Sudan University of Science &Technology

College of Graduate Studies

Estimation of Sub- mucosal Layer Spread of Esophageal Carcinoma using Computed Tomography

تقييم انتشار سرطان المرئ تحت الطبقة المخاطية بواسطة الأشعة المقطعية المحوسبة

A Thesis submitted for partial fulfillment the Requirements of M.Sc degree in Radio Diagnostic Technology

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Jul - 2o17

الآيـة

قال الله تعالى :

(قُلْ سِيرُوا فِي الأَرْضِ فَانظُرُوا كَيْفَ بَدَأَ الْخَلْقَ ثُمَّ اللَّهُ يُنشِئُ النَّشْأَةَ الآخِرَةَ إِنَّ اللَّهَ عَلَى كُلِّ شَيْءٍ قَدِيرٌ)

صدق الله العظيم سورة العنكبوت الآية (20)

Dedication

We all have dreams but in order to make them come into reality it takes us an awful lot of determination , dedication , self-discipline and effort .
To my respective family and friends
To everyone who lightened a dark spot in my mind
To those who occupy spaces within my heart
I lovingly dedicated this research.

Acknowledgements

Praise and thanks are to lord Allah who guided me through the way.

Special thanks go to those who contributed to this paper : Dr. Asma Ibrahim for her supervision.

And to all those supporting, participating people who advised me through this research .

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List of Abbreviations

Abbreviation	Meaning
CT	Computed Tomography
DNA	Dioxy Nucleic Acid
SCCs	Squamus Cell Carcinoma
ACs	Adenocarcinoma
PET	Positron Emession Tomography
3D	Three Dimention
T3 ,T4	Third and fourth thoracic vertebrae
Ca	Cancer
SPSS	Social Packege for statistical science
GI	Gastrointestine
US	Ultrasound
SD	Standard Dediviation
EUS	Endoscopic ultrasonography
TEE	Tracheoesophageal fistula

Abstract

Esophageal cancer is the third most common gastrointestinal malignancy and is among the 10 most prevalent cancers worldwide (Beasley P. 1997) . the main objective of this study to Assessment of Sub- mucosal Layer Spread of Esophageal Carcinoma using computed tomography . which done to the 35 patients with histologically confirmed esophageal carcinoma ,referred to Alamal Hospital and Alneleen Medical Center, for determine the accurate site and size of tumor for possible treatment from november 2016 to february 2017 . measurement done by using CT software to the tumor, tumor size to determine the sub-mucosal extension (by using CT number of tumor) and Anatomical Site .the collected data has been analyzed using Social Package for Statistical Science (SPSS) and it revealed that :the esophageal carcinoma is predominant among female more than male with a percent of 62.9% and 37.1% respectively and the most susceptible segment of esophagus for carcinogenesis is the lower third . with percent of 54.3% , then the middle third .taking a percent 25.7% and the minimum incidence observed in the upper third with percent 20% . and the common histopathological type of the esophageal carcinoma is the adenocarcinoma (60%).and Squamous Cell Carcinoma (40%)

مستخلص الدراسة

سرطان المرئ هو ثالث سرطانات الجهاز الهضمي الأكثر شيوعاً.

ويعتبر من بين 10 أنواع السرطانات الأكثر انتشارا في جميع انحاء العالم (Beasley P. 1997) الهدف الرئيسي من هذه الدراسه هو تقييم غزو سرطان المرئ للطبقه تحت المخاطيه بالأشعه المقطعيه و أجريت الدراسة على (35) مريض مصابين بسرطان المرئ و تم ذلك بمستشفى الأمل و مركز النيلين الطبي لتحديد موقع الورم و حجمه للعلاج .

في الفترة ما بين نوفمبر2016إلى فبراير 2017.

تم تحديد الورم و حجمه و تحديد غزو الورم تحت الطبقة المخاطية بإستخدام رقم الأشعة المقطعية .

تم تحليل البيانات بواسطة برنامج التحليل الإجتماعي للبيانات الإحصائية (SPSS) والذي أوضح أن سرطان المرئ أكثر انتشارا بين الإناث بنسبة (62.9 ٪) مقارنة بالرجال بمعدل انتشار أقل بنسبة (37.1٪) كما أوضحت الدراسة أن نسبة السرطان الغدي أكثر شيوعا و يصيب المقطع السفلي من المرئ بنسبة (54.3٪) و المقطع الأوسط بنسبة (25.7٪) والمقطع العلوي بنسبة (20٪) .

و النوع الشائع من سرطان المرئ هو السرطان الغدي بنسبة (60٪) و سرطان الخلايا الحرشفية بنسبة (40٪) .

Chapter One

1.1 Introduction

The Process of cell proliferation (cell division and cell growth) is controlled by genes in the DNA of the cell nucleus. a cancer forms when this genetic control is damaged or lost in one or more cells, which then continue to divide and divide again producing more abnormal cells that continue to divide and increase in number, and this abnormal growth when affected region it is spread intramurally underneath the mucosa. Esophageal cancer is the third most common gastrointestinal malignancy and is among the 10 most prevalent cancers worldwide (Stewart BW,Kleihues P:IARC,2003).

More than 90% of esophageal cancers are either squamous cell carcinomas (SCCs) or adenocarcinomas ACs are evenly distributed between the middle and lower esophagus, whereas approximately three-fourths of all adenocarcinomas are found in the distal esophagus (Lau S,Tam KF 2004).

As with all other tumors, the outcome for patients with esophageal cancer is strongly associated with the stage at initial diagnosis. Surgical resection is currently the best curative treatment for ` patients without distant metastasis or locally advanced tumor growth. An excellent 5-year survival rate in the range of 57%–78% has been reported in patients with early esophageal cancer (Gourtsoyiannis N 2001).

The increasing use of endoscopic ultrasonography (US) and positron emission tomography (PET) has improved the staging algorithm for newly diagnosed esophageal cancer. Currently, the combined use of CT, endoscopic US, and PET is advocated to determine whether a patient should be treated with surgery, chemotherapy, or a combination of chemotherapy and radiation therapy. As with many malignancies, the staging criteria for esophageal cancer include depth of local invasion, regional lymph node involvement, and distant metastasis. The afore mentioned imaging modalities have different strengths and weaknesses with respect to each of these criteria .Therefore, accurate sub-mucosal assessment of esophageal cancer requires knowledge of the advantages and disadvantages of each modality, Recent advances in CT have drawn attention to the use of CT for evaluating the GI tract(Lau S,Tam KF 2004). Cross-sectional CT has the

primary role in staging GI tumors (Elzohairy M 2005) . New multi-slice CT has some advantages compared to single-slice spiral scanners, such as elimination of motion artifacts and acquisition of thinner sections. CT has an advantage compared with EUS, namely the possibility of delineating the full extension of the tumor (Blay JY 2004).

The forces of CT are demonstration of a tumor, its size, relation to adjacent organs and revelation of metastasis , and therefore are the tasks of CT primarily staging, surgical planning and follow-up (Stroobants S 2003).

1.2 Problem of the study:

The radiotherapy of the esophageal cancer is commonly depends on the field size of tumor and the field size conventionally made by taking save margin extended to 2-5 cm from the tumor. However sub-mucosal spread of cancer may exceed such field size and leading to recurrent later, so the use of CT in staging ca of esophagus can improve the radiotherapy treatment .

1.3 Objectives of the Study:

1.3.1 General objectives :

The general objective is to estimate sub-mucosal layer spread of ca esophagus to assist in its treatment and management **.**

1.3.2 Specific objectives :

- To determine the common age involved by esophageal carcinoma.
- To determine the common anatomical site of involvement and histopathology.

1.4 Thesis Outlines:

The thesis will be built in five chapters. Chapter one will deal with introduction, problem of the study, objectives and thesis out line. Chapter two will concern with anatomy and literature review. Chapter three will express the methodology of the study. Chapter four will show the result. Chapter five will concern with the discussion, conclusion, recommendations, references and appendices .

Chapter Two

Literature Review and previous studies

2-1 Anatomy of the esophagus:

The esophagus is a 25-cm long muscular tube with an average diameter of 2 cm thatconnectsthe pharynx with the stomach. Itextends from the lower border of the cricoid cartilage (at the level of the sixth cervical vertebra) to the cardiac orifice of the stomach at the side of the body of the 11th thoracic vertebra.

The esophagus follows the concavity of the vertebral column as it descends through the neck and mediastinum . It passes through the elliptical esophageal hiatus in the muscular diaphragm , just to the left of the median plane at the level of the 10^{th}thoracic vertebrae .

