Evaluation of the Functional Outcome of laparoscopic Heller Cardiomyotomy in treatment of patients with achalasia of the cardia

Thesis

Submitted for partial fulfillmentof MD degree in general surgery

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2022

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بالمنظار في علاج مرضى تعذر ارتخاء المرىء

رسالة مقدمه من

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2022

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LIST OF ABBREVIATIONS

ECG	Electrocardiography
EPT	Esophageal pressure topography
EUS	Endoscopic ultrasound
FNA	Fine needle aspiration
GEJ	Gastroesophageal junction
GERD	Gastroesophageal reflux disease
HRM	High-resolution manometry
HSV-1	Herpes simplex virus-1
IRP	Integrated relaxation pressure
LES	Lower esophageal sphincter
LHM	Laparoscopic Heller myotomy
PBD	Pneumatic balloon dilation
SCJ	Squamocolumnar junction
tLESRs	Transient LES relaxations
UES	Upper esophageal sphincter
VIP	Vasoactive intestinal peptide

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INTRODUCTION

Esophageal achalasia is an esophageal motility disorder of unknown etiology that results in impaired relaxation of the lower esophageal sphincter (LES) and loss of esophageal peristalsis ***(*Pandolfino *et al., 2015).***

Achalasia can be primary (idiopathic) or secondary. In secondary achalasia, the cause for the degeneration of esophageal nerve fibers is known. Pathophysiologically, achalasia is caused by loss of inhibitory ganglion cells in the myenteric plexus. Several studies have attempted to explore initiating agents that may cause the disease such as viral infection, other environmental factors, autoimmunity, and genetic factors. However, the exact pathogenesis of primary achalasia is still not known ***(*Pandolfino *et al., 2016).***

The diagnosis of achalasia usually starts with a barium esophagram followed by esophageal manometry the latter being considered the "gold standard" for the diagnosis. On conventional manometry, absence of peristalsis sometimes with increased intraesophageal pressure owing to stasis of food and saliva and incomplete relaxation of the LES on swallowing (residual pressure>8– 10 mmHg) are the hallmarks of achalasia ***(Boeckxstaens et al., 2014).***

However, traditional manometry had limitations: (1) 20–25 % of suspected achalasia patients had normal LES relaxation despite all the other features of achalasia (2) "vigorous" achalasia was a nebulous term overlapping with diffuse esophageal spasm, and (3) despite its key role in diagnosis, manometric features did not help predict response to medical or surgical treatment. The new system of high-resolution manometry

(HRM) records intraluminal pressures circumferentially at 1-cm intervals over a 36-cm recording segment. This permits comprehensive description of esophageal motor events that are providing new insights into normal and disordered esophageal motor function ***(Richter et al., 2014).***

Treatments for esophageal achalasia are aimed at long-term symptomatic relief by decompression of the LES pressure. Various treatments are currently available, including pharmacological therapy (such as nitrates and short-acting calcium antagonists), endoscopic injection of botulinum toxin, endoscopic pneumatic balloon dilation (PBD), and laparoscopic or open esophagocardiomyotomy with antireflux procedure ***(Souma et al., 2017).***

Surgical cardiomyotomy (Heller myotomy) is now one hundred years old, the first report being dated in 1914. In the nineties, it has been revived through a minimal invasive approach (Laparoscopic Heller myotomy, LHM) and since then it has become the golden standard to measure the efficacy of treatments for achalasia and the preferred treatment (especially in young patients), achieving good long-term results in about 90 % of cases in most published series. It is a simple, elegant, one-shot therapy that has virtually no mortality and very little morbidity ***(Salvador et al., 2016).***

Apart from its efficacy in resolving dysphagia, LHM is a remarkably safe operation with minimal complications rate and in most cases, it is performed with a postoperative hospital stay of 1–2 days ***(Markar et al., 2015).***

Heller's myotomy requires delicate manipulation by preserving only the mucous membrane. To achieve complete disappearance of preoperative symptoms, myotomy needs to cover the gastric side as well

as the esophageal side sufficiently. For this reason, mucosal injury of the esophagus and stomach can occur as the intraoperative complication during this procedure ***(Tsuboi et al., 2016).***

Intraoperative perforation of the esophageal mucosa is one of the most common complications associated with the procedure while performing the myotomy, which may occur in as many as 10%of cases ***(Salvador et al., 2016).***

Perforations are usually evident during the operation and repaired immediately, without any need to convert to open surgery. They are occasionally discovered afterwards, on a performed contrast swallow study before resuming oral intake, in which case they are generally managed conservatively. Reoperation is seldom necessary ***(Salvador et al., 2016).***

The intraoperative management of mucosal injury by suturing the perforated area with interrupted 3-0 Maxon sutures under laparoscopic guidance and performing Dor fundoplication to cover the perforated area ***(Tsuboi et al., 2016).***

AIM OF THE WORK

The aim of the study is to assess the functional Outcome of laparoscopic heller cardiomyotomy in treatment of patients with achalasia of the cardia using the Eckardt score.

CHAPTER 1

GASTROESOPHAGEAL JUNCTION

The upper esophageal sphincter (UES) and lower esophageal sphincter (LES) mark the entrance and exit to the esophagus, respectively. These sphincters are defined by a high-pressure zone but can be difficult to identify anatomically. The UES corresponds reliably to the cricopharyngeus muscle, but the LES is more complex to discern.

There are four anatomic points that identify the gastroesophageal junction (GEJ): two endoscopic and two external. Endoscopically, there are two anatomic considerations that may be used to identify the GEJ. The squamocolumnar epithelial junction (Z-line) may mark the GEJ provided that the patient does not have a distal esophagus replaced by columnar-lined epithelium, as seen with Barrett esophagus.

The transition from the smooth esophageal lining to the rugal folds of the stomach may also identify the GEJ accurately. Externally, the collar of Helvetius (or loop of Willis), where the circular muscular fibers of the esophagus join the oblique fibers of the stomach, and the gastroesophageal fat pad are consistent identifiers of the GEJ ***(Townsend, 2021).***

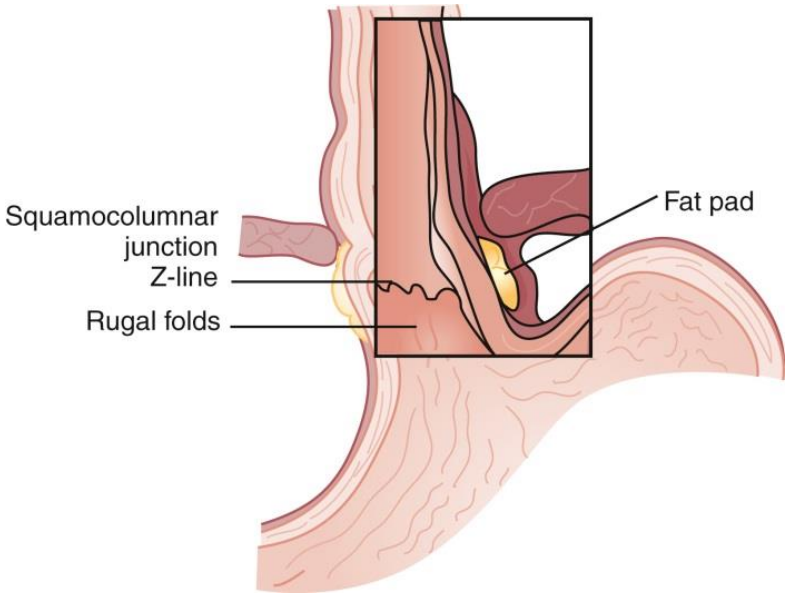

Figure (1): Identifiers of the gastroesophageal junction ***(Townsend, 2021).***

The gastroesophageal junction (GEJ) is the level at which the esophagus ends and the stomach begins. Unfortunately, there are no universally accepted landmarks that clearly delimit the distal esophagus and the proximal stomach, and the GEJ has been defined differently by anatomists, radiologists, physiologists, and endoscopists ***(Oh et al., 2019).***

Landmarks suggested by anatomists, such as the peritoneal reflection or the character of the muscle bundles in the esophageal wall, are not useful for endoscopists. Radiologists refer to the region of the GEJ as the vestibule, and they seldom attempt to localize the precise point at which the esophagus joins the stomach. Physiologists have used the distal border of the LES (determined manometrically) to define the GEJ, but it is not feasible to identify this border precisely by endoscopic techniques ***(Oh et al., 2019).***

Anatomically the distal end of the esophagus is anchored to the diaphragm by the phrenoesophageal ligament that inserts circumferentially into the esophageal musculature close to the squamocolumnar junction (SCJ). The esophagus then traverses the diaphragmatic hiatus and joins the stomach almost tangentially. Thus, there are 3 contributors to the EGJ high-pressure zone: the LES, the crural diaphragm, and the musculature of the gastric cardia that constitutes the distal aspect of the EGJ. The LES is a 3- to 4-cm segment of tonically contracted smooth muscle at the distal extreme of the esophagus. Surrounding the LES at the level of the SCJ is the crural diaphragm; most commonly bundles of the right diaphragmatic crus forming a teardrop-shaped canal about 2 cm long on its major axis ***(Jaffee, 2002).***

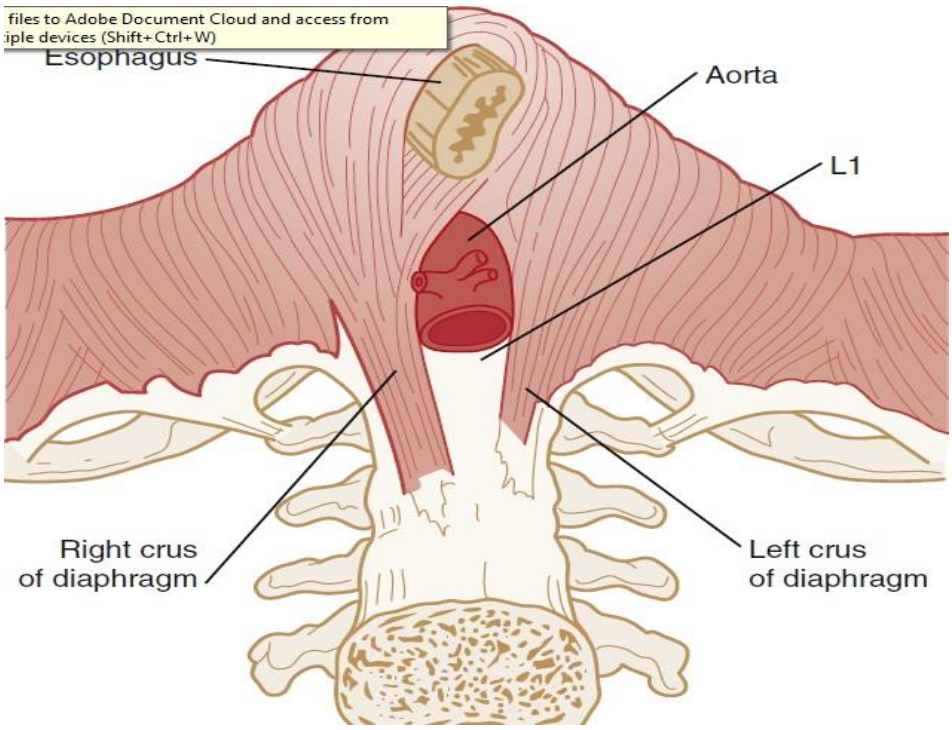

Figure (2): Anatomy of the diaphragmatic hiatus as viewed from below. The most common anatomy, in which the muscular elements of the crural diaphragm derive from the right diaphragmatic crus, is shown. The right crus arises from the anterior longitudinal ligament overlying the lumbar vertebrae. Once muscular elements

emerge from the tendon, 2 flat muscular bands form that cross each other in scissor-like fashion forming the walls of the hiatus and then merging with each other anterior to the esophagus. ***(Jaffee, 2002).***

The component of the EGJ high-pressure zone distal to the SCJ is largely attributable to the opposing sling and clasp fibers of the middle layer of gastric cardia musculature. In this region, the lateral wall of the esophagus meets the medial aspect of the dome of the stomach at an acute angle, defined as the angle of His. Viewed intraluminally, this region extends within the gastric lumen, appearing as a fold that has been conceptually referred to as a "flap valve" because increased intragastric pressure forces it closed, sealing off the entry to the esophagus ***(Pandolfino and Kahrilas, 2016).***

Physiologically, the EGJ high-pressure zone is attributable to a composite of both the LES and the surrounding crural diaphragm extending 1 to 1.5 cm proximal to the SCJ and about 2 cm distal to it ***(Pandolfino and Kahrilas, 2016).***

Resting LES tone ranges from 10 to 30 mm Hg relative to intragastric pressure, with considerable temporal fluctuation. With HRM, this is quantified as the EGJ contractile integral, and the normal value ranges from 28 to 125 mm Hg/cm ***(Pandolfino and Kahrilas, 2016).***

The mechanism of LES tonic contraction is likely both myogenic and neurogenic, consistent with the observation that pressure within the sphincter persists after elimination of neural activity with tetrodotoxin. Myogenic LES tone varies directly with membrane potential that leads to an influx of Ca 2+. Apart from myogenic factors, LES pressure is also modulated by intra-abdominal pressure, gastric distention, peptides,

hormones, foods, and many medications ***(Pandolfino and Kahrilas, 2016).***

Histologically the wall of the esophagus is described as constituted by four layers: mucosa, submucosa, muscularis propria, and serosa ***(Pandolfino and Kahrilas, 2016).***

Cardiac Mucosa

There is great controversy regarding the nature and the origin of the cardiac-type mucosa at the GEJ. The view that the distal 2–3 cm of the esophagus is normally lined by columnar cardiac-type mucosa, extending between the esophageal squamous mucosa and the gastric acid-producing oxyntic mucosa, is denied by some investigators ***(Chandrasoma et al., 2000).***

Chandrasoma et al. (2000) suggested that the presence of cardiac or oxyntocardiac mucosa represents early histological evidence of gastroesophageal reflux.

