Four:

The results

Chapter Four

4.1 Results:-

400 patients in different ages were diagnosed using different types of conventional contrast enhanced studies, e.g. Barium Studies, HSG, IVU…etc. The data were collected from request forms of patients and from the radiology reports, as different variables of this study and were analyzed using SPSS. Frequency tables, charts and cross tabulation between some variables wereperformedas presented below.

Table (4.1): Gender of patient

Gender	Frequency	Percent
Male	214	53.5%
Female	186	46.5%
Total	400	100%

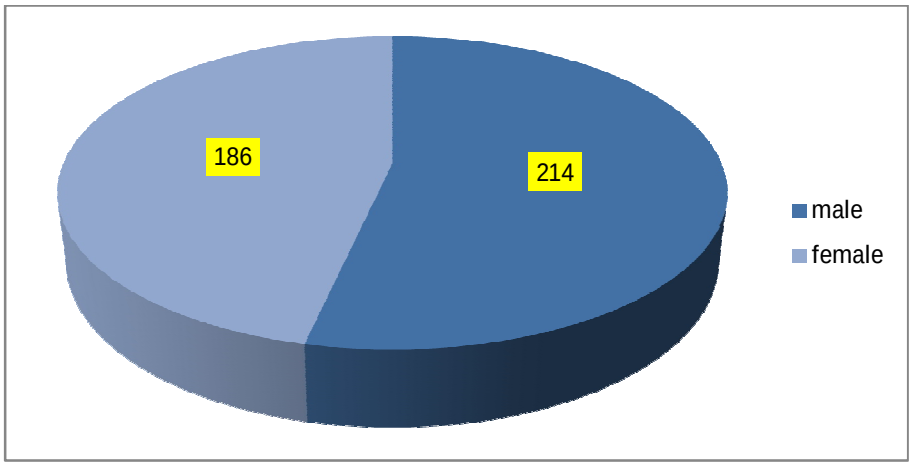

Fig (4.1): gender of patient

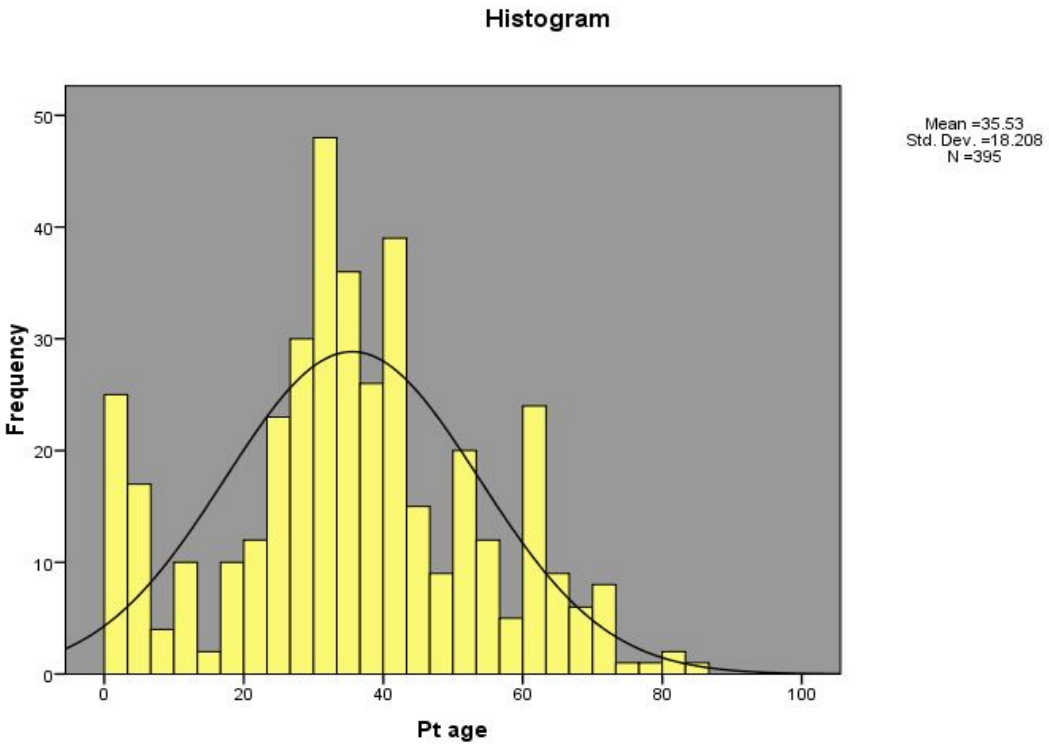

Fig (4.2): Patients age

Table (4.2): Different types of contrast examinations

Contrast studies	Frequencies	Percent
Barium Studies	116	29%
IVU	110	27.5%
HSG	93	23.2%
Urethrogram	38	9.5%
Cystogram	4	1.0%
T-Tube Cholesystogram	6	1.5%
MCUG	18	4.5%
Fistulogram	10	2.5%
Nephrostogram	3	0.5%
Sinogram	2	0.1%
Total	400	100%