It terminates at the gastroesophageal junction, where ingested matter enters the cardiac orifice of the stomach which is located to the left of the midline at the level of the 7^{th} . Left costal cartilage and the 11^{th} thoracic vertebrae . The esophagus is retroperitoneal during its short abdominal course . (Keith and Anne,2007).

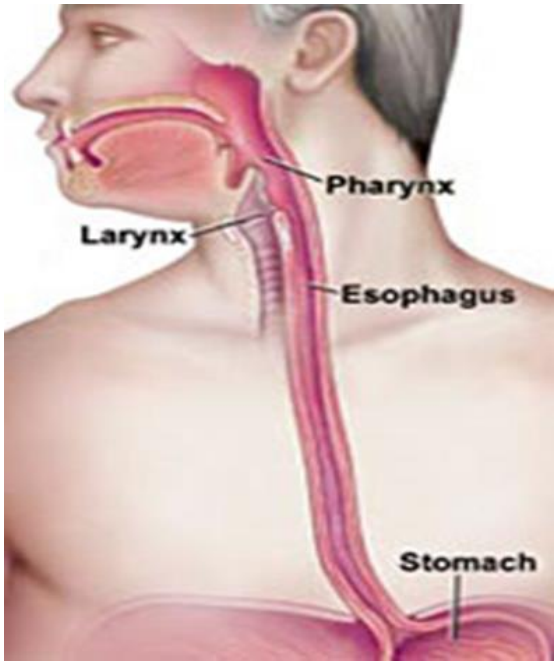

Figure 2.1 shows the anatomy of the esophagus (Keith and Anne,2007).

2-1-1 Histology of the Esophagus:

Histologically, the esophagus has the following 4 concentric layers (picture):

- Mucosal layer
- Submucosal layer
- Muscular layer
- Adventitial layer

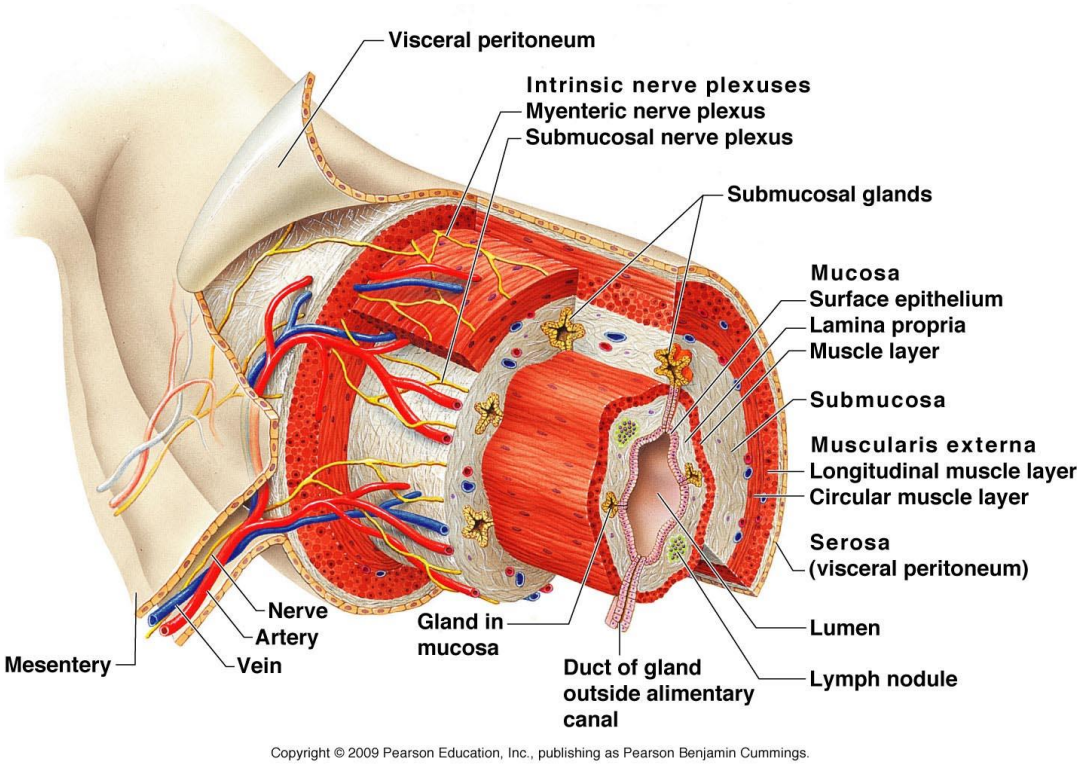

Figure 2.2 show the layers of the esophagus (Keith and Anne,2007).

Mucosa form the innermost layer and is formed by squamous epithelium that is continuous with that of the pharynx. Mucosal epithelium changes from squamous cell epithelium to columnar cell epithelium at the gastroesophageal junction (Beasley P 2008).

The second layer is formed by submucosa, and it loosely connects the mucous membrane and the muscular coat. This layer contains the larger blood vessels, the submucosal nerve plexus, and esophageal glands.

The third layer is formed by circular and longitudinal muscle fibers.

In These fibers are continuous superiorly with the fibers of the cricopharyngeal part of the inferior constrictor and inferiorly with oblique fibers of the stomach (Beasley P 2008).

Outer longitudinal muscle fibers: The longitudinal muscle fibers form a continuous coat around the whole of the esophagus except posterosuperiorly, 3-4 cm below the cricoid cartilage; here, they diverge as 2 fascicles that ascend obliquely to the anterior aspect of the esophagus .

The proximal one-third of the esophagus consists primarily of striated muscle. Smooth muscle predominates in the distal portion.

The fourth and the outermost fibrous layer is formed by external adventitia of irregular, dense connective tissue containing many elastic fibers. The esophagus has no serosa, which makes it unique to the rest of the gastrointestinal tract.

The esophagus has been subdivided into 3 portions, as follows:

The cervical portion extends from the cricopharyngeus to the suprasternal notch.

The thoracic portion extends from the suprasternal notch to the diaphragm

The abdominal portion extends from the diaphragm to the cardiac portion of the stomach (Levy AD 2003).

2-1-2 Relationships of the esophagus:

The relationships of the cervical esophagus, thoracic esophagus, and abdominal esophagus are described below (Postma GN 2009).

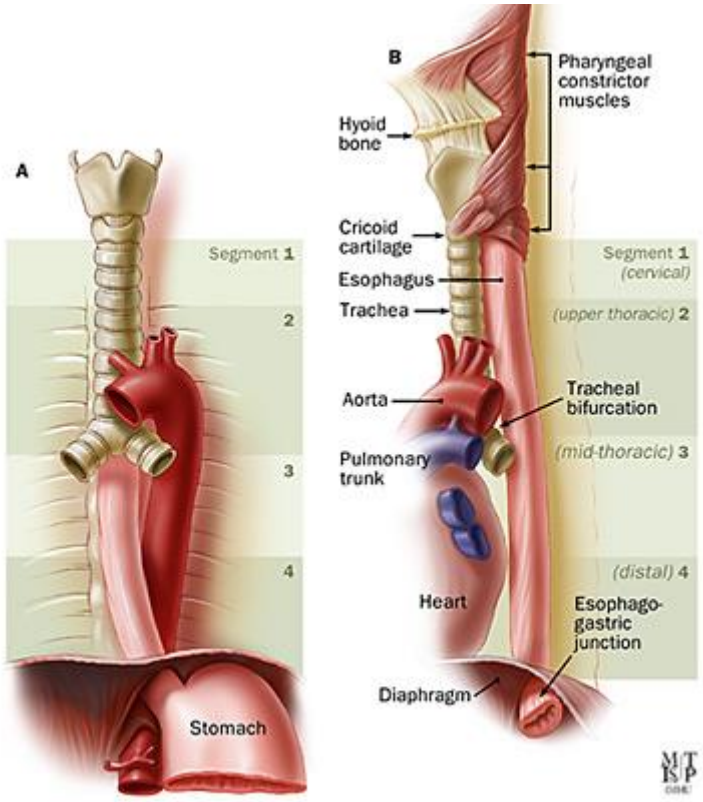

Figure 2.3 show the relationships of the esophagus(Keith and Anne,2007).

2-1-2-1 The cervical part of the esophagus:

The trachea lies anterior to the esophagus and is connected to it by a loose connective tissue. Posteriorly, it is related to prevertebral muscles and prevertebral fascia covering the bodies of sixth, seventh, and eighth cervical vertebra. and lower poles of the lateral lobes of thyroid gland are in lateral relation to the esophagus on both the sides (Beasley P 1997).