On the contrary, other investigators consider that cardiac mucosa is a normal structure at the GEJ and that it is defined by the presence of mucous cells without regard to the presence or absence of parietal cells (oxyntic mucosa) ***(Kilgore et al., 1999).***

Cohen et al. (2009) suggested that columnar-lined cardiac-type mucosa is usually seen at the GEJ in fetuses and children. Interestingly, the columnar cells of the cardiac-type mucosa present at the distal esophagus/GEJ region contain neutral mucins and can also contain acidic mucins.

Despite this debate, it has been suggested that it is still possible that a metaplastic expansion of the cardiac mucosa into the distal esophagus can occur as part of the stepwise transformation of the mucosa as a consequence of long-standing gastroesophageal reflux ***(Cohen et al., 2009).***

The Squamous Mucosa

The mucosa is composed of the lamina propria and the muscularis mucosae, both lined by epithelium ***(Cohen, 2017).***

This is most usually non-keratinizing squamous epithelium. The non-keratinizing squamous epithelium is composed of three major cell layers: a deep basal cell layer, an intermediate or prickle cell layer, and a superficial functional cell layer ***(De Nardi and Riddell, 2007).***

The intermediate or prickle cell layer is composed of several layers of polygonal cells with numerous intercellular bridges ***(de Hertogh et al., 2006).***

The superficial functional layer contains pale cells, rich in glycogen, gradually flattened, and with pyknotic nuclei. In addition, their long axis gradually becomes parallel to the basal membrane ***(de Hertogh et al., 2006).***

Other cells present in the mucosa include endocrine cells, rare melanocytes, and Langerhans cells. The latter is part of the local immune system and acts as antigen-presenting cells. Occasionally mast cells and single eosinophils can be found in the epithelium of the normal GEJ ***(de Hertogh et al., 2006).***

The Lamina Propria

This is comprised of loose connective tissue located between the muscularis mucosae and the epithelium. It contains vessels and mucus-secreting glands.

The connective tissue projects into the overlying epithelium as papillae. These contain delicate blood vessels that nourish the mucosa. In normal conditions, the papillae do not reach the upper third of the epithelium. However, in circumstances of gastroesophageal reflux, they become hyperplastic, reaching the most superficial part of the squamous mucosa. The glands present in the lamina propria of the GEJ are mucous-secreting cardiac-type glands ***(De Nardi and Riddell, 2007)***

The Muscularis Mucosae

It is composed of longitudinal-oriented smooth muscle fibers and is characteristically thicker at the distal esophagus (GEJ) than in other segments of the esophagus ***(Cohen, 2017).***

The Submucosa

This is composed of connective tissue containing blood vessels, nerves, and mucus-secreting glands. These glands have a lobulated shape, produce acid mucins, and drain to the surface of the esophagus by squamous-lined ducts ***(Cohen, 2017).***

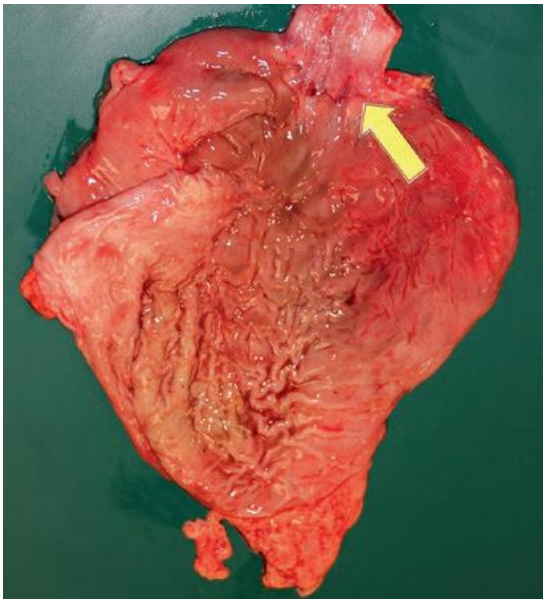

Figure (3): Postmortem specimen from a 4-year-old child showing the irregular gastroesophageal junction (arrow) where the white esophageal mucosa joins the red gastric mucosa ***(Cohen, 2017).***

CHAPTER 2

PATHOPHYSIOLOGY

Introduction

Achalasia results from progressive degeneration of ganglion cells in the myenteric plexus in the esophageal wall, leading to failure of relaxation of the lower esophageal sphincter, accompanied by a loss of peristalsis in the distal esophagus. This topic will review the etiology, pathogenesis, clinical manifestations, and diagnosis of achalasia ***(Schlottmann et al., 2018).***

Epidemiology

Achalasia is an uncommon disorder with an annual incidence of approximately 1.6 cases per 100,000 individuals and prevalence of 10 cases per 100,000 individuals ***(Schlottmann et al., 2018).*** Men and women are affected with equal frequency. The disease can occur at any age, but onset before adolescence is rare. Achalasia is usually diagnosed in patients between the ages of 25 and 60 years ***(Samo et al., 2017).***

Achalasia may occur in association with adrenal insufficiency and alacrima in patients with triple A syndrome or Allgrove syndrome, a rare autosomal recessive genetic disorder ***(Zaninotto et al., 2008).***

Etiology

Achalasia is thought to occur from the degeneration of the myenteric plexus and vagus nerve fibers of the lower esophageal sphincter ***(Zaninotto et al., 2008).*** There is a loss of inhibitory neurons containing vasoactive intestinal peptide (VIP) and nitric oxide synthase at the

esophageal myenteric plexus, but in severe cases, it also involves cholinergic neurons ***(Rohof et al., 2013).***

The exact etiology of this degeneration is unclear though many theories have been proposed. These theories include an autoimmune phenomenon, viral infection, and genetic predisposition ***(Pandolfino and Gawron, 2015).***

Most cases are primary idiopathic achalasia; however, secondary achalasia may be seen in Chagas disease caused by Trypanosoma cruzi, esophageal infiltration by gastric carcinoma, eosinophilic gastroenteritis, lymphoma, certain viral infections, and neurodegenerative disorders ***(Pandolfino et al., 2008).***

1. Familial

The existence of familial cases may suggest that achalasia is an inherited disease. Such familial cases have been mostly seen in the pediatric population, between siblings and in a few cases in monozygotic twins ***(Rohof et al., 2013).***

There are also a few reports of a parent-child association for achalasia. Although these evidences suggest an autosomal recessive mode of inheritance for this disease, the rarity of familial occurrence does not support the hypothesis that genetic inheritance is a significant etiologic factor in most cases of achalasia ***(Kahrilas et al., 2016).***

Instead, it is proposed that genetic predisposition in such individuals probably increases their susceptibility to acquiring achalasia after exposure to common environmental factors that may play a role in the pathogenesis ***(Pandolfino and Gawron, 2015).***

2. Infection

Several studies have suggested a possible association between viral infections and achalasia. In such studies, various viral antibodies were measured in sera of the patients with achalasia and the normal controls, and only measles and varicella zoster virus antibodies were found to be higher among a number of achalasia patients ***(Zaninotto et al., 2008).***

On the other hand, in the clinical setting not all patients with measles and varicella will develop achalasia. Using polymerase chain reaction, other studies have demonstrated no evidence of any viral products in the esophageal tissue of patients with achalasia. In addition, even those studies that found evidence of a virus, could not establish a causal relationship ***(Vaezi et al., 2013).***

In conclusion, available evidence suggests that infection may not be a definite cause for esophageal achalasia. One strong piece of evidence in favor of infection in the pathogenesis of achalasia, however, is the fact that Chagas disease, caused by *Trypanosoma cruzi*, very closely mimics the pathophysiology of primary achalasia ***(Pandolfino and Gawron, 2015).***

3. Autoimmune

Increased prevalence of circulating antibodies against myenteric plexus in some achalasia patients led to the suggestion of a role for autoantibodies in the pathogenesis of this disease ***(Pandolfino and Gawron, 2015).***

However, another study suggested that these circulatory antibodies are most likely the result of a nonspecific reaction to the disease process instead of being the cause of the disease ***(Moses et al., 2003).***

This idea was supported by detection of similar antibodies in patients without achalasia. Ultrastructural studies of the esophageal tissue of patients with achalasia have also found inflammatory infiltrates around myenteric neurons, while in control group normal myenteric plexus was found without infiltration ***(Moses et al., 2003).***

Multiple case-control studies have reported a significant association with HLA class II antigens in idiopathic achalasia. HLA association also suggests immunogenetic predisposition for idiopathic achalasia; however, this should be taken with caution as not all the achalasia patients have associated HLA antigens ***(Sodikoff et al., 2016).***

The most recent genetic association study in 4,242 controls and 1,068 achalasia patients imputed classical HLA haplotype and amino acid polymorphisms suggesting immune mediated processes in idiopathic achalasia ***(Sodikoff et al., 2016).***

Pathogenesis

Achalasia results from inflammation and degeneration of neurons in the esophageal wall. The cause of the inflammatory degeneration of neurons in primary achalasia is not known. The observations that achalasia is associated with variants in the HLA-DQ region and that affected patients often have circulating antibodies to enteric neurons suggest that achalasia is an autoimmune disorder ***(Borhan-Manesh et al., 2016).***

Some investigators have proposed that the inflammatory attack on esophageal neurons in achalasia is triggered by an antibody response to viral infections (eg, herpes zoster, measles viruses), but data have been inconclusive ***(Sodikoff et al., 2016).*** A study evaluating T cells in patients

with achalasia found reactivity to HSV-1, suggesting that achalasia may be triggered by HSV-1 infection ***(Gockel et al., 2014).***

A genetic predisposition to the inflammatory degeneration of ganglion cells in achalasia is suggested by its association with variants in the HLA-DQ region and by its occurrence in genetic syndromes such as Allgrove syndrome ***(Gockel et al., 2014).***

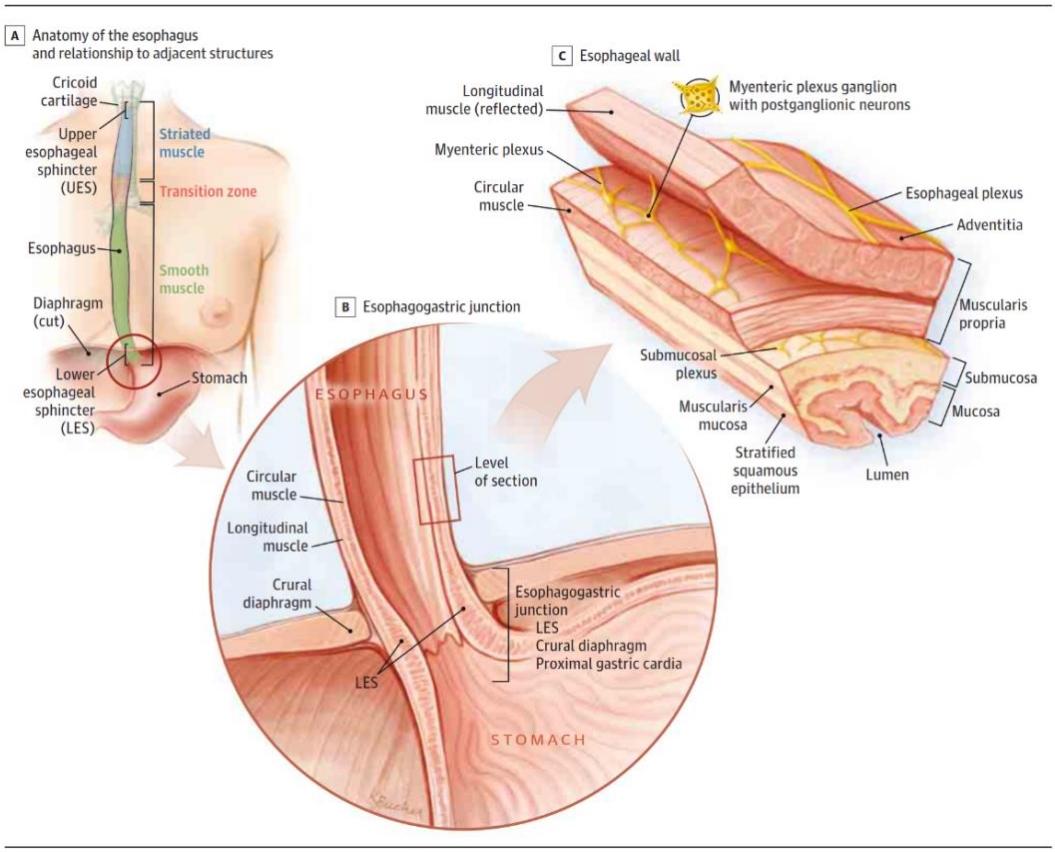

Figure (4): Anatomy and innervation of the esophagus ***(Pandolfino and Gawron, 2015).***