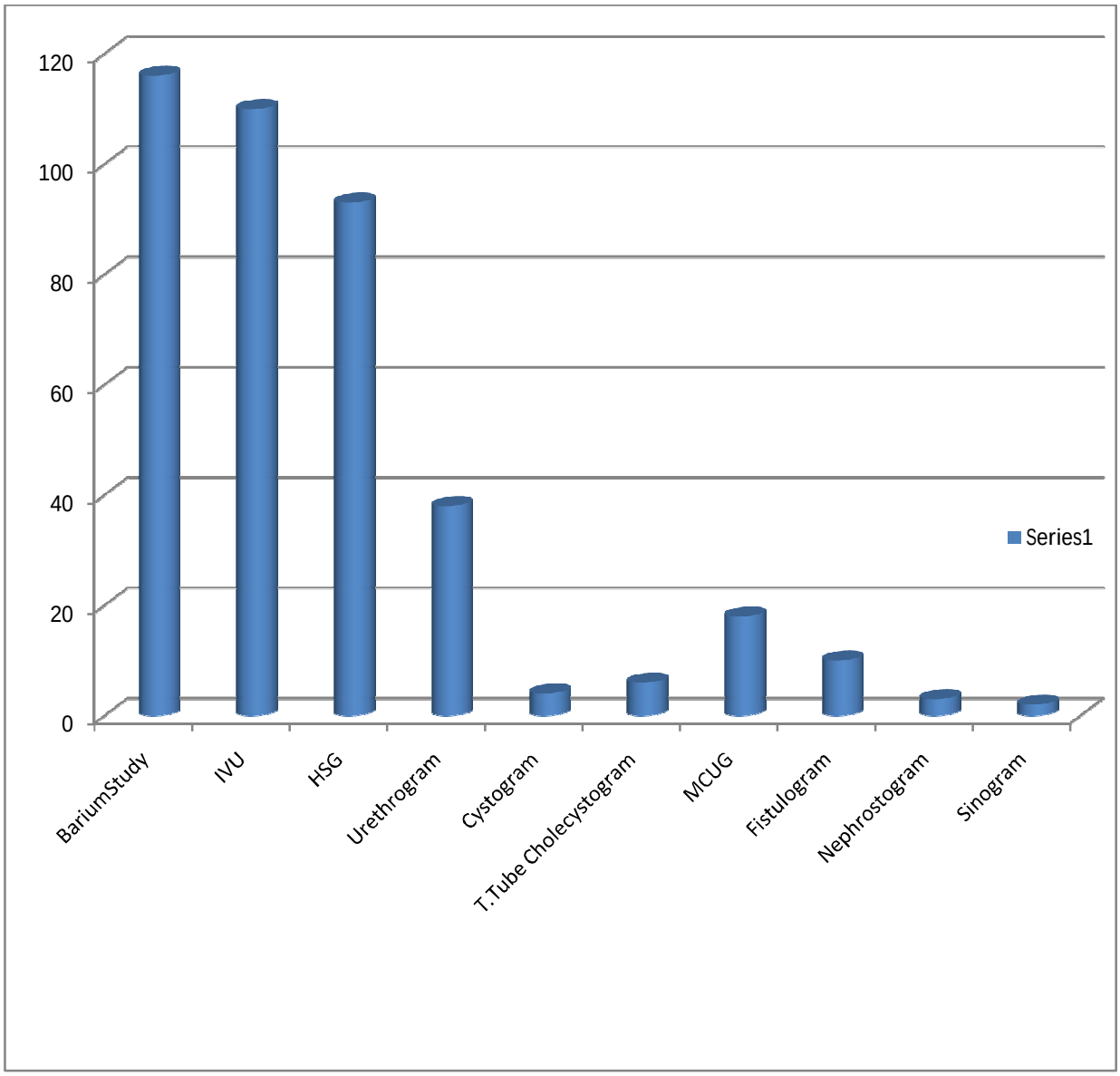

Fig (4.3): Different types ofcontrast examinations

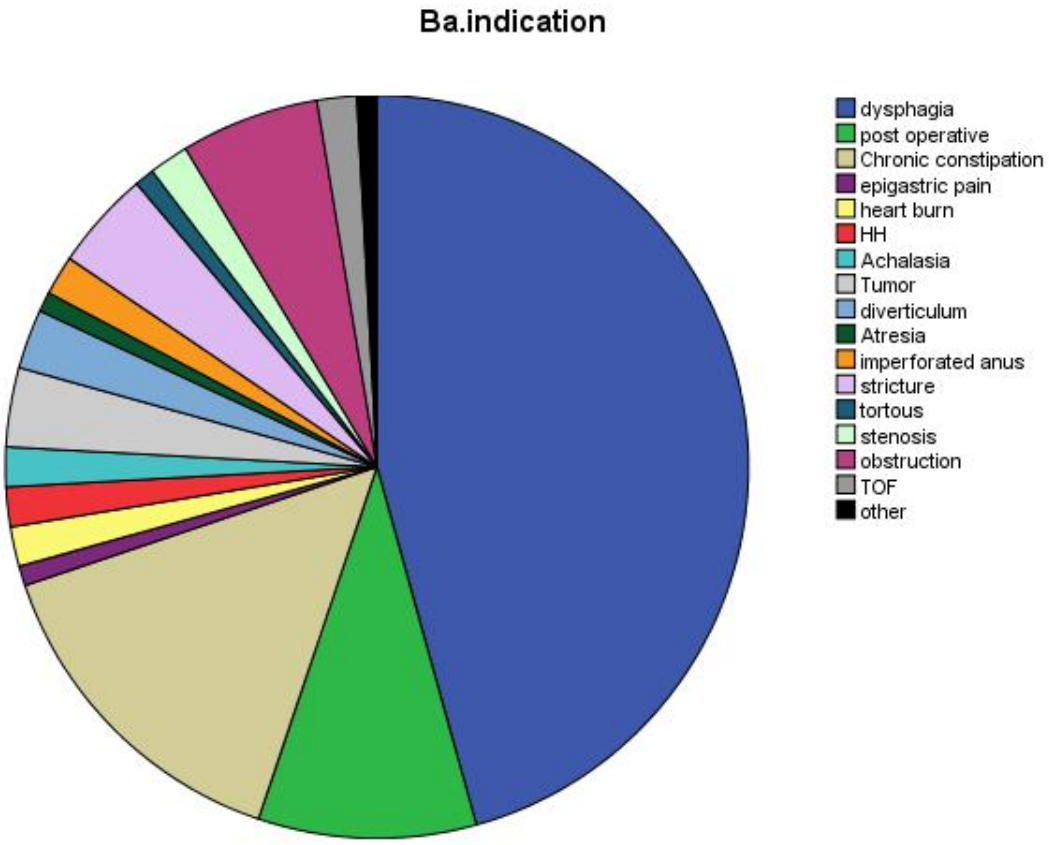

Fig (4.4): Indications of barium studies

Table (4.3): Types of barium studies

Types of Barium	Frequencies	percent
Barium Swallow	64	55.2%
Barium Meal	10	8.6%
Barium Follow-Through	3	2.6%
Barium Enema	39	33.6%
Total	116	100%