2-1-2-2 The thoracic part of the esophagus:

The esophagus lies between the trachea and vertebral column in the superior mediastinum. On its way down, the esophagus passes behind the aortic arch, and, at the level of T4/T5 intervertebral discs, it enters the posterior mediastinum (Beasley P 1997)

2-1-2-3 The Abdominal part of the Esophagus:

The Esophagus passes through the right crus of the diaphragm. In its abdominal course, it is covered with the peritoneum of the greater sac anteriorly and on its left side, and it is covered with the lesser sac peritoneum

on the right side. The right border continues evenly into the lesser curvature, whereas the left border is separated from the fundus of the stomach by the cardiac notch (Beasley P 1997).

2-1-3 Blood Supply of the Esophagus :

The cervical portion is supplied by the inferior thyroid artery.

The thoracic portion is supplied by bronchial and esophageal branches of the thoracic aorta.

The abdominal portion is supplied by ascending branches of the left phrenic and left gastric arteries (Gray H.S ed 2008).

2-1-4 Venous Drainage :

Esophageal veins drain in a segmental way similar to the arterial supply, as follows:

From the cervical esophagus, veins drain into the inferior thyroid vein

From the thoracic esophagus, veins drain into the azygos veins, hemiazygos, intercostal, and bronchial veins

From the abdominal portion, esophagus veins drain into the left gastric vein; the left gastric vein is a tributary of the portal system (Larsen WJ 2001)

2-1-5 Lymphatic Drainage :

The esophagus has an extensive, longitudinally continuous, submucosal lymphatic system.The esophagus has 2 types of lymphatic vessels. A plexus of large vessels is present in the mucous membrane, and it is continuous above with the mucosal lymphatic vessels of pharynx and below with mucosal lymphatic vessels of gastric mucosa. The second plexus of finer vessels is situated in the muscular coat. Efferent vessels from the cervical part drain into the deep cervical nodes. Vessels from the thoracic part drain to the posterior mediastinal nodes and from the abdominal part drain to the left gastric nodes. Some vessels may pass directly to the thoracic duct.involvement several centimeters away from the primary lesion (Gray H.S 2008).

2-1-6 Nerve supply:

Recurrent laryngeal branches of the vagus nerve supply the striated muscle in the upper third of the esophagus, and cell bodies for these fibers are situated in the rostral part of the nucleus ambiguus. Motor supply to the nonstriated muscle is parasympathetic, and cell bodies for these fibers are situated in the dorsal nucleus of vagus. These fibers reach the esophagus through the vagus and its recurrent laryngeal branches. They synapse in the esophagus wall in the ganglia of submucosal plexus (Meissner) and myenteric plexus (Auerbach). The myenteric is situated between the outer longitudinal and inner circular muscle fibers. From these plexuses, short, postganglionic fibers emerge to innervate the mucous glands and smooth muscle fibers within the walls of the esophagus.

Vasomotor sympathetic fibers that supply the esophagus arise from the upper 4-6 thoracic spinal cord segments. Fibers from the upper ganglia pass to the middle and inferior cervical ganglia and synapse on postganglionic neurons. The axons of these neurons innervate the vessels of the cervical and upper thoracic esophagus. Postsynaptic fibers from the lower ganglia pass to the esophageal plexus to innervate the distal esophagus. Afferent visceral pain fibers travel via the sympathetic fibers to the first 4 segments of the thoracic spinal cord (Vollweiler JF 2005).

2-2 Physiology of the Esophagus :

2-2-1 Swallowing:

Food is ingested through the mouth and when swallowed passes first into the pharynx and then into the esophagus. The esophagus is thus one of the first components of the digestive system and the gastrointestinal tract. After food passes through the esophagus, it enters the stomach. When food is being swallowed, the epiglottis moves backward to cover the larynx, preventing food from entering the trachea. At the same time, the upper esophageal sphincter relaxes, allowing abolus of food to enter. Peristaltic contractions of the esophageal muscle push the food down the esophagus. These rhythmic contractions occur both as a reflex response to food that is in the mouth, and also as a response to the sensation of food within the esophagus itself. Along with peristalsis, the lower esophageal sphincter relaxes (Beasley P 1997).

2-2-2 Reducing gastric reflux

The stomach produces gastric acid, a strongly acidic mixture consisting of hydrochloric acid (HCl) and potassium andsodium salts to enable food digestion. Constriction of the upper and lower esophageal sphincters help to prevent reflux (backflow) of gastric contents and acid into the esophagus, protecting the esophageal mucosa. In addition, the acute angle of His and the lower crura of the diaphragm helps this sphincteric action (Horton KM 2003).

2.3 Pathology :

Lesions of the esophagus are classified as following :

2.3.1.Congenital Anomalies:

2.3.1.1 Atrsia:

An **esophageal atresia** refers to an absence in contiguity of the esophagus due to an inappropriate division of the primitive foregut into the trachea anteriorly and the esophagus posteriorly. This usually occurs at ~ the 4^{th} week of gestation.

. The esophagus is divided into two blind pouches, an upper and lower, which may or may not communicate with the tracheobronchial tree through fistulous tracts called tracheoesophageal fistula (Okubo K 2004).

2.3.1.2 Esophageal stenosis:

Is anabnormal narrowing of the esophageal lumen. It may occur as development defect or may acquired secondary to inflammatory fibrosis, neoplastic narrowing, compression by tumor or aneurysm (Levy AD 2003).

2.3.2 Lesions due to motor dysfunction :

2.3.2.1 Achalasia :

Disorder of esophagus motiliy characterized by incomplete relaxation of the lower esophageal sphincter in response to swallowing. This produces functional obstruction with consequent dilation of the more proximal esophagus (Postma GN 2009)

2.3.2.2 Rings and Webs :

They are the annular narrowings of the esophagus which may produce dysphasia.

The narrowingsin upper esophagus (above the aortic arch) are called "webs".

The narrowings in the lower esophagus are known as "rings"(Postma GN 2009).

2.3.3 Vascular lesion; esophagealvarices :

The abnormal dilatation of the esophageal veins and venous plexus, caused by Portal hypertension which results usually from liver cirrhosis, Varices asymptomic, until rupture produces massive hemorrhage may lead to death (Postma GN 2009).

2.3.4 Neoplasm: Benign and malignant tumours:

Esophageal carcinoma accounts for 95% tumors of esophagus, its peak age is over 50 years, the risk factors are long standing oesphagitis, Achalasia, alcohol consumption, tabaco, hot tea.

Its locations:

Middle third in 40-50 %.

Lower third 35-40%.

Upper third of the oesophagus in 10-15%.

It is asymptomatic initially but later on the patient will suffer fromdysphagia and oesophageal obstruction, weight loss, anemia, fatigue and weakness.

The esophageal carcinoma is divided into Squamous cell carcinoma 80-90 % , Adenocarcinoma 5-10% , Undifferentiated carcinoma 5-10% (Stroobants S 2003).

2.3.4.1 Squamous cell carcinoma:

is preceded by epithelial dysplasia and carcinoma in situ. Fungating polypoid, necrotic ulcerating lesion and diffuse infiltration lesion.

2.3.4.2 Adenocarcinoma:

Rise from dysplastic mucosa , usually in distal oesophagus and may invade gastric cardia. Initially appearing as flat or raised patches on an otherwise intact mucosa , may give large nodular masses and ulceration(Stroobants S 2003).

2.4 Computed tomography [CT]:

2.4.1 Principle of CT:

Computed tomography, like conventional radiography, relies on x-ray transmitted through the body. Computed tomography differs from conventional radiography in that it uses a more sensitive x-ray detection system than photographic film, namely gas or crystal detectors, and manipulates the data using computer. The x-ray tube and detectors rotate around the patient, andthe patient lies with part to be examined within the gantry housing. By the moving the patient through the gantry, multiple adjacent section can be imaged allowing a picture of the body to be built up (Buzug, 2008).

There are two method of CT scanning:

- Slice -by- slice "conventional CT": In this method the table top supporting the patient comes to a stop for each section.
- Spiral "helical" CT: the patient is transported continuously through the scanner, so in effect the x-ray beam traces a spiral path, while the data are collecting continuously, to create "volume of data" within the computer memory(William et al, 2002).