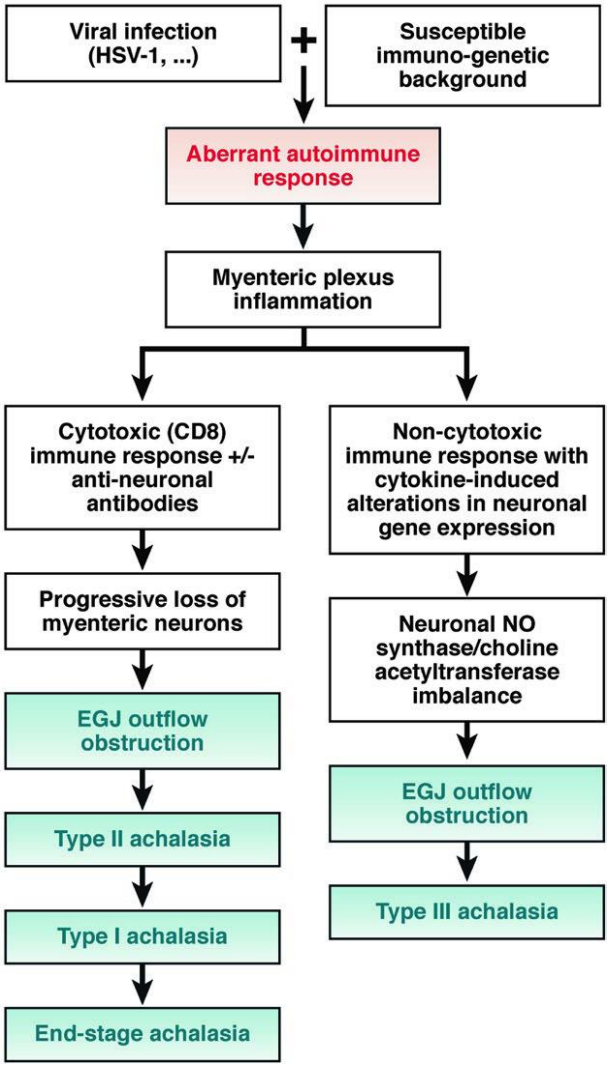

Figure (5): Flow chart ***(Stuart et al., 2020).***

Histologic examination of the esophagus in patients with achalasia reveals decreased numbers of neurons (ganglion cells) in the myenteric plexuses, and the ganglion cells that remain often are surrounded by lymphocytes and, less prominently, by eosinophils ***(Boeckxstaens et al., 2014).***

This inflammatory degeneration preferentially involves the nitric oxide-producing, inhibitory neurons that affect the relaxation of esophageal smooth muscle; the cholinergic neurons that contribute to

lower esophageal sphincter (LES) tone by causing smooth muscle contraction may be relatively spared ***(Gockel et al., 2014).***

In some patients, degenerative changes are also found in the ganglion cells of the dorsal motor nucleus of the vagus in the brainstem, and Wallerian degeneration has been observed in the vagal fibers that supply the esophagus ***(Sodikoff et al., 2016).***

However, the disordered motility that characterizes achalasia appears to result primarily from the loss of inhibitory neurons within the wall of the esophagus itself. Loss of inhibitory innervation in the LES causes the basal sphincter pressure to rise, and renders the sphincter muscle incapable of normal relaxation. In the smooth muscle portion of the esophageal body, the loss of inhibitory neurons results in aperistalsis ***(Pandolfino and Gawron, 2015).***

The manifestations of achalasia depend on the degree and location of ganglion cell loss ***(Pandolfino and Gawron, 2015).*** Loss of peristalsis in the distal esophagus and a failure of LES relaxation with swallowing both impair esophageal emptying; however, most of the symptoms and signs of achalasia are due primarily to the defect in LES relaxation (esophagogastric junction outflow obstruction) ***(Sodikoff et al., 2016).***

Pseudoachalasia

Pseudoachalasia is a rare clinical entity accounting for only 2.4–4% of patients presenting with achalasia‐like symptoms. Horvath first suggested this entity in 1919. Ogilvie later described the syndrome in 1947. He described it as a form of achalasia as a result of the involvement of the cardia region from gastric carcinoma ***(Abubakar et al., 2016).***

Primary malignancies of the esophagus and esophagogastric junction account for 50% of cases of pseudoachalasia. This is followed by secondary malignancies (18%) such as metastases, which primarily originated from the lungs and breast. Malignancies from different parts of the body have also been reported ***(Bonavina et al., 2007).***

Benign causes of pseudoachalasia include benign mesenchymal tumors, secondary amyloidosis, and peripheral neuropathy. Others include pancreatic pseudocyst, sarcoidosis, neurofibromatosis, esophageal leiomyomatosis, esophageal mesenchymal tumors, juvenile Sjogren syndrome, chronic idiopathic intestinal pseudo‐obstruction, and a few surgeries (vagotomy, bariatric, and Nissen fundoplication) ***(Campo et al., 2013).***

The classic symptom presentation of short‐term interval weight loss, progressive dysphagia, and chest pain are secondary to impaired esophageal emptying at the distal esophagus ***(Fabian et al., 2019).***

Patients with pseudoachalasia are usually over 50 years of age; they present with a short history of progressive dysphagia usually <1 year and significant weight loss usually >7 kg and retrosternal pain. They may present with other features of primary malignancy ***(Lipka and Katz, 2013).***

Pseudoachalasia often presents serious diagnostic difficulty and the consequent delay in instituting appropriate treatment may result in an underlying carcinoma becoming inoperable ***(Ravi et al., 2016).***

Careful preoperative assessment is imperative prior to surgical intervention Barium swallow findings often mimic the classic primary achalasia finding of the smooth tapering distal esophagus (“Bird’s beak”

appearance) and dilated esophagus with barium column ***(Campo et al., 2013).***

However, barium swallow features that may be suggestive of pseudoachalasia are a short segment of dilated esophagus, asymmetry of esophageal narrowing, asymmetry of esophageal wall thickness, rigidity of lower esophagus, deformity of the stomach, and mucosal ulceration ***(Abubakar et al., 2016).***

Endoscopic biopsy remains the most definitive tool for the diagnosis of pseudoachalasia occurring secondary to distal esophageal or esophagogastric junction carcinoma. The hallmark pathologic characteristics of this condition are an invasion and disruption of the myenteric plexus or a paraneoplastic autoimmune‐mediated depletion of myenteric ganglion cells CT scan may also show intrathoracic malignancies infiltrating the esophagus ***(Campo et al., 2013).***

CHAPTER 3

PNEUMATIC BALLOON DILATATION

The main medical intervention for achalasia is balloon dilatation. It is currently done with a standard noncompliant balloon (with a Rigiflex dilator by Boston Scientific) and comes in three sizes (30, 35, and 40 mm diameters). It is positioned across the LES, commonly under fluoroscopic control and with the aid of a guide wire, and is inflated with air to forcefully stretch the LES muscle ***(Ajayeoba and Diehl, 2020).***

The balloon is kept inflated for about 15 to 60 seconds, while straightening of the balloon waist at the level of the LES is observed ***(Ajayeoba and Diehl, 2020).***

Following dilation, patients are evaluated by a Gastrografin study followed by a barium esophagogram to exclude esophageal perforation. Graded dilation, starting with the smallest diameter, is the recommended approach, with symptomatic and radiographic assessment within 4 to 6 weeks after treatment, and repeat dilation with a larger size balloon in case of failed response ***(Ajayeoba and Diehl, 2020).***

Clinical response following pneumatic balloon dilatation as the initial therapy for achalasia varies depending on the balloon size and number of dilations. A success rate of 28% versus 44% was achieved at 6 years with single versus serial dilation, respectively ***(de Heer et al., 2021).***

A number of variables have been associated with a favorable response to PD, including older age (>45 years), female gender, narrow esophagus prior to PD, and type II pattern on HRM, and may influence

the selection of medical versus surgical treatment approach ***(Oude Nijhuis et al., 2020).***

Balloon dilation can also be performed after failed Heller myotomy, though response is suboptimal in patients with adequate reduction in LES pressure. Chest pain is common after PD, but the feared complication is perforation ***(Sediqi et al., 2021).***

Early literature with pneumatic dilatation quoted high perforation rates (> 5%); however, with adoption of the newer Rigiflex balloons (Boston Scientific, Marlborough), those rates are decidedly lower ***(Ajayeoba and Diehl, 2020).***

In a systematic review of 24 studies encompassing 1144 patients with an average follow-up of approximately 3 years, the overall clinical response to pneumatic dilatation was 78%; however, there was a graded response rate based on the balloon size employed. Dilatation using a 3.0-cm balloon alone resulted in a clinical improvement rate of 74%, versus 86% with a 3.5-cm balloon and 90% with a 4.0-cm balloon ***(Sediqi et al., 2021).***

Approximately one-third of patients were noted to have recurrence of symptoms requiring additional intervention, usually a repeat pneumatic dilatation. The perforation rate was 1.9%.Predictors of decreased response include age over 40 years, male gender, dilated esophagus, small-size balloon, a single dilatation procedure, LES pressure greater than 10 to 15 mm Hg within a year of the procedure, poor esophageal emptying via barium swallow following treatment, and a type III HRM pattern ***(Sediqi et al., 2021).***

Pneumatic dilatation is typically performed in the endoscopy suite utilizing fluoroscopic guidance. If the risk of aspiration is significant (e.g., if the patient has food or liquid retention on prior endoscopy or imaging), then a liquid diet may be employed for a few days and a longer preprocedure fasting period may be utilized ***(Ajayeoba and Diehl, 2020).***

Efforts should be made to perform these procedures in the morning, as patients may require extended postprocedure monitoring. Either conscious sedation in the left lateral position or anesthesia with airway protection can be employed, based on aspiration risk and local practice patterns

During endoscopy, a Savary guidewire is placed in the stomach under endoscopic guidance, and the endoscope is subsequently removed. A Rigiflex balloon (Boston Scientific) is then passed over the guidewire and fluoroscopically positioned across the narrowed EGJ region ***(Sediqi et al., 2021).***

The balloon is then inflated until the radiographic waist from the LES (located ideally in the middle of the balloon) is flattened. The balloon can be held in place for 60 seconds if desired, although there is no convincing evidence that keeping the balloon inflated longer than what is required to achieve initial waist flattening improves outcomes ***(Soffer, 2019).***

The balloon is then deflated and removed. In some centers, radiographic contrast may be used instead of air to enhance radiographic visualization. The patient is then typically monitored for 2 to 6 hours postprocedure. A gastrografin esophagram can be employed to evaluate for perforation if there is significant pain. Some centers obtain this

routinely after pneumatic dilatation to exclude perforation, but this is controversial ***(Soffer, 2019).***

CHAPTER 4

MANAGEMENT OF ACHALASIA

Achalasia has an insidious onset, and disease progression is gradual. Patients typically experience symptoms for years prior to seeking medical attention. In patients with newly diagnosed achalasia, the mean duration of symptoms was 4 years prior to the diagnosis ***(Schlottmann et al., 2018).*** The delay in diagnosis was mainly due to misinterpretation of typical clinical features. Patients are often treated for other disorders including gastroesophageal reflux disease (GERD) before the diagnosis of achalasia is established ***(Vaezi et al., 2013).***

Esophageal achalasia is a primary esophageal motility disorder with a peak incidence occurring between 30 and 60 years of age. It is characterized by absence of esophageal peristalsis and by impaired lower esophageal sphincter (LES) relaxation in response to swallowing. As a consequence, there is abnormal emptying of food from the esophagus into the stomach with consequent stasis ***(Vaezi et al., 2013).***

The diagnosis of achalasia is challenging since it is a rare disease and symptoms are non- specific: dysphagia, regurgitation of undigested food, aspiration, heartburn, and chest pain. As a consequence, there is often a long delay between the onset of symptoms and the diagnosis ***(Zaninotto et al., 2008).***

Since a diagnosis based on symptoms only is uncertain, a proper work-up is necessary to make the diagnosis of achalasia. The diagnostic work- up includes symptom evaluation, upper endoscopy, barium

esophagram, esophageal manometry and ambulatory 24-h pH monitoring ***(Kahrilas et al., 2018).***

This chapter reviews the clinical presentation and the diagnostic evaluation of achalasia.