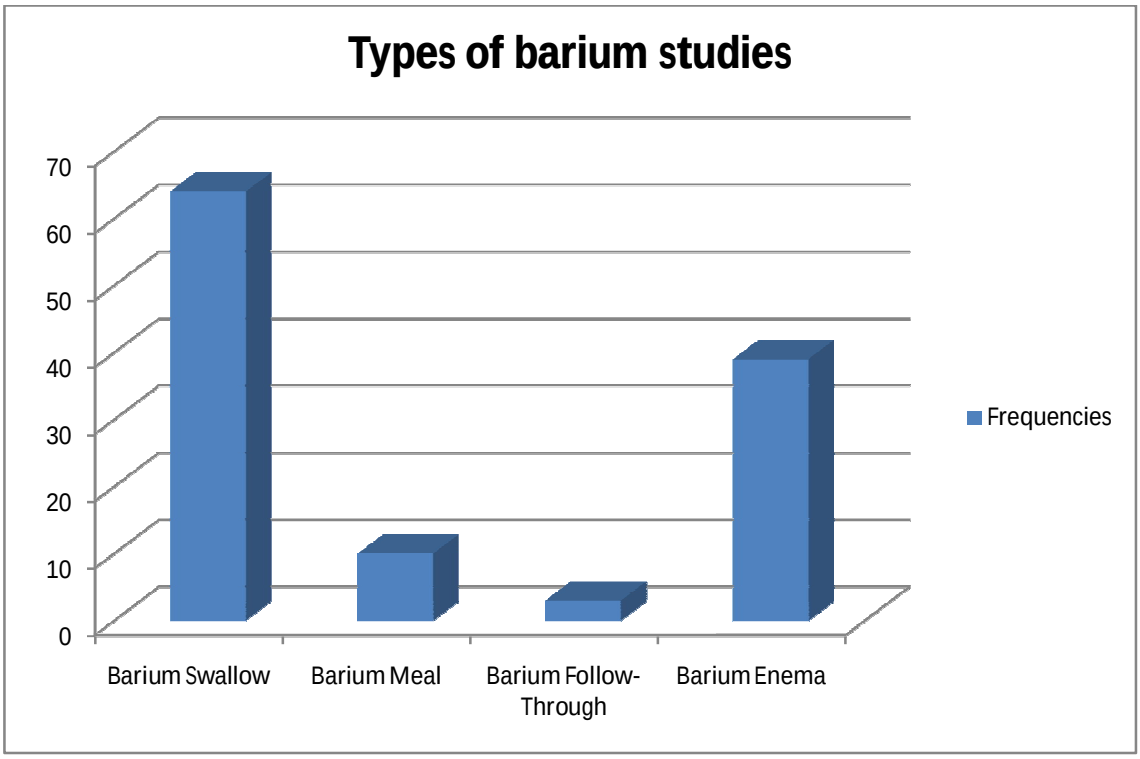

Fig (4.5):Types of barium studies

Table (4.4): Other Investigations before barium studies

Investigations Before Barium	Frequencies	Percent
Yes	5	4.3%
No	93	80.2%
Not found	18	15.5%
Total	116	100%

(**Yes**) Means: There were imaging investigations pre to barium studies

(**No**) Means: There were no investigations done before barium studies

(Not found): Information about previous investigations not available.

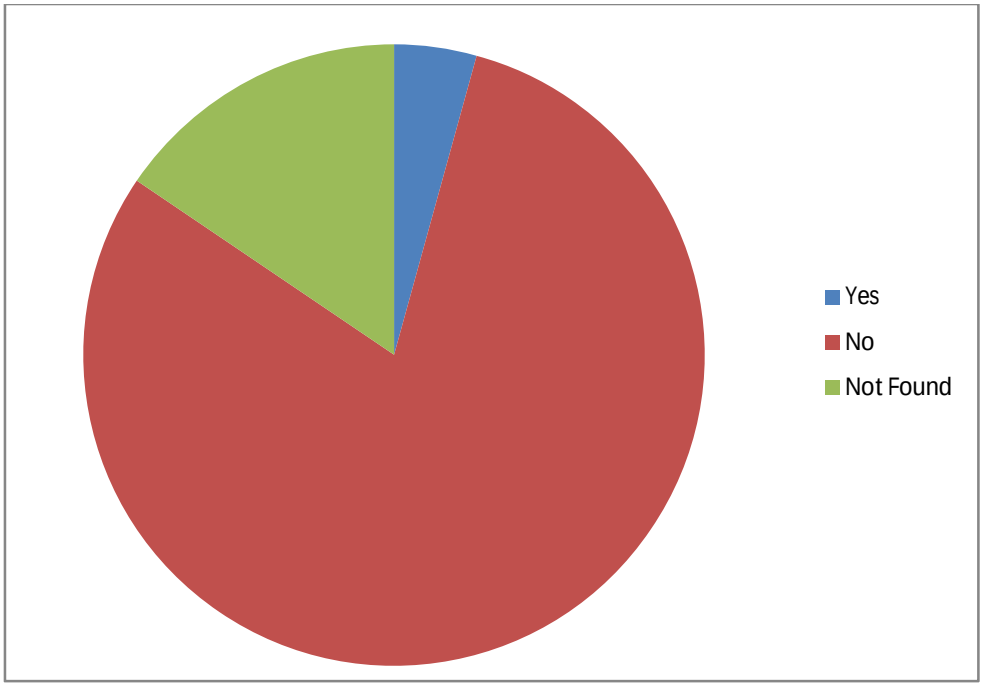

Fig (4.6): Other Investigations before barium studies

Table (4.5): Contrast used In the Alimentary Tract

Contrast	Frequencies	Percent
Barium Sulfate	71	61.2%
Water Soluble	45	38.8%
Total	116	100%