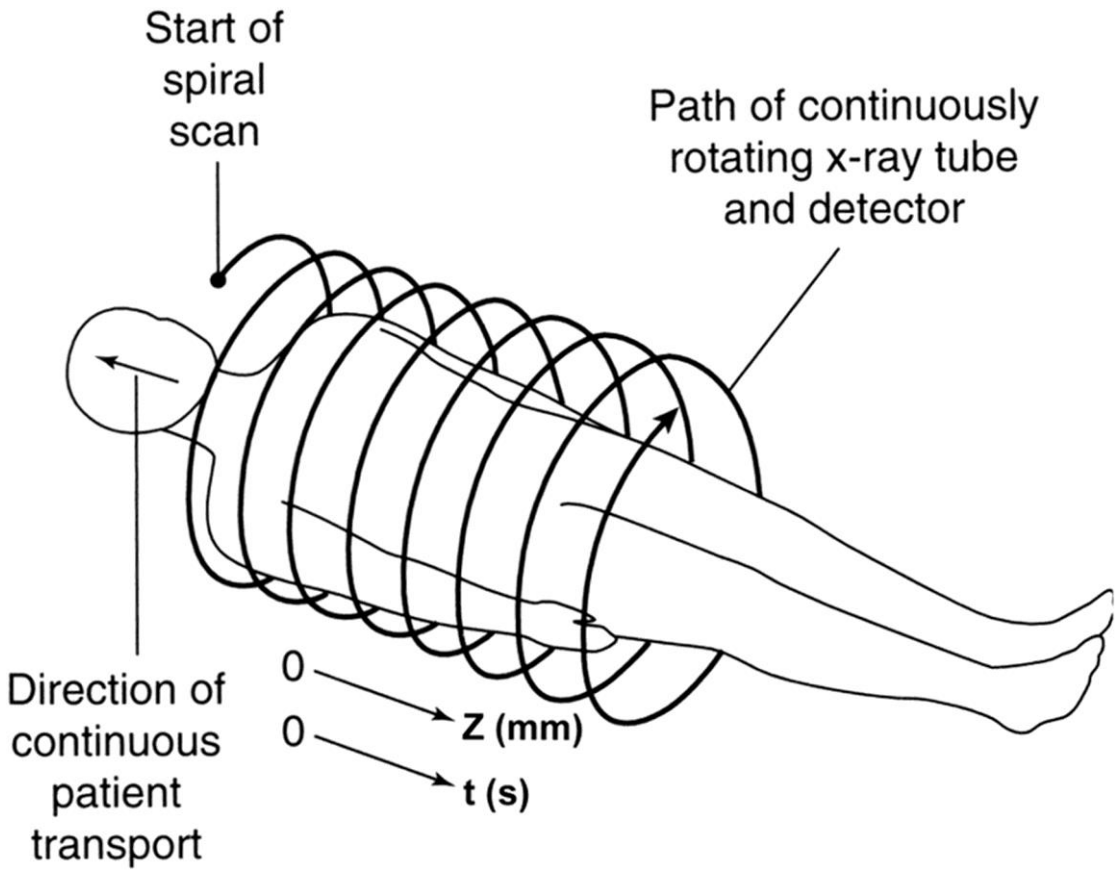

Fig (2.4) shows spiral CT mechanism (JamescD.mace, Nina Kowalczyk 2001).

2.4.2 Spiral CT physics:

The advances enable CT data to be acquired continuously with on-going patient movement:

- **Slip-ring technology**

Slip ring technology was the fundamental step that allowing volume data acquisition. In older "conventional" CT system, there was an inherent delay of3-5 seconds between each exposure. This arose from the physical need to have cables connecting the stationary gantry and the rotating x-ray tube, detector systems, and control system. It depending on cable length, the cable become wound and rotation of the tube-detector assembly had to stop, and change direction. These may lead to mechanical problems. Slip-ring

technology abolished the physical need for presence of an electrical cable between the generator and moving tube-detector assembly. Power is transmitted between the stationary and moving rings by means of brushes (Buzug, 2008).

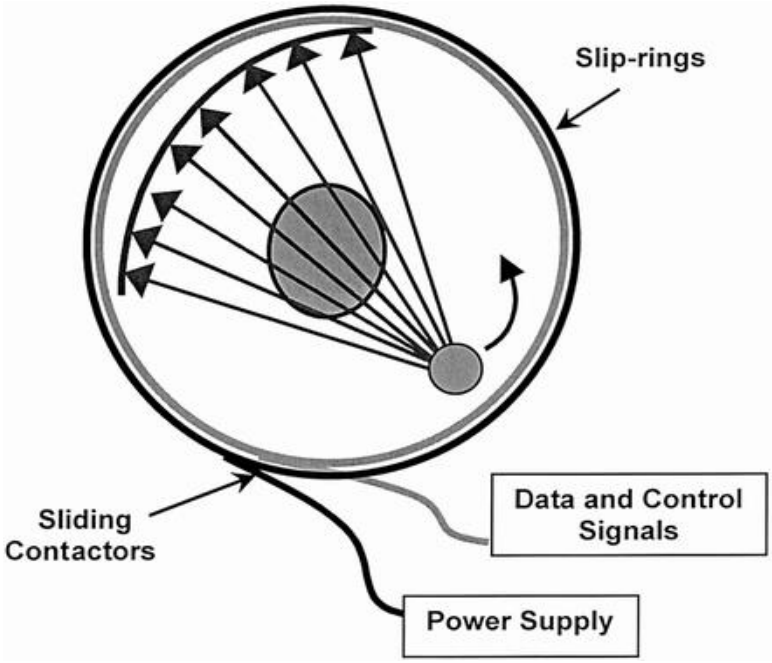

Figure (2.5) shows gantry component including slip-rings technology (Dr. Adel Montaser, 2003).

- **Pitch of image:**

Pitch is relationship of table feed per rotation and x-ray collimators width. This Pitch independent of number of slices acquired and convey two essential imaging qualities. Firstly, increasing pitch results in widening of the slice beam profile and thus effect the image quality. Secondly, increasing the pitch lowers radiation dose (Horton KM 2003).

2.4.3 Software image reconstruction algorithms:

Conventional CT used back projection techniques to reconstructs an image, and that may produce prominent blurring and dense shadowing. The data required for spiral CT image reconstruction is generated from projection acquired at superior and inferior anatomical location interpolation algorithms.

There are three common reconstruction algorithms:

- 720^{o} helical interpolation (360^{o} linear interpolation)
- 360^{o} helical under-scanning.
- Helical extrapolation (180^{o} linear interpolation), (Buzug, 2008).

2.4.4 The Attenuation values:

The attenuation values are expressed on an arbitrary scale (Hounsfield Unit) with water density being zero, air density being 1000 units and bone density being plus 1000 unit. The range and the level of densities to be displayed can be selected by control on the computer. The range of densities visualized on a particular image is known as the window width (WW) and window level (WL) (Buzug 2008).

2.4.5 CT Technique:

- Patient position: supine with arms at chest or head level.
- Volume of investigation:from dome of liver to the inferior border pubic symphysis.
- Nominal slice thickness: 7-10 mm, 4-5 mm if small lesions are suspected.
- Inter-slice distance\pitch: contiguous or a pitch=1.0 in screening investigation.
- FOV:Adjusted to the largest abdominal diameter.

- Gantry tilt: None.
- X-ray tube voltage (KV): standard.
- Tube currant and exposure time product (MAs): should be as low as consistent with required image quality.
- Reconstruction algorithm: standard or soft tissue.
- Window width:150-600HU, 2000-3000 HU (bone if required).
- Window level: 30-60 HU (enhanced examination), 0-30 HU (unenhanced examination), 400-600 HU (bone if required), (William R 2002).

2.4.6 CT artifact:

- Patient motion artifact: motion can be voluntary or involuntary.
- Metal artifact: metallic material such as prosthetic devices, dental filling, surgical clips and electrodes produce streak artifact on the image.
- Beam hardening artifact:beam hardening is a phenomenon result from the increase of main energy of x-ray beam when it passes through object.
- Stair-step artifact: this phenomenon appears as artifact on transverse images and as stair-steps, or strips (zebra artifact) on multiplanar reformation or 3D render images.
- Partial volume artifact: Partial volume artifact arises when avoxel contains many types of tissue. It will produce CT number as an average of all types of tissue (Buzug, 2008).

2.4.7 Advantages of spiral CT:

- Speed of imaging and patient throughput.
- Elimination of respiratory misregistration.
- Minimization of partial volume average effects.
- Exact contiguity of images.
- Optimized used and reduced volume of intravenous contrast medium.
- Volume data acquisition and improved 3D imaging(Buzug, 2008).

2.4.8 Disadvantages of spiral CT:

- Required a cooperative patient.
- Required very precise timing of enhancement.
- Vascular flow artifacts.
- Helical reconstruction artifact.
- Tube cooling and images reconstruction delays on some machines (Buzug, 2008).

2.5 Previous Studies :

James et al (1983) studied the esophageal wall thickening, and they showed that esophageal wall thickening is the earliest CT manifestation of esophageal carcinoma, and it is not the only cause of thickened esophageal walls but many benign conditions as well as involvement of the esophagus from the other malignancies can cause esophageal wall thickening. In addition, the collapsed esophagus can occasionally lead to the false diagnosis of esophageal wall thickening was demonstrated in 50 patients (35%).