Symptom Evaluation

Dysphagia

Dysphagia is the most frequently reported symptom, being present in about 95 % of achalasia patients. It occurs often for both liquids and solids. It may be associated with weight loss; however, most patients are able to maintain a stable weight thanks to changes made in their diet ***(Pandolfino et al., 2008).***

Regurgitation and Aspiration

Regurgitation of undigested food is the second most frequent symptom and is present in about 60–70 % of patients. It occurs more often in the supine position, and may lead to aspiration. Aspiration can cause respiratory symptoms, such as cough, hoarseness, wheezing, and episodes of pneumonia ***(Pandolfino et al., 2008).***

Heart burn

Heartburn is present in about 40 % of patients. It is due to stasis and fermentation of undigested food in the distal esophagus, rather than to gastroesophageal reflux. Since heartburn is frequently reported, misdiagnosis of achalasia as gastroesophageal reflux disease (GERD) can occur, particularly in the early stages of the disease. Because endoscopy is frequently normal and barium esophagram does not show the typical radiological findings of long-lasting achalasia, 24-h pH monitoring is

necessary in addition to esophageal manometry to make the diagnosis ***(Pandolfino and Gawron, 2015).***

Chest Pain

Some achalasia patients also experience chest pain, usually exacerbated by eating. The cause of chest pain is still unknown. In the past, it was thought that chest pain predominantly affected young patients with a shorter duration of symptoms than patients with no chest pain, and that it was associated to the presence of vigorous achalasia ***(Kahrilas et al., 2018).*** In untreated patients, chest pain frequency tends to diminish spontaneously with advancing age ***(Vaezi et al., 2013).***

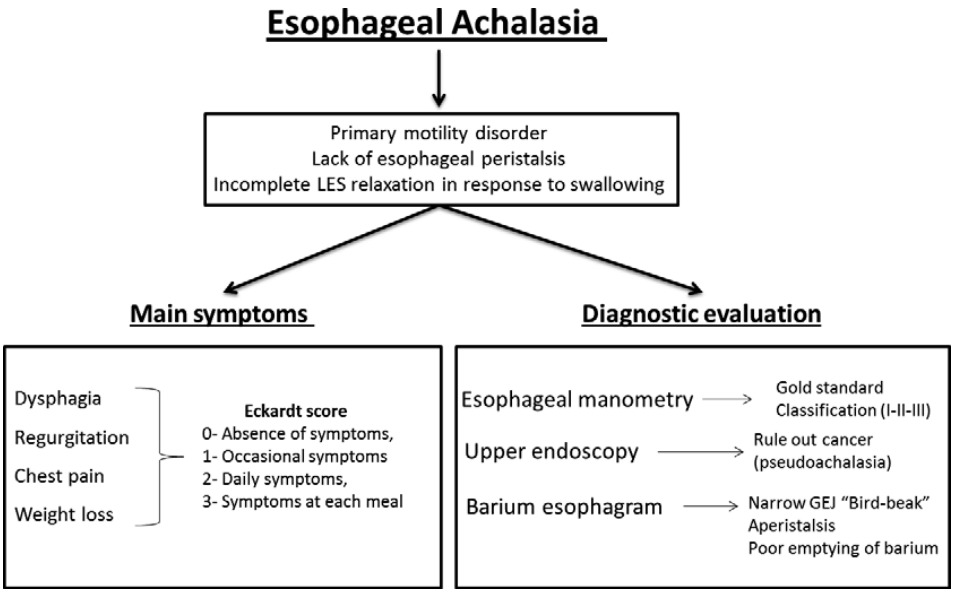

Figure (6): Esophageal achalasia ***(Allaix and Patti, 2016).***

More recently, some large studies evaluating the prevalence of chest pain, the clinical and manometric features of patients with chest pain in the setting of achalasia, have challenged these concepts. For instance, ***Perretta et al. (2008)*** analyzed 211 achalasia patients. Chest pain was present in 117 patients (55 %) at the time of presentation. It was felt in the retrosternal area in most cases, and it was experienced mainly during

the day. No differences were observed in age, duration of symptoms or manometric profile between patients with or without chest pain. With a median follow-up of 24 months, chest pain resolved in 84 % and improved in 11 % of patients after laparoscopic Heller myotomy. These data suggest that the relief or improvement of chest pain is due to the improved esophageal emptying ***(Von Renteln et al., 2013).***

The most common extraesophageal manifestations are pulmonary complications. Structural or functional pulmonary abnormalities occur in more than half of patients, and might be due to recurrent aspiration or tracheal compression from a dilated esophagus. Chagas´ disease may affect other target organs such as the colon and the heart ***(Zaninotto et al., 2008).***

Symptom Scores

The Eckardt score is the most commonly used score system. It is the sum of the scores for dysphagia, regurgitation, and chest pain (a score of 0 indicates the absence of symptoms, 1 indicates occasional symptoms, 2 indicates daily symptoms, and 3 indicates symptoms at each meal and weight loss (a score of 0 indicates no weight loss, 1 indicates a loss of less than 5 kg, 2 indicates a loss of 5–10 kg, and 3 indicates a loss of more than 10 kg). The maximum score on the Eckardt scale is 12 ***(Kahrilas et al., 2016).***

Table (1): Eckardt score for symptomatic evaluation in achalasia ***(Pandolfino et al., 2008).***

Score	Weight loss (kg)	Dysphagia	Retrosternal Pain	Regurgitation
0	None	None	None	None
1	< 5	Occasional	Occasional	Occasional
2	5-10	Daily	Daily	Daily
3	> 10	Each meal	Each meal	Each meal

Symptoms only, however, do not reliably diagnose the disease since there is an overlap of symptoms with other esophageal diseases, particularly gastroesophageal reflux disease. Furthermore, symptoms presence or severity does not correlate with manometric findings, degree of esophageal dilatation or prognosis. A complete workup is necessary in these patients, not only for the etdiagnosis but for prognosis and to establish the proper therapeutic approach ***(Borhan-Manesh et al., 2016).***

Diagnostic Evaluation

A thorough evaluation to establish the diagnosis should be performed in all patients with symptoms suggestive for achalasia ***(Zaninotto et al., 2008).***

Diagnostic approach — Achalasia should be suspected in the following patients:

- Dysphagia to solids and liquids
- Heartburn unresponsive to a trial of proton pump inhibitor therapy
- Retained food in the esophagus on upper endoscopy
- Unusually increased resistance to passage of an endoscope through the esophagogastric junction (EGJ) ***(Vaezi et al., 2013).***

Esophageal manometry is required to establish the diagnosis. Diagnostic manometric findings of achalasia are incomplete relaxation of the lower esophageal sphincter (LES) (integrated relaxation pressure above the upper limit of normal) and aperistalsis in the distal two thirds of the esophagus. In patients with equivocal esophageal manometry results (eg, incomplete LES relaxation but some preserved peristalsis; some complete LES relaxation with aperistalsis), barium esophagram should be performed to assess esophageal emptying and EGJ morphology ***(Pandolfino et al., 2008).***

Endoscopic evaluation with upper gastrointestinal endoscopy should be performed in patients with suspected achalasia to exclude a malignancy at the EGJ that can mimic achalasia ***(Moonen et al., 2016).***

Roman et al. (2012), performed additional evaluation with endoscopic ultrasound with fine-needle aspiration to definitively rule out a malignancy at the EGJ in patients with any one of the following

Clinical features suggestive of a malignancy (eg, symptoms of less than six months duration, new onset of dysphagia in patients >60 years, rapid or marked weight loss) ***(Min et al., 2012).***

Abnormal endoscopic evaluation (eg, unusually increased resistance to passage of endoscope through the EGJ or mucosal changes suggestive of a malignancy) ***(Min et al., 2012).***

Diagnostic evaluation in patients with suspected achalasia

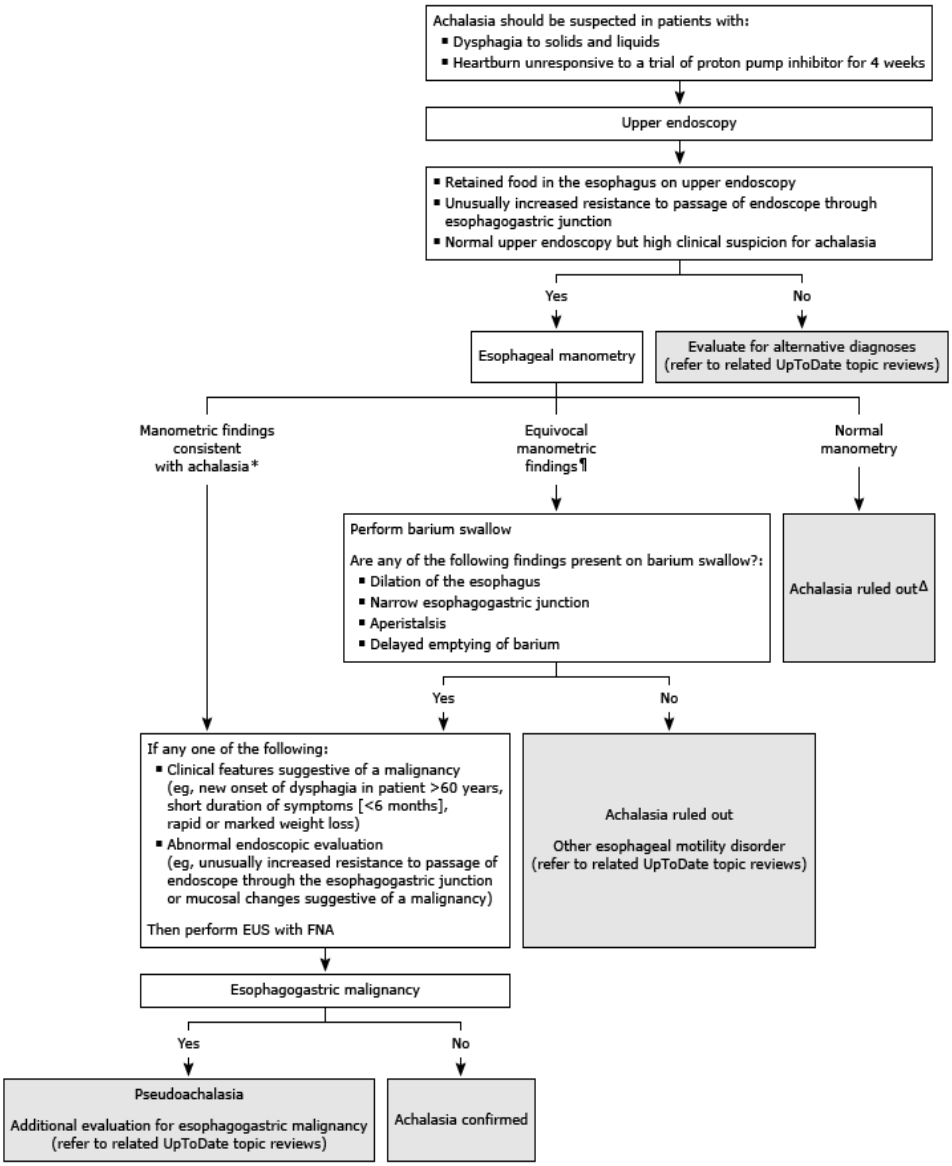

Figure (7): Diagnostic evaluation in patients with suspected achalasia ***(Stuart et al., 2020).***

LES: lower esophageal sphincter; EUS: endoscopic ultrasound; FNA: fine needle aspiration; IRP: integrated relaxation pressure.