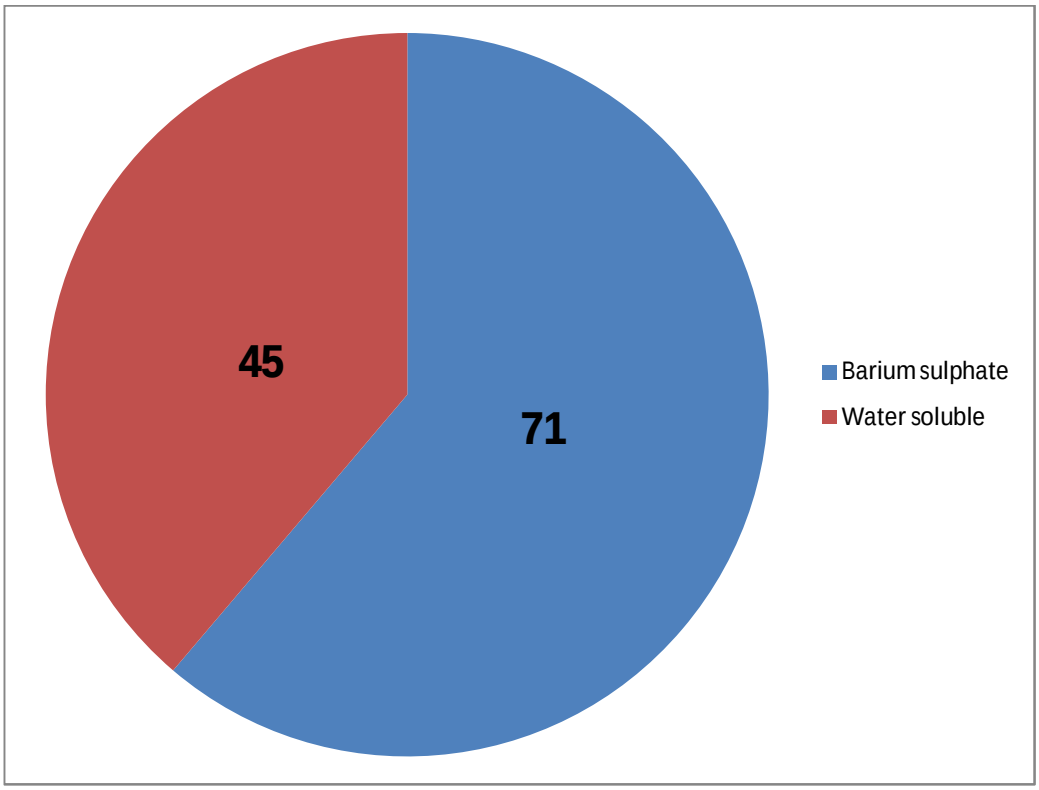

Fig (4.7): Contrast used in the Alimentary Tract

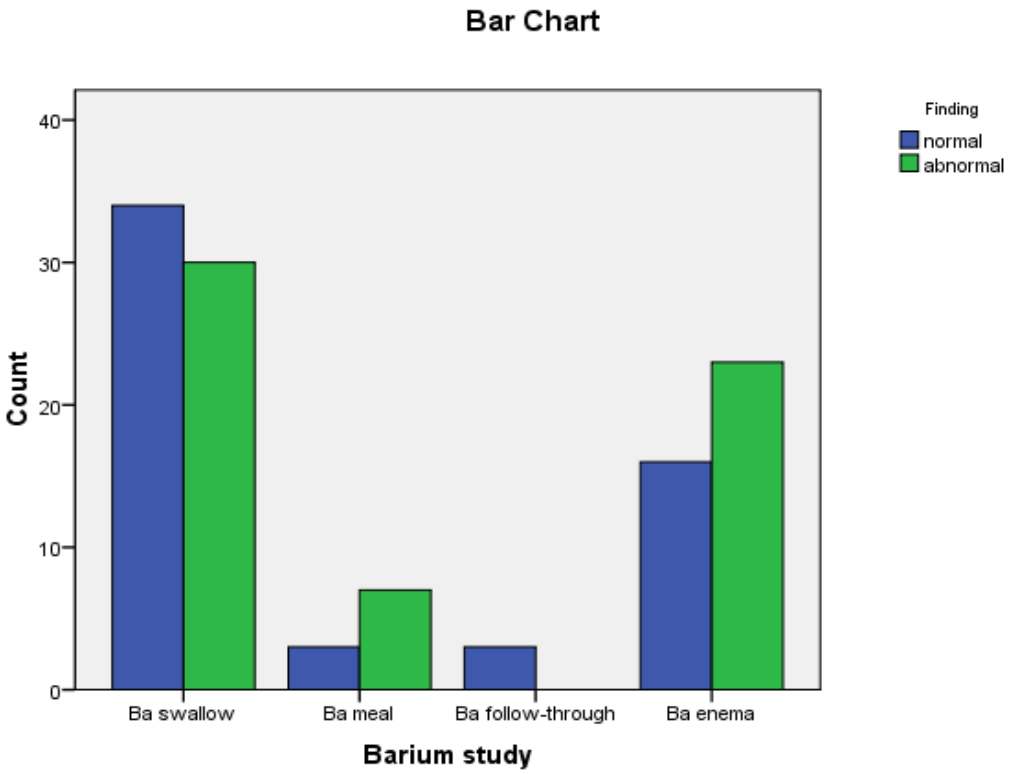

Fig (4.8): Findings of Barium Studies

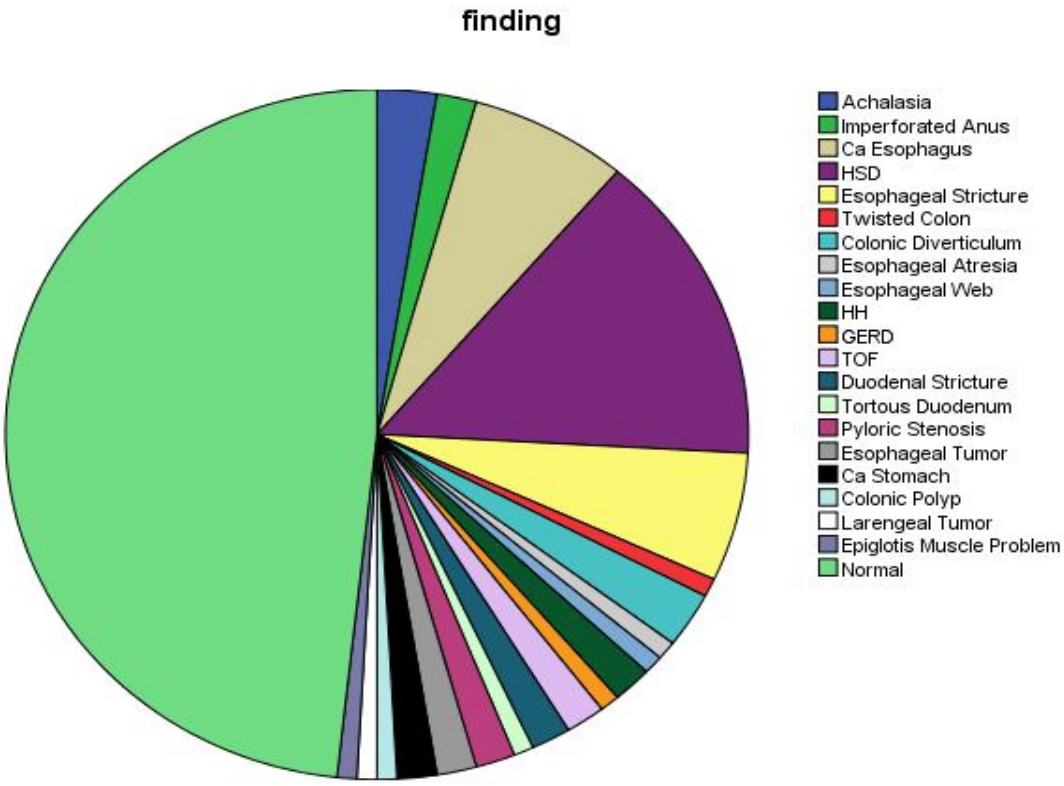

Fig (4.9): Diagnosis of barium studies

Table (4.6): Study centers

Study Centre	Frequencies	Percent
Military Hospital	31	26.7%
Fideel Hospital	59	50.9%
Alnileencentre	13	11.2%
The Modern Medical centre	13	11.2%
Total	116	100%

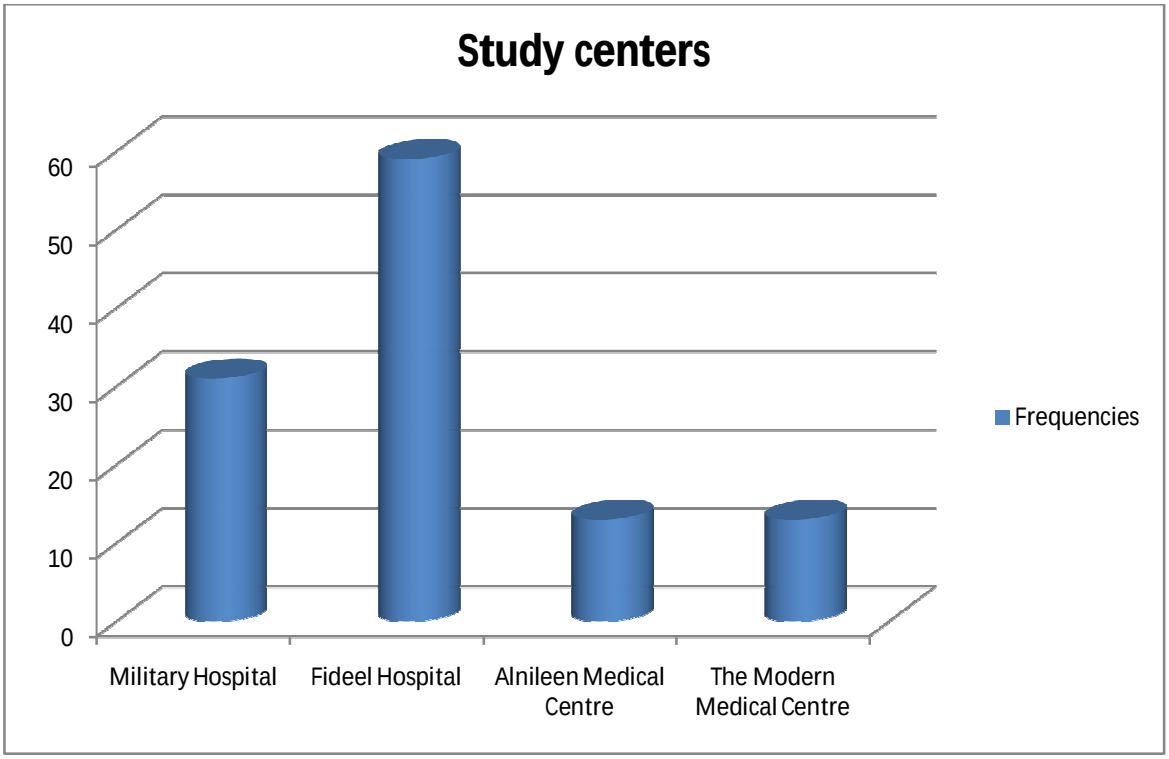

Figure (4.10): Study Centers

Table (4.7): Observed Results: Evaluation of Radiology Departments

Center	**Staff**			**Equipments**					**Protective Tools**	**Who is Doing Barium studies**
	Tech	Radio	Nurse	US	CT	MRI	Fluoro	CR		
Military Hospital	22	2	4	√	√	√	√	2	Apron (5) Glasses(2) Thyroid (2)	Radiologist + Technologist
Fideel Hospital	12	12	2	√	√	√	√	1	Lead Apron(2)	Technologist
Alnileen Centre	8	4	2	√	√	√	x	2	Lead Apron(2)	Technologist
The Modern Medical Centre	6	2	1	√	√	√	x	2	Lead Apron(3)	Technologist