All patients with thickened walls and further diagnostic studies, including barium esophagram and \or endoscopy confirming pathology at the site of CT –demonstrated wall thickening. Dr. Tom R. DeMeester (Los Angeles, California) Lymphatic spread was more common in patients with submucosal squamous cell cancer as compared with submucosal adenocarcinoma (36.4% versus 20.7%). Although lymph node metastases were usually limited to loco regional lymph node stations in early adenocarcinoma, distant lymphatic spread was frequent in early squamous cell cancer.

On multivariate analysis, only histologic tumor type and the presence of lymph node metastases were independent predictors of long-term survival. Five-year survival rate was 83.4% for early adenocarcinoma versus 62.9% for early squamous cell cancer and 48.2% versus 79.5% for patients with/without lymphatic spread.

In the study carried out by Joerg et al , (2005) A CT- Scan of the thorax and the mediastinum showed a tumor of the middle third of the esophagus with

asuspicion of tumor infiltration of the thoracic aorta and the left main bronchus, while PET scan demonstrate apathologic tracer uptake at the level of the middle third of the esophagus with no signs of distal metastasis .

Esophageo-gastro-dudenoscopy showed a tumot stenosis of 7 cm length, from 30 to 37 cm, and diameter of 4-6mm, further there was an intreluminal obstruction about more than 50% which was additional confirmed by an esophogram in addition to sub mucosal jejuna nodule with diameter of 1cm was detected about 40cm distal to the duodeno-jejunal fold.

In the studies related to high incidence of esophageal carcinoma among male, there some hypothesized that male predominance in esophageal adenocarcinoma is due at least to establish risk factors having a more harmful effect on male than female and that protective factor have stronger preventive effect on female than male . The established risks factors are gastro-esophageal reflux (Lagergren et al ,1999a Shaheen and Ranosohoff , 2002 ,Vakil et al, 2006) , obesity (Lagergren et al, 1999b) and tobacco smoking (Lagergren et al, 2000), whereas the two protective factors are high intake of fruits and vegetables(Terry et al, 2001) and infection with helicobacter pylori (H.Pylori) (Ye et al ,2004 , Rokkasetal, 2007).

Chapter Three

Materials and Methods

3.1 Materials :

3.1.1 Population of the study :

The study population included 35 patients (13 male & 22 female) with esophageal cancer histopathologically proved at endoscopic biopsy who were referred to Alamal Hospital and Alnileen Medical Diagnostic Center, for determine the accurate site and size of tumor for possible treatment (surgical, chemotherapy, radiotherapy or combination of them) from November 2016 to February 2017.

3.1.2 Equipment :

- Al-Aml Hospital : helical CT scans were acquired with Toshiba Aquilion 64 slice devise (model TSX-101A, Output 120kv – 600 mA) and U/S scans were acquired with ALOKA (model prosound, probe 3.54 MHz).
- Alnilen diagnostic center l: helical CT scans were acquired with SIMENS 16 slice devise (model Sensation, Output 120kv – 600 mA)

3.2 Method :

3.2.1 Patient preparation :

Explain the procedure to the patient prior to beginning and instructed to remove all metallic objects from the scan area, and change her/his clothes to the hospital-gown and lie supine on the CT couch.

3.2.2 Technique of the study :

It is doneby selection of CT esophogram Protocol done without contrast media then repeated with oral contrast solution given, for complete staging and evaluation of recurrent or metastatic disease (Solomon et al, 1986).

3.2.3 Study variables :

The study variables include age and gender also presence, site and size of tumor.

3.2.4 Data collection methods :

Quantitative measurement done by using CT software to the tumor CT number, tumor size, sub-mucosal extension and Anatomical Site .

3.3 Data analysis :

The data of the study was analyzed by SPSS statistical program.

3.4 Data presentation :

Data displayed in the form of tables and figures.

3.5 Data storage :

The data stored in CD.

3.6 Ethical consideration :

The patients did not enter any unnecessary examination and had known that the data had been taken for the research **.**

Chapter Four

Result

The following Tables and Figures presented the data obtained from 35 patients with Ca esophagus, the data including patient gender classification, tumor size, site, type, extension, CT number.

Table 4.1 The Gender classification :

Gender	Frequency	Percentage
Female	22	62.9%
Male	13	37.1%
Total	35	100%

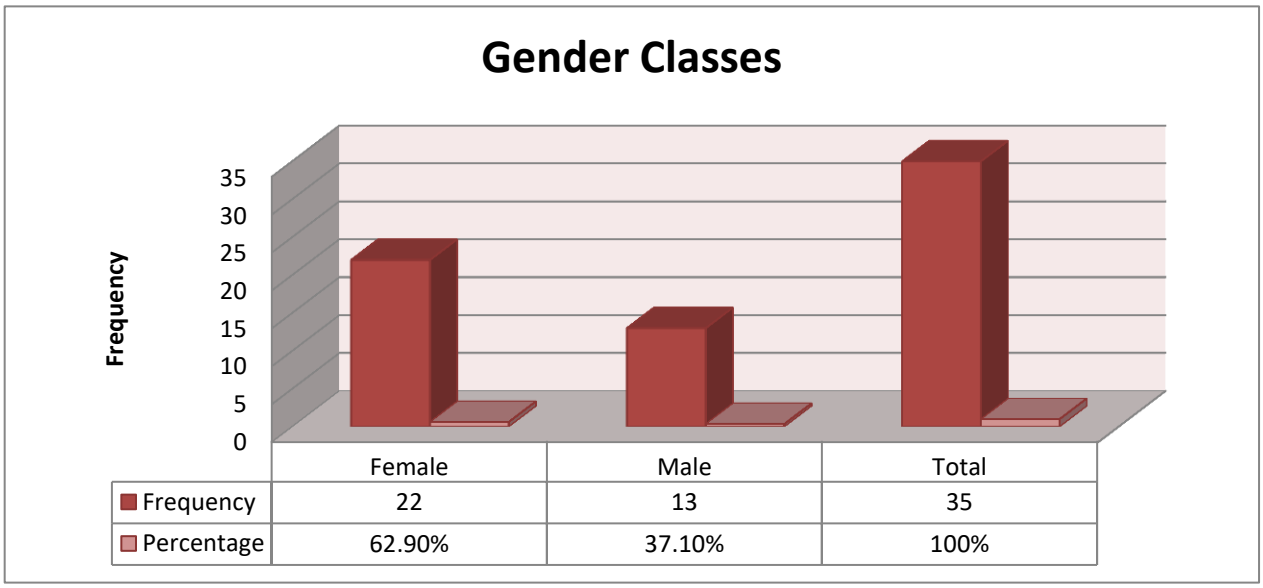

Figure 4.1 The Gender classification.

Table 4.2 Age Classes :

Age Classes	Frequency	Percentage
50-55	4	11.4%
56-61	11	31.4%
62-67	7	20.0%
68-73	8	22.9%
>73	5	14.3%
Total	35	100%

Figure 4.2 Age Classes.

Table 4.3 Mean and Standard Deviation (STDV) of the CT number (Hounsfield Unit) and Tumor Size and sub mucosal extension :

Variable	Tumor CT number	Tumor Size(MM)	sub mucosal extension(MM)
Mean	42.9	386.8	61.2
STDV	±5.4	±99.9	±18.9

Table 4.4 The Frequency and Percentage of the type of Tumor :

Type Of tumor	Frequency	Percentage
Adeno –Carcinoma	21	60
Squamous Cell Carcinoma	14	40
Total Number Of Cases	35	100%