Esophageal manometry

Both conventional and high-resolution manometry can diagnose achalasia. High-resolution manometry may have a higher sensitivity in diagnosing achalasia as compared with conventional manometry, as it provides enhanced detail in the characterization of achalasia and the morphology of the EGJ ***(Kahrilas et al., 2018).***

High-resolution manometry can also be used to accurately categorize achalasia into one of three distinctive subtypes, which can guide management Conventional manometry cannot reliably identify the type II and III achalasia, an important distinction as the prognostic implications for these entities are different ***(Kahrilas et al., 2018).***

Conventional manometry

Aperistalsis in the distal two-thirds of the esophagus and incomplete LES relaxation are diagnostic findings of achalasia on conventional manometry. Elevated resting LES pressure is supportive of the diagnosis of achalasia, but is not always present and is not diagnostic ***(Greene et al., 2015).***

Typical conventional manometric findings:

Aperistalsis in the distal two-thirds of the esophagus – In patients with achalasia, aperistalsis is seen in the smooth muscle portion of the body of the esophagus. Swallows may elicit no esophageal contraction or may be followed by simultaneous contractions with amplitudes <40 mmHg ***(Müller, 2015).***

Incomplete LES relaxation – Incomplete LES relaxation distinguishes achalasia from other disorders associated with aperistalsis. In normal

individuals, there is complete relaxation of the LES after a swallow (to a level <8 mmHg above gastric pressure). In contrast, in patients with achalasia, LES relaxation in response to a swallow may be incomplete or absent with a mean swallow-induced fall in resting LES pressure to a nadir value of >8 mmHg above gastric pressure ***(Müller, 2015).***

Elevated resting LES pressure – Loss of inhibitory neurons in patients with achalasia can cause resting LES pressures to rise to hypertensive levels (above 45 mmHg) ***(Albis et al., 2015).***

Atypical manometric findings – A number of atypical manometric findings have been reported in patients with achalasia, including achalasia with preserved peristalsis, cases with occasional complete or partial LES relaxation, and vigorous achalasia. Vigorous achalasia is an outdated term that has been used for patients who have simultaneous esophageal body contractions with amplitudes >40 mmHg in the presence of a non-relaxing LES on conventional manometry, sometimes associated with spastic esophageal activity on barium swallow ***(Greene et al., 2015).***

Preserved peristalsis with esophageal contractions >40 mmHg also has been described in patients with vigorous achalasia. The distinction between vigorous and classic achalasia appears to have little clinical significance ***(Greene et al., 2015).*** Some patients diagnosed with vigorous achalasia by conventional manometry have type III achalasia by high-resolution manometry (HRM) ***(Albis et al., 2015).***

High-resolution manometry

Achalasia is diagnosed on high-resolution manometry by an elevated median integrated relaxation pressure (IRP), which indicates impaired EGJ relaxation, and absence of normal peristalsis. The IRP is the median of the

maximal relaxation pressures of the EGJ in four seconds during the 10-second window of EGJ relaxation that follows a swallow. The upper limit of normal median IRP value varies among manometry systems; for the most widely used system at this time, an elevated median IRP is identified as ≥15 mmHg ***(Greene et al., 2015).***

According to the Chicago Classification (CC, version 3.0 [CC-3]) of patterns of esophageal pressurization on HRM, achalasia is subtyped into the following:

- Type I (classic achalasia) – Swallowing results in no significant change in esophageal pressurization. By CC-3 criteria, type I achalasia has 100 percent failed peristalsis with a distal contractile integral (DCI, an index of the strength of distal esophageal contraction) <100 mmHg ***(Müller, 2015).***

- Type II – Swallowing results in simultaneous pressurization that spans the entire length of the esophagus. According to CC-3, type II achalasia has 100 percent failed peristalsis and pan-esophageal pressurization with ≥20 percent of swallows ***(Müller, 2015).***

- Type III (spastic achalasia) – Swallowing results in abnormal, lumen-obliterating contractions or spasms. By CC-3 criteria, type III achalasia has no normal peristalsis and premature (spastic) contractions with DCI >450 mmHg within ≥20 percent of swallows ***(Müller, 2015).***

  These subtypes have important implications for management.

Esophageal pressure topography plot of achalasia subtypes in the Chicago Classification

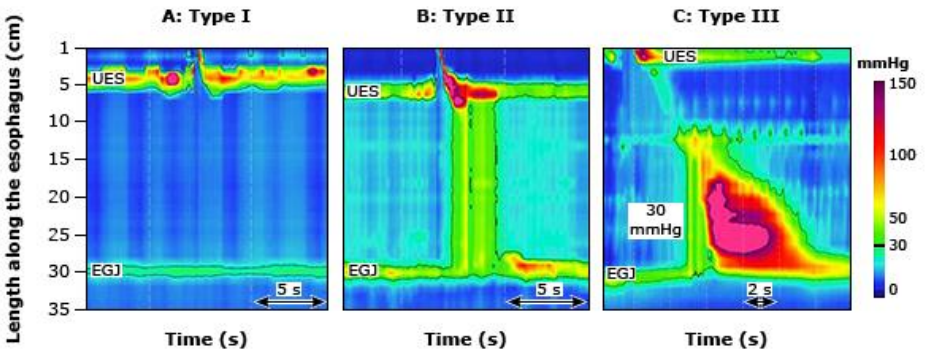

Figure (8): Types of achalasia, EGJ: esophagogastric junction; UES: upper esophageal sphincter ***(Pandolfino et al., 2008).***

In each case, the 30 mmHg isobaric contour is highlighted in black and there is impaired EGJ relaxation evident by the EGJ never relaxing to less than 30 mmHg in any panel. With type I achalasia, there is minimal contractile activity between the UES and EGJ. Type II is defined by ≥20 percent of swallows (supine posture, 5 mL water) with panesophageal pressurization to ≥30 mmHg. With type III, there is ≥20 percent of swallows with either premature contractions or fragments of peristalsis ***(Albis et al., 2015).***

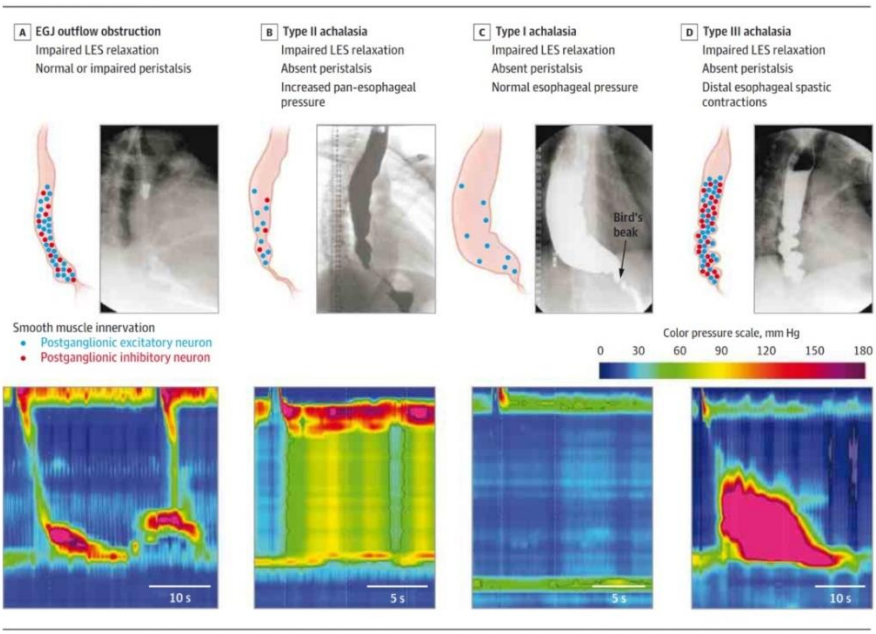

Figure (9): Conceptual model of esophageal disease presentation and progression based on phenotypes described using high resolution manmometry and Barium esophagrams ***(Pandolfino and Gawron, 2015).***

Table (2): Comparison of manometric findings between conventional and high resolution manometry ***(Vaezi et al., 2013).***

Comparison of manometric abnormalities in conventional and high-resolution manometry

Manometric features of achalasia	Conventional manometry Line tracing format	High-resolution manometry Esophageal pressure topography
LES		
	Impaired LES relaxation[a] • Mean swallow induced fall in resting LES pressure to a nadir value of >8 mm Hg above gastric pressure • Complete relaxation to gastric baseline with a short duration (<6 s)[b] *Basal pressure*[b] • >45 mm Hg	*Impaired EGJ relaxation* • Mean 4 s IRP ≥10 mm Hg over test swallows[a]
Esophageal peristalsis		
	Aperistalsis in distal 2/3 of the esophagus • No apparent contractions • Simultaneous contractions with amplitudes <40 mm Hg	*Aperistalsis* • Absent peristalsis (type I) • Pan-esophageal pressurization (type II)
Atypical/variants		
	Vigorous • Preserved peristalsis with esophageal contractions >40 mm Hg • Simultaneous contractions >40 mm Hg -Isobaric -Nonisobaric	• Spastic achalasia (type III)

EGJ, esophagogastric junction; IRP, integrated relaxation pressure; LES, lower esophageal sphincter.
[a]Required for diagnosis.
[b]Supportive for the diagnosis.

Barium esophagram

Findings on barium esophagram that are suggestive of achalasia include:

- Dilation of the esophagus. In patients with late- or end-stage achalasia the esophagus may appear significantly dilated (megaesophagus), angulated, and tortuous, giving it a sigmoid shape.
- Narrow EGJ with "bird-beak" appearance caused by the persistently contracted LES.
- Aperistalsis.
- Delayed emptying of barium ***(Smith et al., 2006).***

However, barium esophagram is not a sensitive test for achalasia, as it may be interpreted as normal in up to one-third of patients ***(Müller, 2015).*** In some patients, purposeless, spastic contractions are observed in the esophageal body.

Dilation of the esophagus in a patient with achalasia (barium esophagram)

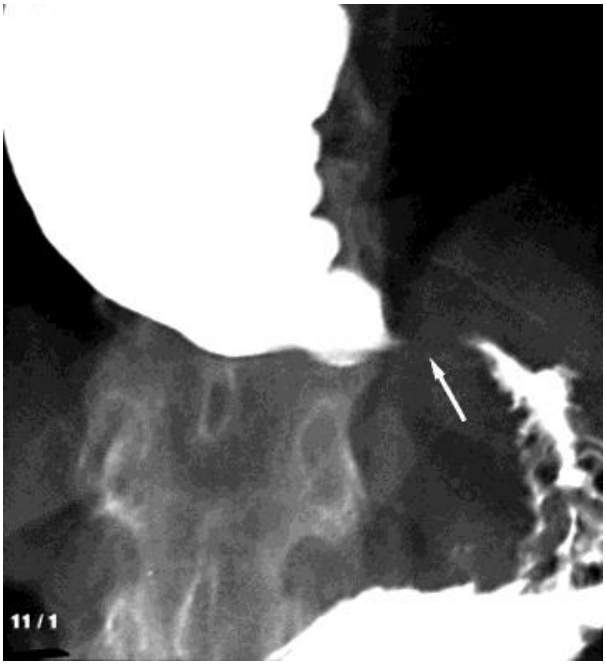

Figure (10): Barium esophagram in a 62-year-old man demonstrates a dilated, barium-filled esophagus with a region of persistent narrowing (arrow) at the gastroesophageal junction, producing the so-called bird's beak appearance. Achalasia was confirmed with manometry and the patient underwent successful dilation of the esophagus. Courtesy of Jonathan Kruskal, MD ***(Piero et al., 2014).***

Figure (11): Barium esophagram showing a dilated esophagus and bird's beak appearance typical of achalasia. Retained food is also visible. Courtesy of Ram Dickman, MD ***(Piero et al., 2014).***

Upper endoscopy

Upper endoscopy may reveal a dilated esophagus that contains residual material, sometimes in large quantities. The appearance of the LES may range from normal to a thickened muscular ring with a rosette configuration on retroflexed view. In patients with achalasia, the LES usually does not open spontaneously to allow effortless passage of the endoscope into the stomach, but, unlike obstruction caused by neoplasms or fibrotic strictures, the contracted LES can usually be traversed easily with gentle pressure on the endoscope ***(Van Hoeij and Bredenoord, 2016).***

The esophageal mucosa usually appears normal in patients with achalasia. Nonspecific changes that may be seen include erythema and ulceration due to inflammation, secondary to retained food and pills. Stasis may predispose to esophageal candidiasis, which may be seen as adherent whitish plaques ***(Müller, 2015).***