(√) Means: Available

(x) Means: Not available

Table (4.8): The Cost and Time of Alimentary Tract Examinations

Exam	Price of Exam	Time of Exam
Barium swallow	350pounds	15minutes
Barium meal	600pounds	25minutes
Barium follow-through		2-5hours
Barium Enema	600pounds	Half an hour
Water soluble GI Exam	1000pounds	
Upper endoscopy	300pounds	10minutes
Colonoscopy	600pounds	20-30minutes
Sigmidoscopy	300pounds	10minutes
CT abdomen	550pounds	

Chapter Five:

Discussion

Conclusion

Recommendations

Chapter Five

5.1 Discussion:

The study had revealed that the incidence of carrying out the contrast studies was greatest in male, (53.5%) than female, (46.3%) as shown on table (4.1). The peak of contrast studies was much more between (35-40) yearsold as shown in figure (4.2).
The study also showed that the barium studies were more occurrence (29%) than IVU studies (27.5%), HSG (23%),urethrogram(9.5%), MCUG(4.5%), fistulogram (2.5%), T-Tube cholecystogram(1.5%), cystogram (1%), nephrostogrm (0.5%), and sinogram (0.1%) as shown in table (4.2).

This study is a cross-sectional study that dealt with current status of both barium studies and other contrast enhanced investigations, while other investigations outside the region took similar studies in a longitudinal fashion.

The study had marked the clinical indications for barium studies as follows: dysphagia, post-operative, chronic constipation in children (hirschsprung disease), obstruction, stricture, tumor, diverticulum, achalasia , imperforated anus, hiatal hernia, stenosis, atresia, epigastric pain, heart burn, Tracheosophageal fistula, tortuous, and other (epiglottis muscles problem) as shown in figure(4.4). These results had objected the study of Marc in 2009 which denoted that patients with dysphagia or reflux symptoms are subjected to endoscopy and manometry rather than barium study. Also These results disagreed with results of Benjamin and Laura in 2011 ,which revealed that patients referred to fluoroscopy tend to be more debilitated, less mobile, limited in their ability to be cooperate, and morbidly obese but agreed with their result in referral ofpostoperative patients.
The study detected that barium swallow had the highest frequency (55.2%) in

comparison with barium enema (33.6%), barium meal (8.6%), and barium follow-through (2.6%) as shown in table (4.3). These results had agreed with the results of David in 2008 in which the numbers of esophagograms and swallowing studies actually increased, and the volume of upper GI studies suffered a steep drop, but it disagreed with the volumes of barium enema suffered a steep drop. These results had agreed with the result of Gelfannd and Ott in 1987 in which there were greatest decreased in the volume of the small bowel examinations whereas the volume of the barium enema was steady.

The study had declared that the barium studies were the first choice in diagnosing (80.2%), (15.5%) were not known to have pre-barium study or not, (4.3%) of the patients had done other investigations before barium studies as shown in table (4.4). These results disagreed with the results of Benjamin and Laura in 2011, which revealed that the Fluoroscopic studies areused more for problem-solving situations than for primary screening.

The study had elaborated that, barium sulfate was used in most of the cases (61.2%) and water soluble contrast was used in a certain cases (post-operative, congenital abnormalities) with about (38.8%), as shown in table(4.5).

The study had denoted that, most of the barium swallow findings were normal, most of the barium meal findings were abnormal, all of the barium follow-through findings were normal, and for that in barium enema findings were abnormal as shown in figure (4.8).

The study had highlighted that, the most common findings for barium studies was normal and showed less findings such as (hirschsprung disease, esophageal stricture, ca. esophagus, achalasia, colonic diverticulum, imperforated anus, hiatal hernia, ca.stomch, esophageal atresia, esophageal web, esophageal tumor, pyloric stenosis, duodenal stricture, tracheosophgeal fistula, colonic polyp, laryngeal tumor, tortuous duodenum, epiglottis muscle problem, gastro-esophageal reflux disease, and twisted colon) as shown in figure (4.9).

The study had found that, the barium studies were conducted more in

FideelHospital(50.9%), Military Hospital (26.7%), Alnileen Medical Centre (11.2%), and The Modern Medical Centre (11.2%) as shown in table (4.6).

The reason for low frequency of barium investigations in The Modern Medical Centre and Alnileen Medical Centre was the lack of facilities like fluoroscopy, while the opposite applies to Fideel and Military Hospitals as shown in tables (4.7) (4.8).

The cost of barium studies is approximately close to other modern diagnostic modalities, whereas water soluble GIT studies are the highest cost among others as shown in table (4.8).

5.2 Conclusion:

- The study has dragged us for important information regarding incidence, indications, and findings for barium studies.
- Despite the presence of the recent new modalities, barium is still of great values for diagnosing GIT abnormalities.
- The most using of barium studies was in diagnosis of dysphagia, chronic constipation in children and post-operative patients.
- Most of barium studies were barium swallow.
- The frequencies of barium meal and follow- through had declined, and that for barium swallow and enema are steady.
- Water soluble contrast was also used under certain circumstances, but it didn't provide good radiographic contrast in comparison with the barium suspension contrast.
- The cost of barium studies is approximately close to other modern diagnostic modalities, whereas water soluble GIT studies are the highest cost among others.
- Fluoroscopic unit is the best choice for performing barium studies, and the presence of radiologist during fluoroscopic exam will aid in accurate diagnosis.

5.3 Recommendations:

- The importance of using fluoroscopic unit for barium studies and the necessity of presence of radiologist during the procedure.
- Using the available resources for obtaining accurate diagnosis, and maintaining enough budgets for acquiring newly advance diagnostic modalities.
- Regarding to the lack of awareness of clinicians about multidisciplinary technologies, there is increasing importance of interactions and communication between the gastroenterologist and radiologist in order tolearn about new and different technologies to provide the best and most cost-effective diagnosis to the patient.
- There must be increased Awareness and training courses on new modalities for both radiologist and radio technologists, because barium studies have the disadvantage of time consuming and operator dependent nature.
- Barium studies, are still of great value for diagnosing GIT abnormalities, thus, tasty- flavor barium sulfate must be supplied instead of the currentunpleasant barium used at most radiology departments.
- The barium studies are somewhat expensive, so they must be requested for a reasonable justification.