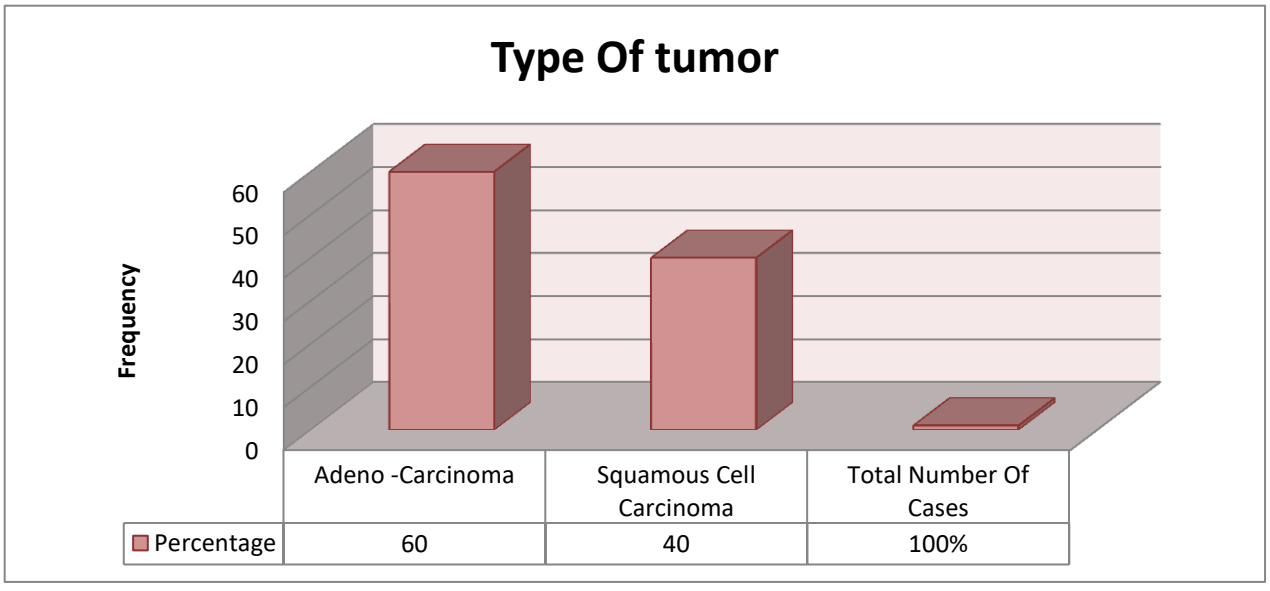

Figure 4.3The Frequency and Percentage of The type of Tumor.

Table 4.5 The site of The tumor in the Esophagus (Upper, Middle, Lower) :

Site of The Tumor	Frequency	Percentage
Upper Third Of The Esophagus	7	20%
Middle Third Of The Esophagus	9	25.7%
Lower Third Of The Esophagus	19	54.3%
Total	35	100%

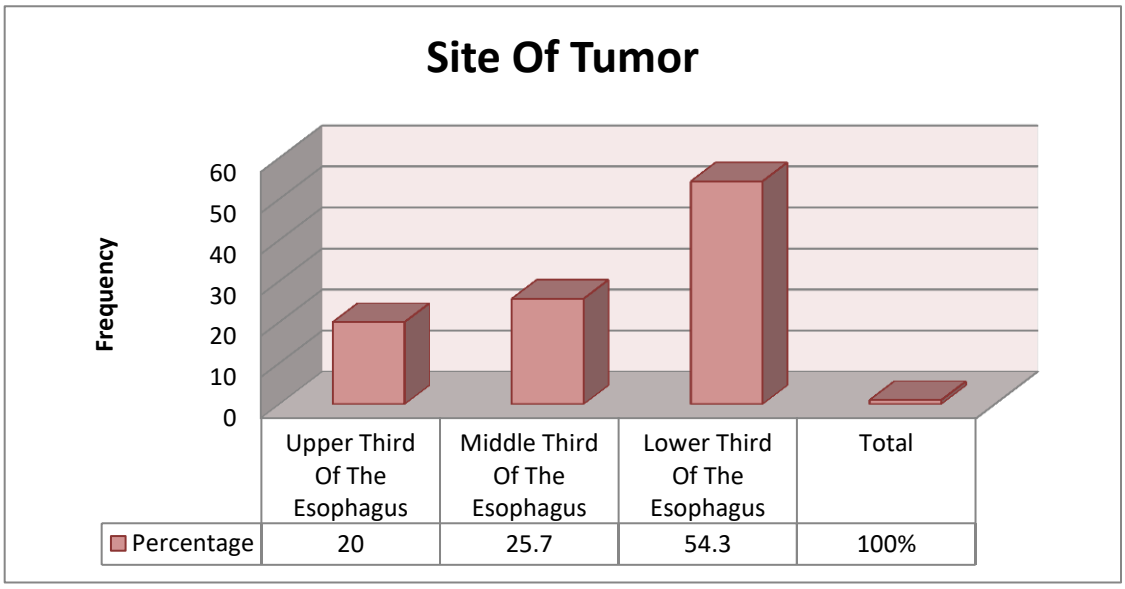

Figure 4.4The site Of The tumor in the Esophagus (Upper, Middle, Lower), Frequency and Percentage.

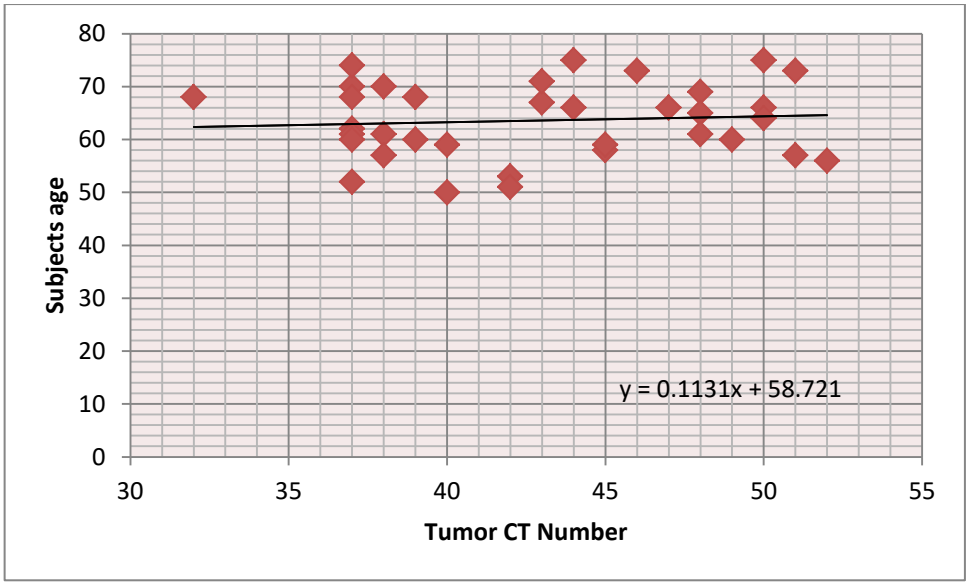

Figure 4.5 scatter plot diagram shows the linear relationship between Tumor CT number and Subjects Age, the CT number increased by 0.113 as the age increased starting from 58.7 years.

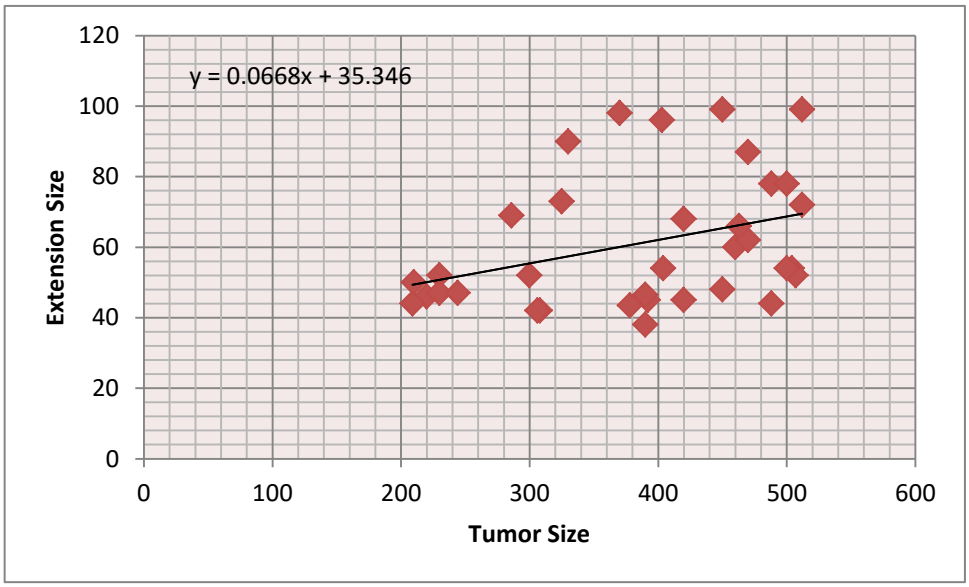

Figure 4.6 scatter plot diagram shows the linear relationship between Tumor Size and Tumor extension size, as the tumor Size increase the extension size will also increased by 0.066.

Table 4.6 Cross tabulation between Tumor type and Tumor Site :

Tumor Type * site Cross tabulation					
		Site			Total
		Upper Esophagus	Middle Esophagus	Lower Esophagus	
Tumor Type	Adeno Carcinoma	3	7	11	21
	Squamous cell Carcinoma	4	2	8	14
Total		7	9	19	35

Table 4.7 Chi square Test Shows the Linear by linear association between Tumor type and Tumor Site :

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.077[a]	2	.354
Likelihood Ratio	2.151	2	.341
Linear-by-Linear Association	.118	1	.731
N of Valid Cases	35		
a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.80.			