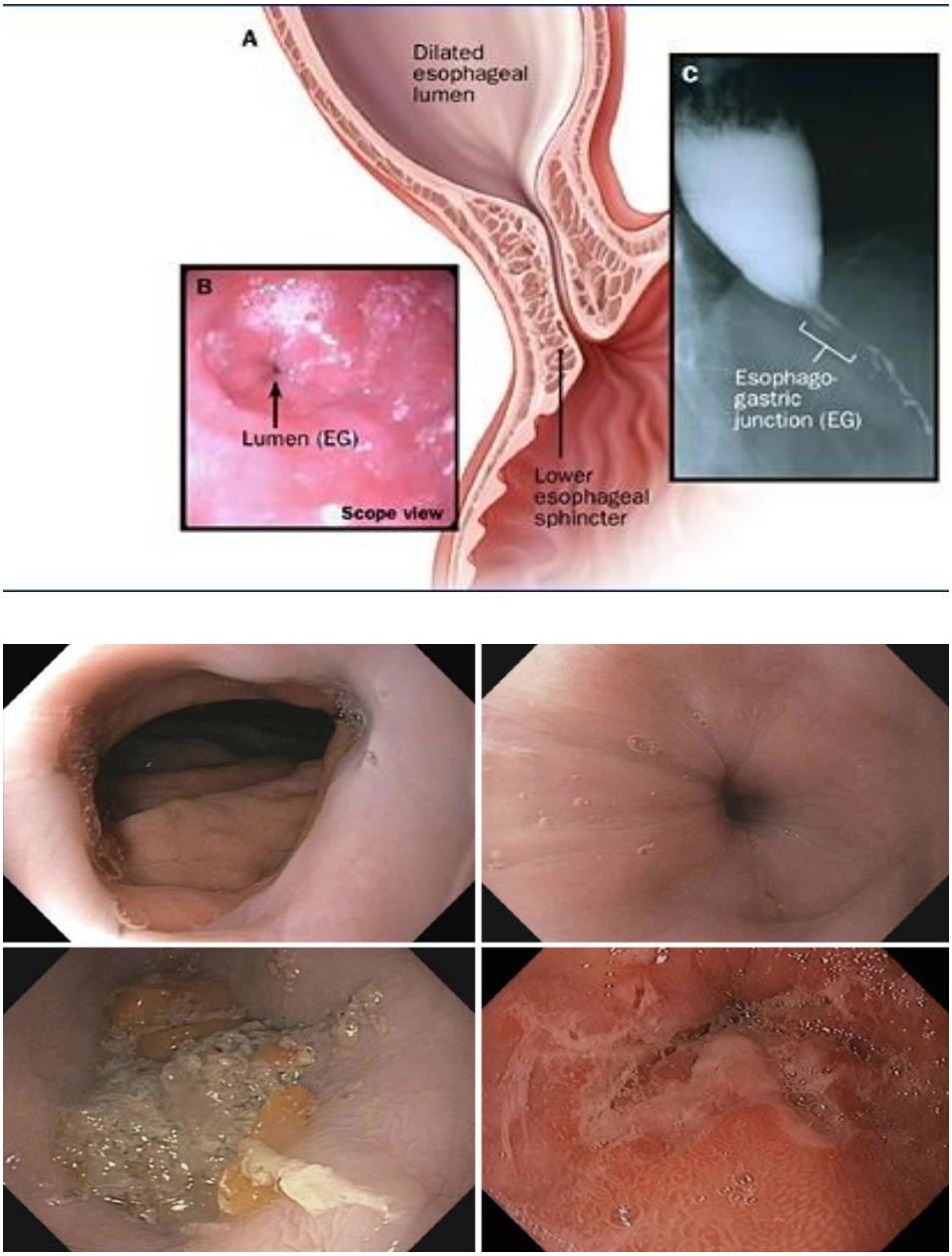

Figure (12): A, Anatomic findings in achalasia; B, endoscopic image; B, radiographic image ***(Müller, 2015).***

Table (3): Diagnostic features of achalasia during esophageal manometry, barium esophagogram and upper GI endoscopy and clinical relevance of using these procedures for initial diagnosis and in the follow-up of patients ***(Pohl and Tutuian, 2007)***

	Esophageal manometry	Barium esophagogram	Endoscopy
Features			
Typical	Esophageal aperistalsis + Poorly relaxing LES + Hypertensive LES	Smooth tapering distal esophagus ("bird beak"), dilated esophagus with barium column	Distended esophagus with retained food and "absent peristalsis"
Often in clinical practice	Only aperistalsis is present ± poor LES relaxation	Smooth tapering distal esophagus ("bird beak")	Normal
Clinical relevance			
Initial diagnosis	Required for establishing diagnosis	Supports diagnosis, helps differentiating between achalasia and scleroderma esophagus	Excluding pseudoachalasia; assists balloon dilatation
Clinical follow-up	Limited utility; peristalsis will not return to normal; follow-up LES resting pressure after treatment	Timed barium swallow; identifying pre-clinical disease relapse	Limited utility

Endoscopic ultrasound

Findings of achalasia on endoscopic ultrasound (EUS) include a thickened circular muscle layer at the LES and through the smooth muscle esophagus. Although the accuracy of EUS in distinguishing achalasia from pseudoachalasia has not been established, EUS is useful for characterizing tumors of the distal esophagus and gastric cardia. EUS findings of marked (>10 mm) and/or asymmetric esophageal wall thickening are suggestive of an underlying malignancy ***(Van Hoeij and Bredenoord, 2016).***

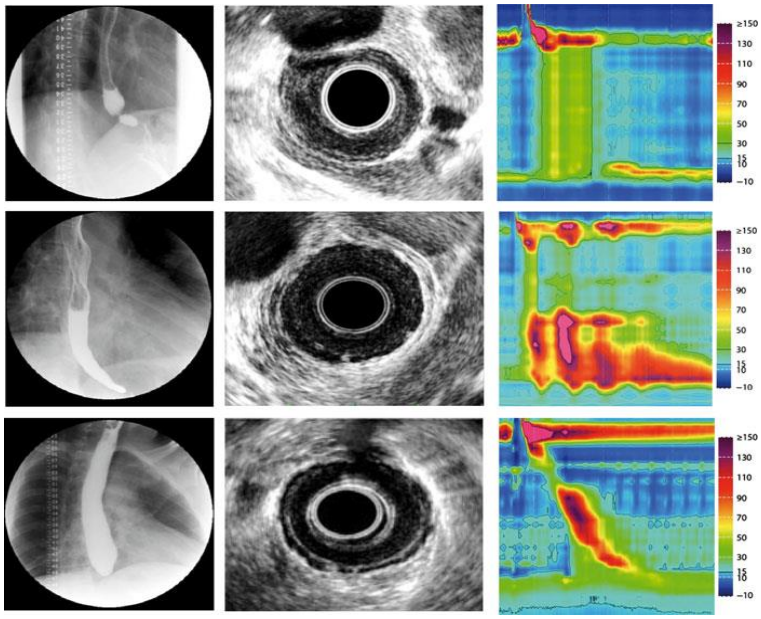

Figure (13): Representative EUS images in patients with achalasia. (A) Fluoroscopy, EUS and high resolution manometry (HRM) are shown in a patient with typical type II achalasia. The fluoroscopy revealed retained barium with narrowing toward the EGJ. Endosonographically, the esophageal wall was thickened with contribution from a hypoechoic muscular layer and isoechoic submucosal layer. (B) Type III achalasia. Note the typical early latency contraction shown on HRM. Retained contrast was noted on fluoroscopy. EUS revealed a thickened esophageal wall with the majority comprised of an isoechoic mucosal/submucosal layer. (C). A patient with EGJ outflow obstruction. HRM revealed intact peristalsis with elevated IRP ***(Krishnan et al., 2014).***

Fluoroscopy revealed a high column of retained barium. EUS revealed a predominately thickened hypoechoic muscular layer ***(Krishnan et al., 2014).***

Diagnosis

The diagnosis of achalasia is established by the presence of aperistalsis in the distal two-thirds of the esophagus and incomplete lower esophageal sphincter relaxation on manometry (elevated median

integrated relaxation pressure by high-resolution manometry) ***(Orenstein et al., 2015).***

In patients with typical achalasia symptoms (dysphagia to solids and liquids and regurgitation of bland undigested food or saliva) and equivocal manometric findings, the diagnosis is supported by aperistalsis, dilation of the esophagus, narrow esophagogastric junction, and poor emptying on barium esophagram. Pseudoachalasia due to cancer at the esophagogastric junction should be excluded by endoscopic evaluation as discussed above ***(Inoue et al., 2015).***

Differential diagnosis

Achalasia may be misdiagnosed as gastroesophageal reflux disease, especially in patients with chest pain of a burning quality typical of heartburn. The differential diagnosis of achalasia also includes other esophageal motility disorders and pseudoachalasia due to a malignancy. The differential diagnosis of dysphagia is discussed in detail, separately ***(La Rosée et al., 2019).***

- ***Gastroesophageal reflux disease***

In patients with gastroesophageal reflux disease (GERD), regurgitated food is typically sour tasting due to the presence of gastric acid. In contrast, in patients with achalasia, food and saliva are regurgitated from the esophagus and are therefore bland. Esophageal manometry is diagnostic of achalasia. In contrast, patients with GERD often have non-specific manometric findings including ineffective esophageal motility, hypotensive lower esophageal sphincter (LES), and excessive transient LES relaxations ***(La Rosée et al., 2019).***

- ***Pseudoachalasia***

Malignancy can cause pseudoachalasia either by invading the esophageal neural plexuses directly (eg, adenocarcinoma of the esophagogastric junction) or through the release of uncharacterized humoral factors that disrupt esophageal function as part of a paraneoplastic syndrome. In addition to gastric carcinoma, other tumors that can produce the syndrome include cancer of the esophagus, carcinoma of the lung, lymphoma, and pancreatic carcinoma ***(Kumbhari et al., 2015).*** Patients with pseudoachalasia can have the same manometric findings as those with achalasia but can be differentiated by upper endoscopy and endoscopic ultrasound ***(Inoue et al., 2015).***

- ***Other esophageal motility disorders***

Patients with diffuse (distal) esophageal spasm and jackhammer (nutcracker) esophagus may also present with dysphagia to solids and liquids. Esophageal manometry testing can distinguish achalasia from these esophageal motility disorders as lower esophageal sphincter relaxation (integrated relaxation pressure) is normal in these conditions ***(Kumbhari et al., 2015).***

Table (4): Differential diagnosis ***(La Rosée et al., 2019).***

Differential Diagnosis

Disease/Condition	Differentiating Signs/Symptoms	Differentiating Tests
Esophageal carcinoma	→ Dysphagia is mainly for solids, although difficulty in swallowing liquids develops with advanced disease. → Weight loss may be severe.	→ Barium swallow and endoscopy will show esophageal obstruction by the tumor.
Reflux Esophagitis	→ Can give rise to dysphagia through inflammatory swelling or a fibrotic peptic stricture, sometimes even in the absence of endoscopic abnormalities. → The patient will usually also report heartburn and/or regurgitation in addition to dysphagia.	→ Endoscopy usually shows reflux esophagitis, with or without a peptic stricture. A hiatus hernia may be present below the stricture. → Barium swallow has low sensitivity for esophagitis but will show up strictures and hiatus hernias. Gastroesophageal reflux will likely be demonstrated. → Lower esophageal pH studies will demonstrate pathologic gastroesophageal reflux.
Connective tissue disorders (e.g., systemic sclerosis)	→ Muscle and joint pain, Raynaud phenomenon, skin changes (e.g., rash, skin swelling or thickening).	→ Antinuclear antibodies, rheumatoid factor, creatine kinase, and ESR are useful initial screening tests for connective tissue pathology.
Esophageal spasm	→ Chest pain is often more prominent than dysphagia, which tends to be intermittent.	→ Manometry shows high-amplitude esophageal contractions rather than the aperistalsis usually seen in achalasia.
Eosinophilic esophagitis	→ Presents with dysphagia, or food bolus obstruction, often in young men with history of atopy.	→ Endoscopy may show a ringed esophagus with furrows and white spots. Esophageal biopsy shows eosinophilic infiltration (>15 eosinophils per high-power field).
Pseudoachalasia (or secondary achalasia)	→ Underlying malignancy that mimics idiopathic achalasia. → Patients tend to be older, duration of symptoms shorter, and weight loss greater and more rapid. → Dysphagia is clinically indistinguishable.	→ Gastroscopic biopsy of gastroesophageal junction and cardia may demonstrate malignancy. → Findings at endoscopy, barium swallow, and manometry may be indistinguishable from achalasia.
Chagas Disease	→ Endemic to Latin America; multiple-organ involvement likely causing atonic colon, myocarditis, and Romana sign; swelling of the eyelids in acute disease.	→ Microscopic examination of fresh blood showing presence of *Trypanosoma cruzi*. → PCR for precise identification of trypanosome subtype. → Giemsa staining of thick and thin blood films detects parasite.