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Appendices

Appendix (A)

Sudan University of Science &Technology

College of post graduate studies

Data Collection sheet

Evaluation of Gastrointestinal Contrast Studies in the Presence of New Diagnostic Modalities

No	Sex	Age	Contras Exam	C/O	Type of Barium	First Line	Contrast used	Findings	Center

Master Sheet (2)

Evaluation ofRadiology Departments in the Study Centers

Center	Staff			Equipments					Protecive Tools	Who is doing Procedure
	Technologist	Radiologist	Nurse	US	CT	MRI	Fluoroscopy	Conventional		
Military Hospital										
Fideel Hospital										
Alnileen Medical Centre										
The Modern Medical Centre										

Exam	Price of Exam	Time of Exam
Barium swallow		
Barium meal		
Barium follow-through		
Barium enema		
Water soluble GI exam		
Upper endoscopy		
Colonoscopy		
Sigmidoscopy		
CT abdomen		

Appendix (B)

Figure (B.1): 3year old,boy,presented with chronic constipation and abdominal pain hisdistal loopogram demonstrated Hirschsprung Disease (HD)

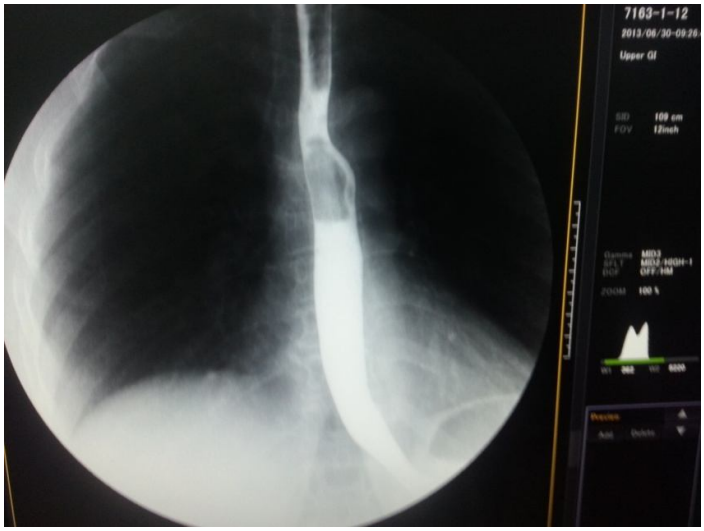

Figure (B.2): 35year old, male,smoker c/o chronic heart burn, barium swallow was normal

Figure (B.3): Female of 65years, presented with left iliac fossa pain and diarrhia mixed with blood, double-contrast barium enema Showed the diverticulosis.

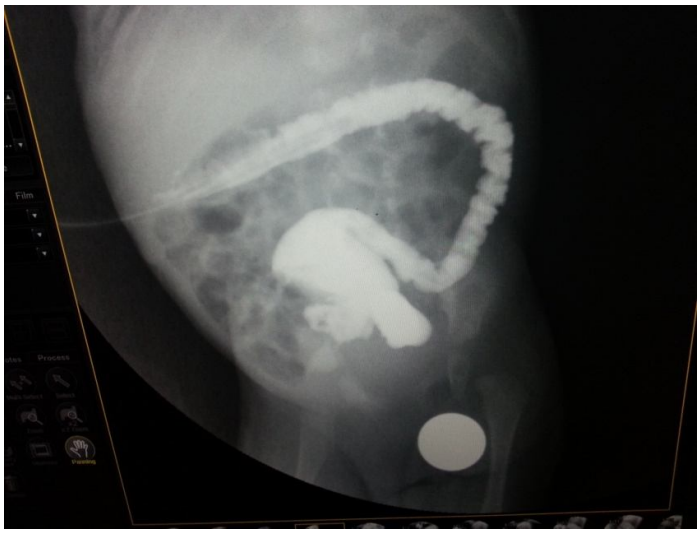

Figure (B.4): Neonate of 3days, presented by his parent by abdominal distension and and nothing passed per rectum,distal loopogram demonstrated imperforated anus.

Figure (B.5):46 year old, male, suffering from difficulty of swallowing of the solid food 10months ago, Barium swallow showed filing defect.

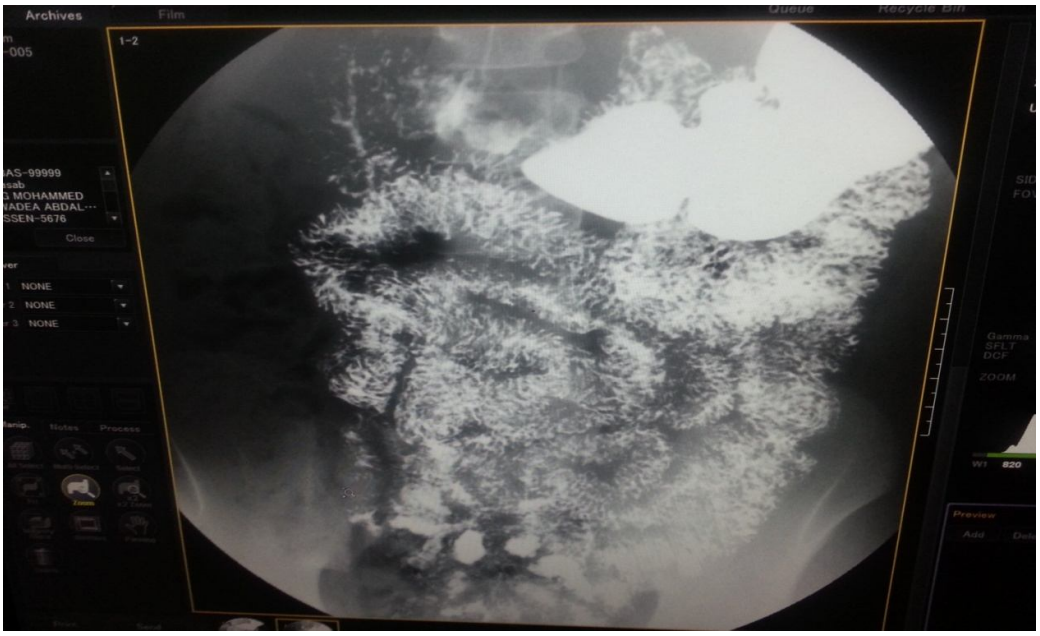

Figure (B.6): Normal single-contrast barium follow- through.