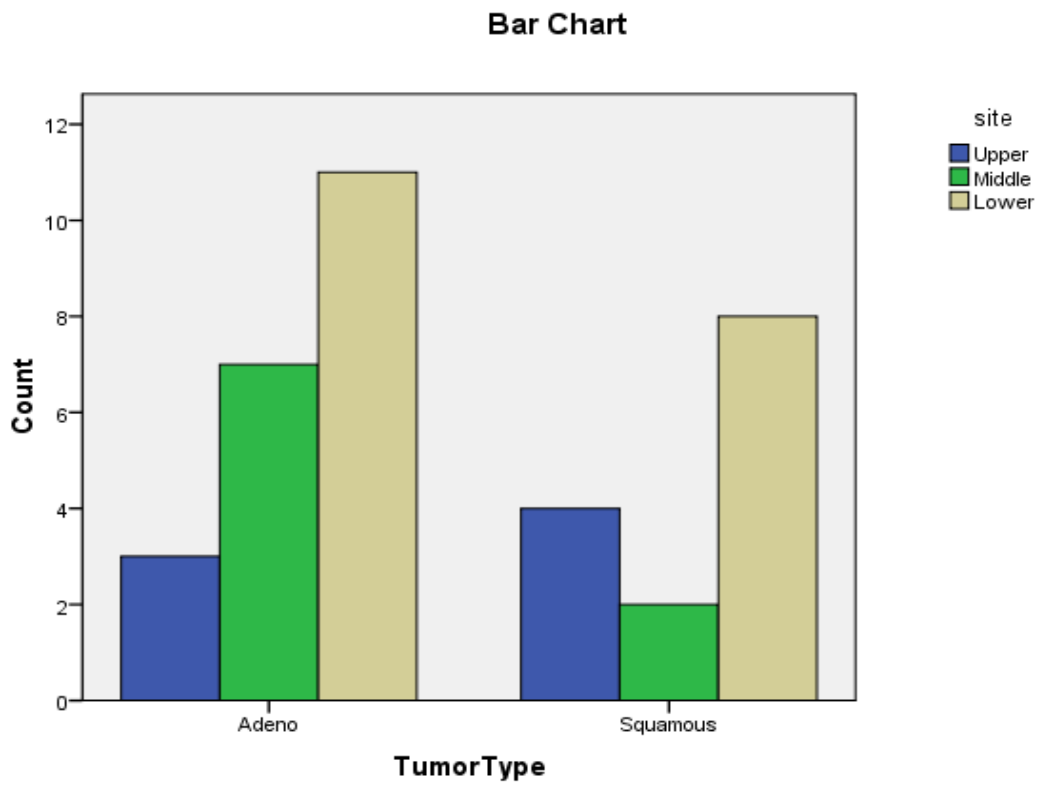

Figure 4.7 Bar chart shows the tumor type and Site as upper third of the esophagus, Middle Third, Lower Third.

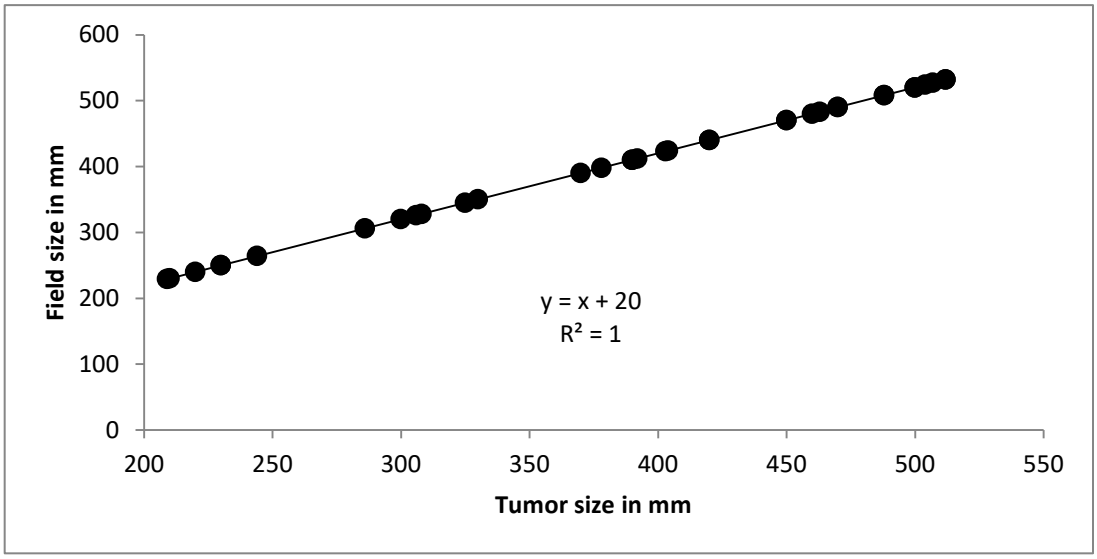

Figure 4.8 scatter plot diagram shows the linear relationship between field Size and Tumor size, as the tumor Size increase the field Size will also increased by x+20

Chapter Five

Discussion,Conclusion and Recommendation

5-1 Discussion :

The result of data analysis collected from 35 patients with confirmed esophageal carcinoma with ages from (50 to74) year , show that the age group (56-61) year is the most affected group (31%) ,the lower frequency group is (50-55) year (11,4%), and esophageal carcinoma is more common in female (62.9%) than male (37.1%) and commonly adenocarcinoma (60%), Squamous Cell Carcinoma (40%) , the average CT number tumor cells is 42.9 Hounsfield Unit (HU) and the average tumor size is 386.8 mm with sub-mucosal extension 61.2 mm , the common anatomical site of the esophagus involved is the lower third of esophagus (54.3%) followed by the middle third (25.7%) and the upper third (20%) , there was linear relationship between tumor CT number and patient age after 58.7 years. when the tumor sub-mucosal extension also increase 0.066mm , and the common site of esophagus affected by adenocarcinoma is the lower third of esophagus and gradually decrease when moving superiorly , however squamous cell carcinoma is not. According to previous studies of the esophageal carcinoma and it's assessment by CT the result showed increasing in the distribution among males more than females. The result taken from (Hongal , (2004) 84.5 % male versus 15.5% female .The lower third of the esophagus is the most common site of the esophageal carcinoma (54.3%) Then the middle third (37.1%), the upper third (8.6%),the common histological type of esophageal carcinoma is adenocarcinoma (64.3%), in contrast with the other type such as squamous cell carcinoma and carcinoma insitu which representing (34.3%) and 1.4% respectively (Enas, 2o12) .

5-2 Conclusion :

The Diagnosis of esophageal carcinoma commonly done by endoscopic ultrasonography(EUS) , computed tomography (CT) and Positron emission tomography (PET).

Currently the combined use of CT , EUS,and PET is the best to determine the route of treatment .

Our study population include 35 patients with esophageal carcinoma who had a CT scan to determine the accurate site , size of tumor and possible sub-mucosal extension in order to determine the best treatment .

The result of data analysis showed that the most affected age with esophageal carcinoma is from (56-61)years (31%) and esophageal carcinoma is more common in females (62.9%) than males (37.1%) .

The common anatomical site of the esophagus involved is the lower third (54.3%) .

5-3 Recommendations :

During the fulfillment of the following thesis, the researchers encountered with some ideas and hypothesis if they could be achieved would strengthen the current thesis else they could be considering in future works such as:

- The tumor sub-mucosal invasion better be visualized and planned by using PET-CT.
- The utilization of CT has to be applied as conventional tool in radiotherapy field.
- Many cancer types have microscopic invasion such as cervical carcinoma, ovarian carcinoma, Bladder, prostate … etc., all need to be studied and re-assessing their radiation field size relative to tumor extension.
- A research related to the induction factors of adenocarcinoma has to be motivated nationally.