CHAPTER 5

OPERATIVE MANAGEMENT

Surgical myotomy

Surgical myotomy, in which the LES is weakened by cutting its muscle fibers, has been the primary alternative to pneumatic dilation for achalasia. Heller myotomy is usually performed laparoscopically ***(Pandolfino et al., 2008).*** Since LES disruption can cause reflux esophagitis, it is frequently combined with an antireflux procedure such as a partial fundoplication ***(Yaghoobi et al., 2013).***

The advantages of surgical myotomy are high initial success rates and, compared with pneumatic dilation, lower rates of symptom recurrence. The main disadvantages of surgery are the high initial cost, the protracted recovery period, and the frequent development of gastroesophageal reflux disease postoperatively, especially if a fundoplication is not part of the procedure ***(Wang et al., 2009).*** Thus, the primary goal of the operative treatment is to relieve the functional obstruction of the LES while preventing reflux ***(Hirano, 2006).***

Surgical myotomy was first described in 1913 by Ernest Heller, who performed both anterior and posterior incisions at the gastroesophageal junction His technique was modified to include only the anterior myotomy ***(Heller, 1913).***

The modified Heller myotomy is the most common operative procedure used to treat achalasia ***(Spiess and Kahrilas, 1998).*** The operation can be performed using an open or a minimally invasive technique, and the esophagus can be approached through the abdomen or

thorax ***(Arreola-Risa et al., 1995).*** With advances in minimally invasive surgery in the early 1990s, the thoracoscopic approach and later the laparoscopic approach became popular ***(Holzman et al., 1997).***

There are advantages and disadvantages to each approach. The main disadvantages of a thoracoscopic approach compared with a laparoscopic esophageal myotomy include limited exposure of the distal LES and stomach and the technical challenges of performing a fundoplication ***(Patti et al., 1999).***

With regard to clinical outcomes, the thoracoscopic approach is associated with a higher rate of residual or recurrent dysphagia (because of the shorter gastric myotomy), gastroesophageal reflux, more postoperative pain, and a longer hospital stay ***(Patti et al., 1999).***

Laparoscopic technique

The following is a description of the key technical elements of performing a laparoscopic esophageal myotomy ***(Froukje and Albert, 2016).***

Patient position — Patients can be placed in a supine, split leg, or lithotomy position with padding, such as on a surgical bean bag. We prefer the split leg position for optimal ergonomics (surgeon stands between the legs) and access to the hiatus. The patient is positioned in a steep reverse Trendelenburg position, which allows the stomach and other organs to fall away from the esophageal hiatus ***(Francisco et al., 2020).***

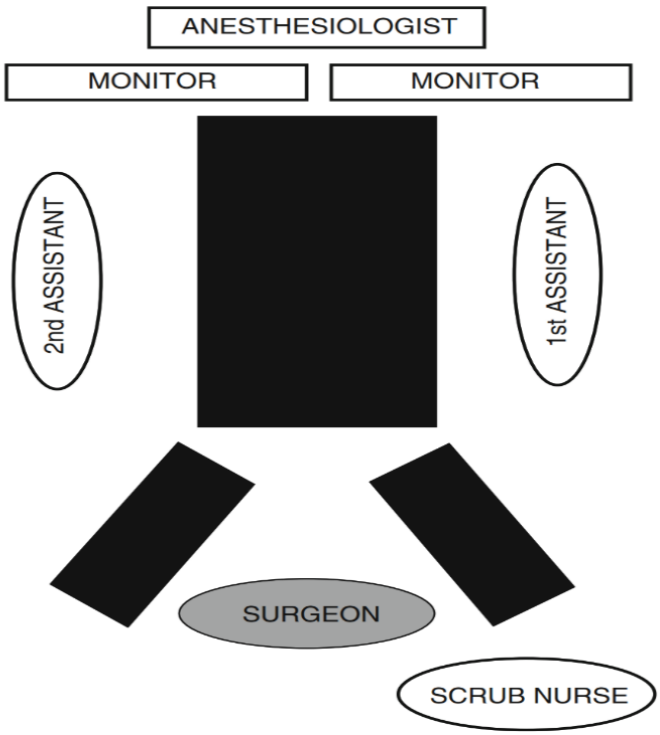

Figure (14): Organization of the operating room for a laparoscopic Heller myotomy ***(Francisco et al., 2020).***

Abdominal access and port placement — Abdominal access is obtained at the left upper quadrant just inferior to the costal margin by inserting a Veress needle followed by placement of an optical trocar after establishing pneumoperitoneum according to standard laparoscopic techniques. Four operative ports (two for the surgeon, one for the assistant, and one for the scope) are then placed under direct vision, and liver retraction is then achieved by any number of such devices on the market via an additional port site. Other port placements can also be used ***(Francisco et al., 2020).***

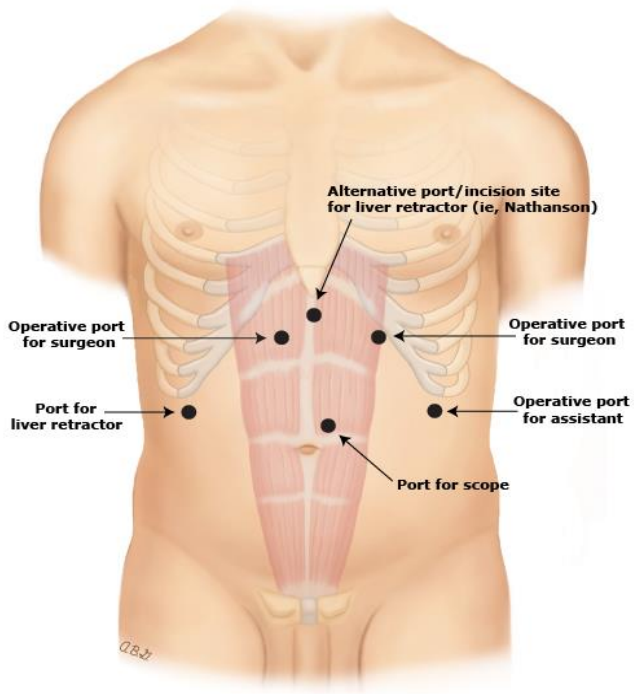

Figure (15): Illustrates the locations of the trocars for laparoscopic esophageal myotomy ***(Francisco et al., 2020).***

Mobilization of the gastric fundus — based on the surgeon's preference, the initial dissection can begin on the right or left side of the esophageal hiatus. The steps to mobilize the gastric fundus include: ***(Paul et al., 2019).***

- Dividing the left phrenogastric ligaments by dividing the short gastric arteries, starting at the inferior pole of the spleen to the exposed left crus of the diaphragm.
- Incising the gastrohepatic ligament in an avascular plane.
- Preserving the nerve of Latarjet and avoiding injury to an accessory or replaced hepatic artery.
- Dividing the right anterior phrenoesophageal ligament and the peritoneum overlying the anterior abdominal esophagus.

- Preserving the anterior vagus nerve, which lies immediately posterior to the right anterior phrenoesophageal ligament.

- a posterior esophageal window is unnecessary unless a hiatal hernia and/or a relatively short esophagus is encountered and there is a need for further mobilization to allow more intra-abdominal length in order to construct a proper fundoplication ***(Paul et al., 2019).***

Mobilization of the mediastinal esophagus

The distal portion of the mediastinal esophagus is mobilized to achieve sufficient length to perform a myotomy incision that divides the entire length of the LES and permits a tension-free fundoplication. A Penrose drain may be placed around the gastroesophageal junction to facilitate retraction of the esophagus but is not essential ***(Paul et al., 2019).***

Myotomy — It is critical when performing the myotomy that visualization and exposure are adequate to prevent inadvertent mucosal injuries. The cardioesophageal fat pad and the anterior vagus nerve must be cleared from the esophagus and the gastroesophageal junction. A continuous myotomy is performed for 6 cm on the esophagus and 3 cm onto the stomach ***(Antonello et al., 2011).***

The following principles are important when performing the myotomy:

A suitable and stable platform is useful. Our preference is a lighted or normal bougie dilator, which illuminates the esophagus and stretches the muscle fibers around the gastroesophageal junction, facilitating their division. An endoscope may be used instead of the lighted bougie dilator. The anterior surface of the esophagus is completely exposed, and slight tension is created by retracting caudally with a Babcock retractor or similar

instrument. The incision may be started on either the stomach or the esophagus ***(Paul et al., 2019)***.

The use of electrocautery should be **avoided** unless critical when creating the myotomy. If bleeding is encountered, it should be controlled with pressure and patience since thermal injury can lead to an unrecognized or delayed perforation of the esophagus ***(Francisco et al., 2020).***

- The myotomy is performed by individually dividing the esophageal and gastric muscle fibers.
- The longitudinal muscles are divided first, which exposes the underlying circular muscles.
- Division of the circular layer reveals a bulging mucosal plane that should appear smooth and white.
- The most critical and challenging factor is to create a 3 cm myotomy caudal to the gastroesophageal junction, where the tissue plane becomes less readily identifiable. An intervening sling of muscle fibers may blur the dissection, and the stomach mucosa is thinner and more prone to perforation.
- The portion of the myotomy on the esophagus should be approximately 6 cm in length. Thus, the total length of the entire myotomy is 9 cm ***(Francisco et al., 2020).***
- Endoscopic inspection of the mucosa and the myotomy is performed prior to proceeding to the next steps to identify and repair any mucosal perforations ***(Paul et al., 2019).***

Heller myotomy performed laparoscopically

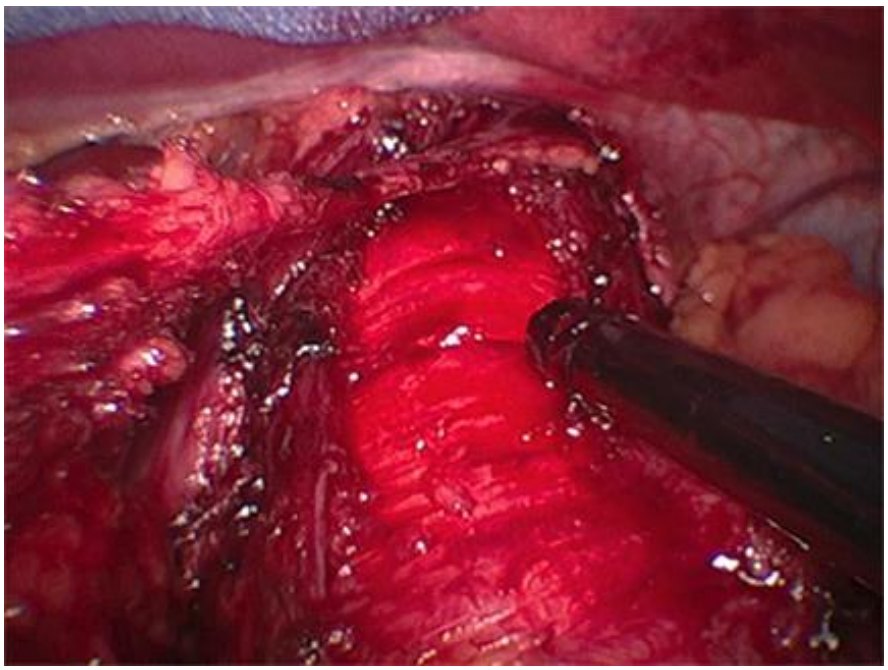

Figure (16): This is an intraoperative photograph of the laparoscopic performance of the myotomy on the esophagus ***(Stuart et al., 2020).***

Fundoplication — If a fundoplication procedure is performed, it is typically a partial (eg, Toupet or Dor) or a circumferential (Nissen) wrap, A Toupet fundoplication is a 270° posterior wrap of the fundus around the esophagus, while the Dor fundoplication is a 180° anterior wrap ***(Gonzalo et al., 2018).***

A Dor (anterior) fundoplication may be particularly useful to buttress the repair of an esophageal perforation that may occur. The greater curve of the fundus is grasped and placed anteriorly to the right side of the gastroesophageal hiatus. The following is a brief description of the technique:

- An inner row of interrupted sutures are used to secure the medial aspect of the fundus to the left side of the myotomy, which begins to recreate the angle of His ***(Francisco et al., 2020).***

- The anterior fundus is folded over the esophagus, and a coronal suture to the right crus and right side of the esophagus is performed.
- A second row of interrupted sutures is placed to fix the leading edge to the right side of the myotomy. A final suture from the apex of the gastroesophageal hiatus to the fundus completes the fundoplication ***(Francisco et al., 2020).***

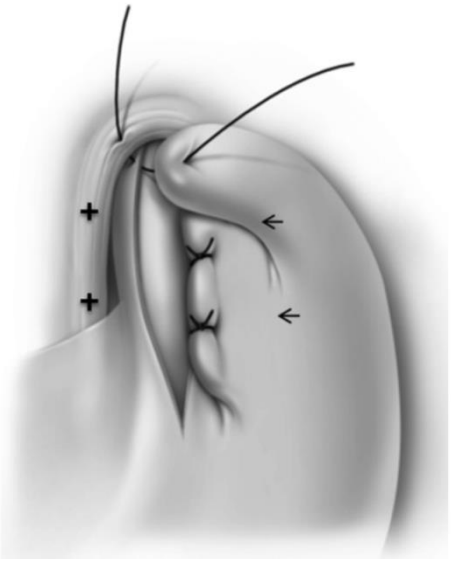

Figure (17): Dor fundoplication, right row of sutures. Uppermost stitch. ***(Francisco et al., 2018)***

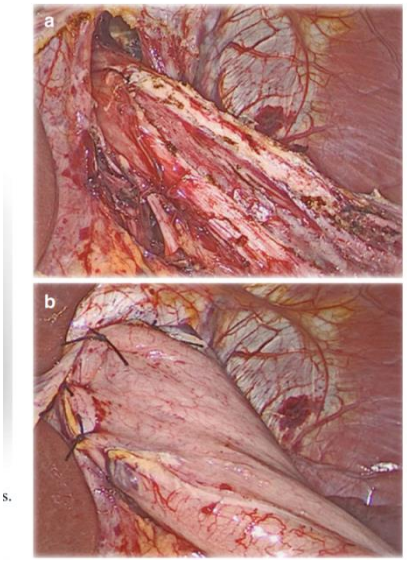

Figure (18): Myotomy (a) and for fundoplication (b) ***(Francisco et al., 2018)***