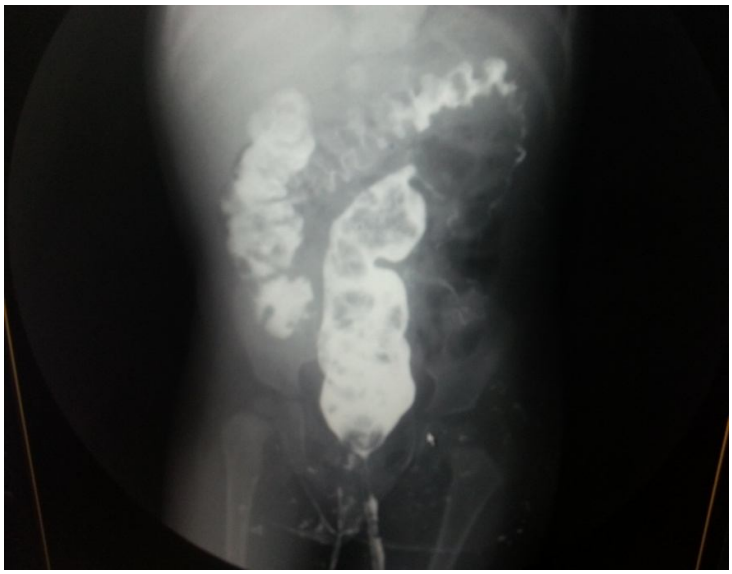

Figure (B.7): 1year old, male, presented with chronic constipation, Single-contrast barium enema showed Hirschsprung disease**.**

Figure (B.9): Delay-film of barium meal-follow-throug

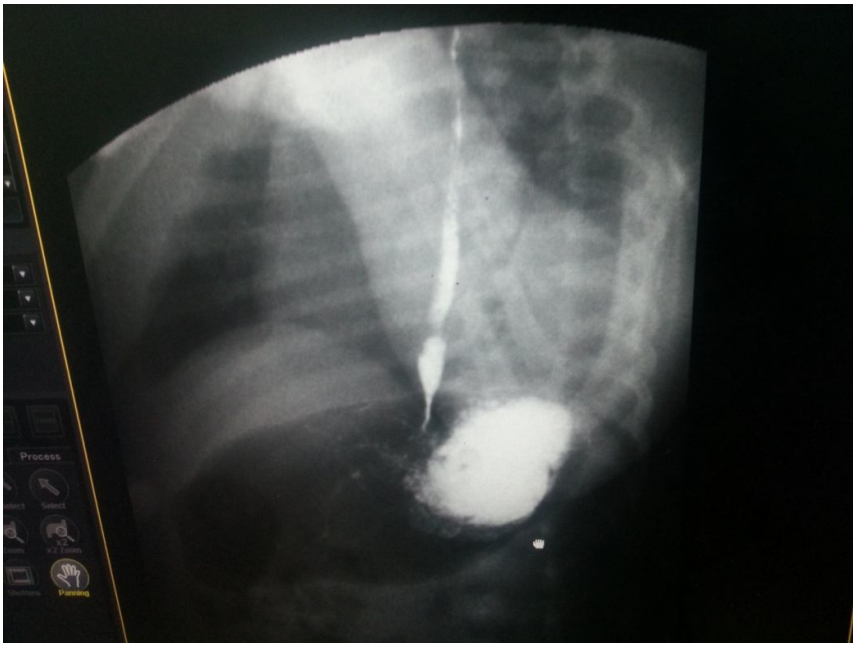

Figure (B.10): Early sequence of barium meal

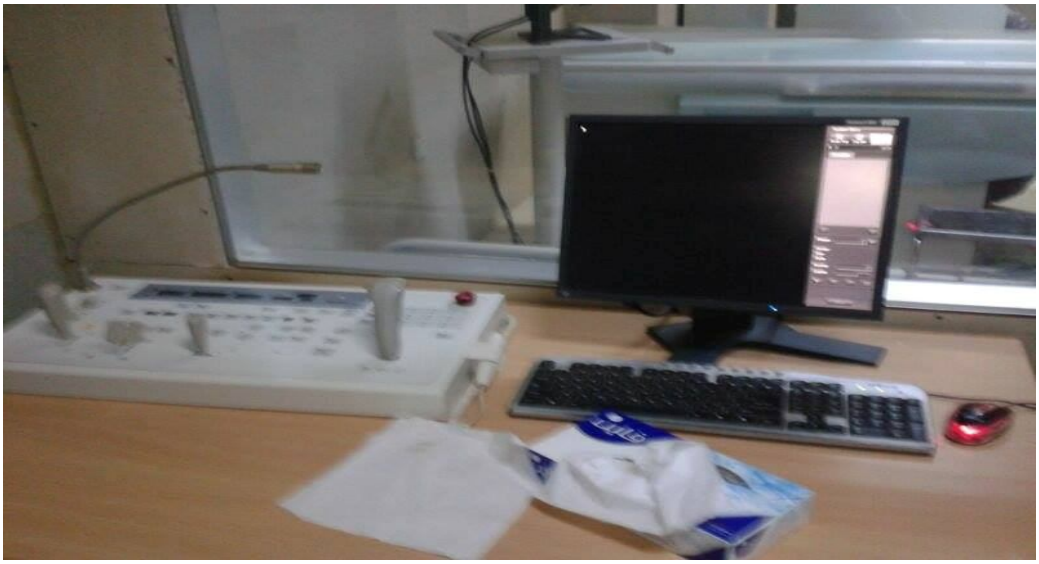

Figure (B.11): Control room of Shimadzu-digital fluoroscopy

(Fideel Hospital)

Figure (B.12): Screening Room (Fideel Hospital)

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