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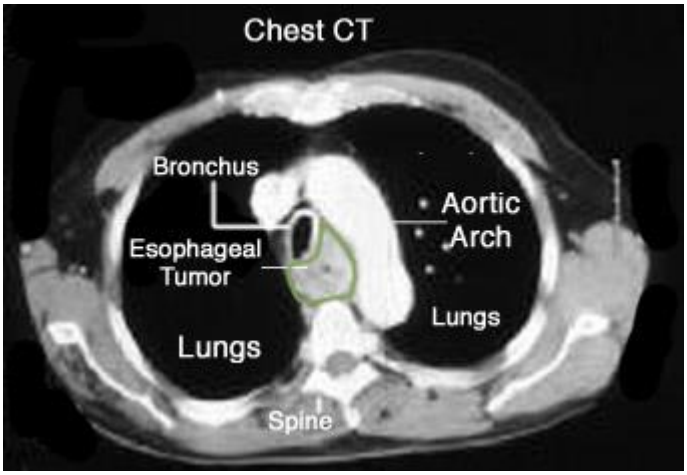
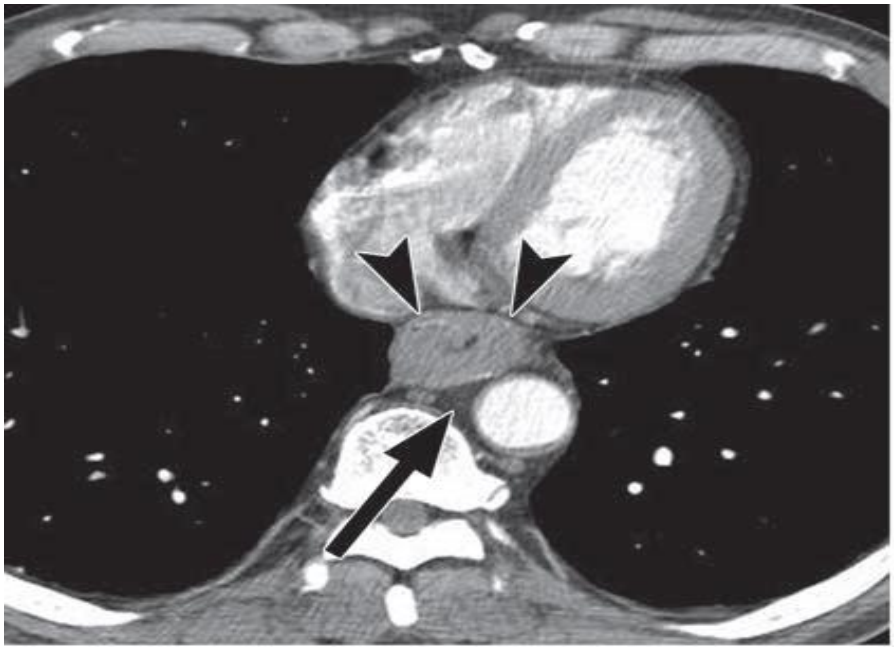
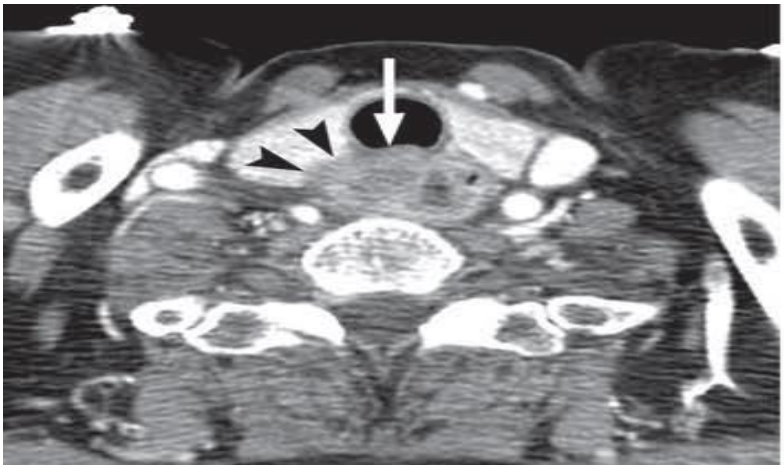
Appendices :



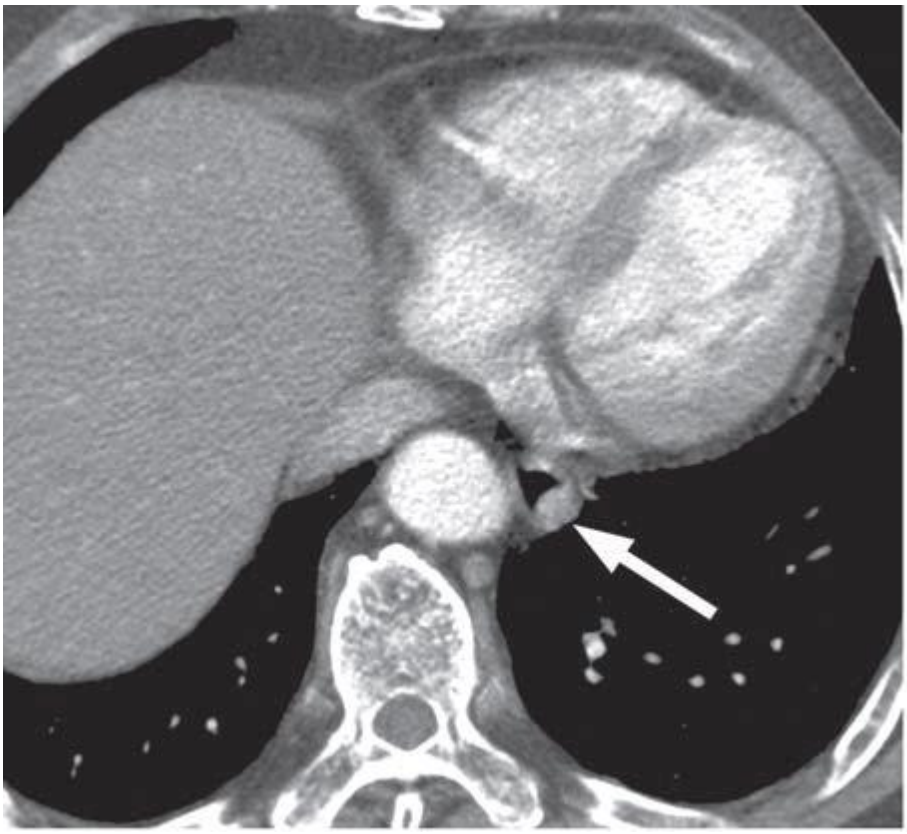
(1) 35 years old male CT axial scan demonstrates an esophageal tumor adjacent to the aorta and the bronchus.



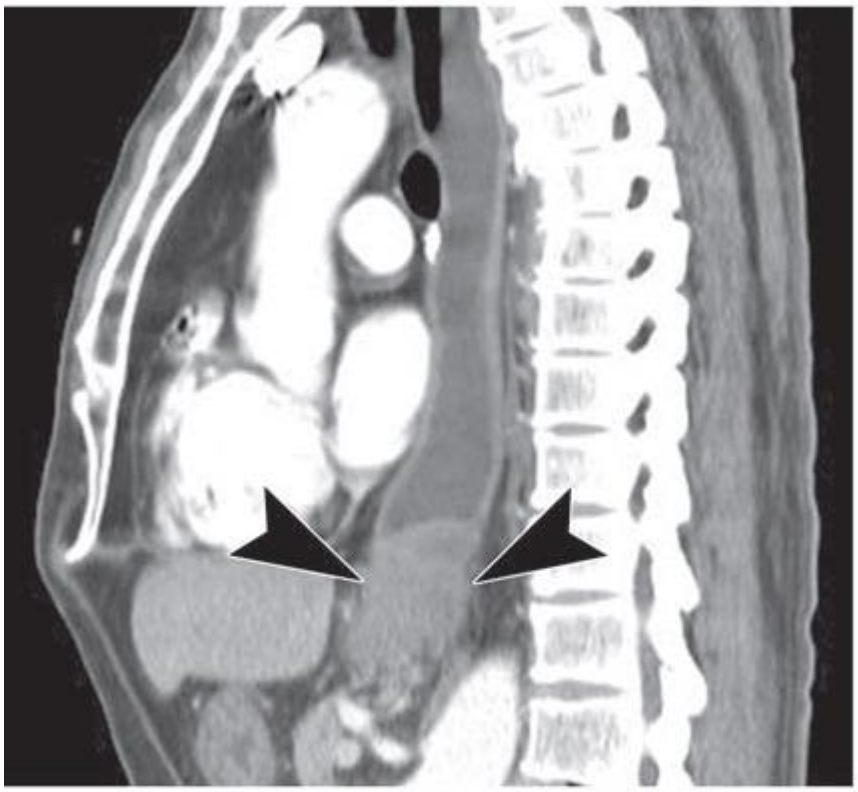
(2) . 66 years old man Axial CT scan obtained at the middle shows lower esophageal carcinoma with diffuse esophageal wall thickening .



(3) .45 years old female Contrast-enhanced CT scan obtained at the level of the thyroid gland shows a tumor that has invaded the posterior portion of the right side of the gland (arrowheads), along with bowing and displacement of the posterior wall of the trachea (arrow)



(4) The lower esophagus in a 61-year-old manContrast-enhanced CT scan obtained at the level of the left ventricle shows an eccentric, nodular esophageal lesion (arrow).



(5) 30 years old maleSagittal CT scan clearly shows tumor involvement of the lower esophagus, gastroesophageal junction, and part of the heart (arrowheads).