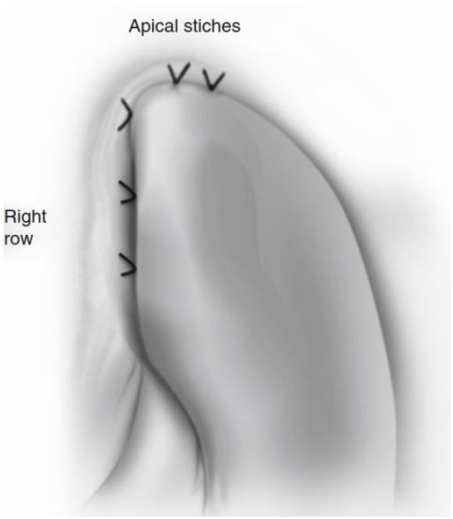

Figure (19): Completed Dor fundoplication ***(Francisco et al., 2018).***

Intraoperative technical risks

The major intraoperative risks include an unrecognized perforation of the esophageal or gastric mucosa, division or injury to the anterior vagus nerve, and splenic injury ***(Kevin et al., 2020).***

- ***Esophageal or gastric perforation***

The risk of an esophageal or gastric perforation during surgical myotomy ranges from 10 to 16 percent. Mucosal perforations are repaired with fine 4-0 and 5-0 absorbable monofilament suture. An advantage of the anterior (Dor) fundoplication is that it will buttress the repair ***(Paul et al., 2019).***

- ***Division of vagus nerve***

Using careful dissection and attention to detail, injury to the vagus nerves is rare. The **anterior** vagus nerve is at risk of injury during several technical steps of the operation, including the initial dissection of the

esophagus, mobilizing the gastroesophageal fat pad, performing the myotomy, and performing the fundoplication ***(Wohlers and Evans, 2009).***

The **posterior** vagus nerve is less likely to be injured. If an injury to only the anterior or posterior vagus nerve occurs, it is not repaired, as postvagotomy diarrhea, bloating, early satiety, and/or dumping syndrome rarely occur with a unilateral vagotomy. Nevertheless, extra care should be taken to identify and preserve both nerves ***(Oelschlager et al., 2008).***

- ***Splenic injury***

The risk of injury to the spleen ranges from <1 to 5 percent ***(Gonzalo et al., 2018).*** The higher rates are from reports when laparoscopic surgery was in the early stages of use ***(Antonello et al., 2011).***

Alternatives to laparoscopic or open surgical myotomy

Robotic surgery — An alternative to laparoscopic surgical myotomy is robotic-assisted minimally invasive surgery. Theoretical advantages for the surgeon over standard laparoscopic surgery include increased range of motion, decreased tremor, improved visibility with respect to depth perception, and improved ability to perform finer movements in a smaller, confined space ***(Giulia et al., 2019).***

Postoperative management

The principle components of postoperative care for laparoscopic myotomy include advancement of diet and control of nausea. The following is a summary of the major issues: ***(Paul and Lee,. 2019)***

While some advocate performing gastrograffin swallow prior to initiating a diet, ***(Paul and Lee, 2019)*** finds this unnecessary if there has been good intraoperative visualization of the esophagus and stomach as

well as intraoperative endoscopy. However, one should have a low threshold for obtaining a gastrograffin swallow if a patient develops symptoms and signs suggestive of an esophageal or gastric perforation (eg, chest pain, epigastric pain, fever, tachycardia, subcutaneous or mediastinal emphysema, and/or otherwise unexplained leukocytosis) ***(Paul and Lee, 2019).***

Clear liquids are typically started the night of the procedure following laparoscopic surgery. If no dysphagia occurs, the diet is advanced to a soft diet the following day. If episodes of dysphagia occur, patients are maintained on a full liquid diet for a longer period of time prior to advancing the diet ***(Rosemurgy et al., 2010).***

Aggressive treatment with antiemetics is provided for patients complaining of nausea to avoid emesis, which can lead to rupture of the repair. Medications can be administered in a crushed form until the patient is tolerating a regular diet ***(Rosemurgy et al., 2010).***

Antacids or proton pump inhibitors are used only if patients experience symptoms of heartburn and regurgitation and a pH monitoring study reveals gastroesophageal reflux ***(Rosemurgy et al., 2010).***

Postoperative complications

The most common complications following laparoscopic myotomy with a fundoplication include perforation, recurrent dysphagia, and gastroesophageal reflux. Following laparoscopic Heller myotomy, the morbidity rate ranges between 1 and 10 percent and the mortality rate is <0.1 percent in the 30 day perioperative period ***(Schuchert et al., 2008).***

Perforation — The most common early postoperative complication is gastric or esophageal perforation, which occurs in 1 to 7 percent of patients ***(Rossetti et al., 2009).***

Late perforations usually result from either direct mucosal injury that is not recognized during surgery, or inadvertent thermal injury. Perforations usually result in diffuse peritonitis and/or mediastinitis and may be life-threatening ***(Vaziri and Soper, 2008).***

If a perforation is suspected, a water-soluble contrast radiograph should be obtained. Management of a late perforation requires diversion and a gastrostomy tube or an esophagectomy ***(Lynch et al., 2012).***

Recurrent dysphagia — Recurrent dysphagia is a late complication of a Heller myotomy and fundoplication. It occurs in approximately 3 to 10 percent of patients undergoing a Heller myotomy, with the onset of symptoms six months or later after surgery. ***(Petersen and Pellegrini, 2010).***

The most common cause is incomplete myotomy. This can occur with incomplete division of the clasp (semicircular) fibers on the esophagus or failure to divide the sling (oblique) fibers on the stomach at least 3 cm below the gastroesophageal junction. This is more common in patients that were managed with a thoracoscopic approach to myotomy ***(Pratap and Reddy, 2011).***

In some cases, the incision was suboptimal, even with the laparoscopic approach; as a result, a repeat procedure may be warranted to extend the incision further into the stomach ***(Wright et al., 2007).***

Other potential reasons for recurrent dysphagia include:

- Herniated fundoplication
- Perihiatal scarring
- Peptic stricture
- Obstructing tumors

The approach to the patient with recurrent dysphagia is to identify the cause and to rule out significant pathology, such as a malignancy, stricture, or hernia. The diagnostic evaluation typically begins with upper endoscopy or, if endoscopy is not available, a gastrograffin swallow. Manometry may be performed if achalasia is a possible cause of the dysphagia ***(Rosemurgy et al., 2010).***

Gastroesophageal reflux — The rate of gastroesophageal reflux (GER) developing in patients undergoing myotomy with a partial fundoplication ranges from 2 to 26 percent in different series ***(Paul et al., 2019)***.

Patients who develop GER should have pH monitoring performed three to six months after myotomy and repeated with any change in symptoms that could suggest GER, especially heartburn and regurgitation. Patients with abnormal esophageal acid exposure are treated medically. Incomplete myotomy with stasis in the distal esophagus can mimic GER ***(Pratap and Reddy, 2011).***

Other complications — Pneumothorax, bleeding, inadvertent vagal injury, and infection are uncommon complications, with at least one occurring in approximately 3 percent of cases ***(Wang et al., 2009).***

A pneumothorax can be caused from inadvertent injury to the pleura during mobilization of the mediastinal esophagus. If this occurs, the defect can be repaired with a primary suture closure if the patient develops intraoperative hypotension or hypoxia. Otherwise, neither a primary repair nor a chest tube is necessary in most patients ***(Pratap and Reddy, 2011).***

Risk of esophageal cancer

Untreated achalasia is associated with an increased risk of squamous cell esophageal cancer. There is a paucity of long-term data on the development of esophageal cancer following a myotomy. In a retrospective review of 226 patients surgically treated for achalasia, four (1.8 percent) developed a squamous cell carcinoma at 2, 8, 13, and 18 years after the operation ***(Zaninotto et al., 2008).***

Botulinum toxin injection

Botulinum toxin therapy can be considered in patients who are not good candidates for more definitive therapy with pneumatic dilation, surgical myotomy, or POEM. Botulinum toxin injected into the LES poisons the excitatory (acetylcholine-releasing) neurons that increase LES smooth muscle tone. The net effect is a decrease in basal LES pressure in patients with achalasia, which allows emptying of the esophagus when esophageal pressures exceed that of the partially paralyzed LES ***(Wang et al., 2009).***

Botulinum toxin injection has the advantage of being less invasive as compared with surgery and can be easily performed during routine endoscopy. Initial success rates with botulinum toxin are comparable to pneumatic dilation

and surgical myotomy. However, patients treated with botulinum toxin have more frequent relapses and a shorter time to relapse ***(Wang et al., 2009).***

Greater than 50 percent of patients with achalasia treated with botulinum toxin require retreatment within 6 to 12 months. Repeated botulinum toxin injections may also make a subsequent Heller myotomy more challenging ***(Wen et al., 2004).***

Pharmacological therapy — Medical therapy is the least effective treatment option in patients with achalasia, but should be considered in patients who are unwilling or unable to tolerate invasive therapy for achalasia and for patients who have failed botulinum toxin injections ***(Bassotti and Annese, 1999).***

Because nitrates are short-acting, sublingual isosorbide dinitrate (5 mg) is administered 10 to 15 minutes before meals. A sublingual preparation of isosorbide dinitrate is no longer available in the United States, but remains available elsewhere. Sublingual nitroglycerin 0.4 mg is an alternative if sublingual isosorbide dinitrate is unavailable and nitrate therapy is indicated ***(Bassotti and Annese, 1999).***

Nitrates relax the smooth muscle of the LES both in normal individuals and in patients with achalasia. Treatment with sublingual nitroglycerin may result in short-term symptomatic improvement; however, the benefit is not durable ***(Smith et al., 2006).***

In addition, side effects such as headache and flushing are common, and contraindications to nitrate use are discussed separately ***(Kahrilas and Pandolfino, 2017).***

Although 5-phosphodiesterase inhibitors (eg, sildenafil), anticholinergics (eg, atropine, dicyclomine, cimetropium bromide), beta

adrenergic agonists (eg, terbutaline), and theophylline have been used to treat achalasia, there are very limited data to support their use ***(Bassotti and Annese, 1999).***

While studies have described variable efficacy rates for treatment with calcium channel blockers for achalasia ***(Froukje and Albert., 2016),*** we avoid the use of short-acting nifedipine because of the risk of adverse effects including severe hypotension and ischemic complications that are discussed in more detail separately ***(Bassotti and Annese, 1999).***

Peroral endoscopic myotomy (POEM)

Peroral endoscopic myotomy (POEM), a form of natural orifice transluminal endoscopic surgery (NOTES), is an endoscopic method for performing myotomy of the LES ***(Li et al., 2013).***

During POEM, the endoscopist makes an incision in the esophageal mucosa, and the endoscope is passed through that incision into the esophageal submucosa, creating a submucosal tunnel that is extended distally into the gastric cardia. A diathermic scalpel then is passed through the endoscope to sever the muscle of the muscularis propria in and around the LES. Unlike surgical myotomy, which often is combined with fundoplication to prevent reflux, POEM includes no antireflux procedure. Consequently, POEM can result in GERD ***(Kumbhari et al., 2015).***

PATIENTS AND METHODS

Study design:

The current study is prospective randomized study which will be conducted at the General Surgery Department in Benha University Hospital and Mansora university Hospital.

Enrollment of eligible patients will be throughout the period december 2020 to march 2022.

The present study includes 30 patients with achalasia of the cardia who randomly done laparoscopic heller cardiomyotomy and assessment of them postoperative according Eckardt score

The study will be conducted after approval of ethical of research committe banha university.

A written informed consent will be obtained from all included patients.

Study population:

Patients diagnosed with esophageal achalasia undergoing laparoscopic Heller's cardiomyotomy.

Inclusion criteria:

1. Any patients with achalasia of the cardia fit for surgery.

Exclusion criteria:

1. Recurrence .
2. Patients undergo pneumatic dilatation .

3. Associated with hiatus hernia.
4. Uncontrolled co-morbidities as DM and HTN.
5. Patients cannot accommodate pneumoperitoneum.

Sample size:

30 patients

Study procedure:

All patients were subjected to the following:

Preoperative assessment

Full clinical history: Dysphagia for solids and liquids, Regurgitation of undigested food, Respiratory complications (nocturnal cough and aspiration), Chest pain, heartburn, Weight loss.

Full clinical examination*:* general and local abdominal examination.

Investigations including:

1. Routine preoperative laboratory investigations: complete blood count, liver function tests, kidney function tests, coagulation profile, serum electrolytes and viral markers.
2. Routine preoperative radiological investigations: ECG, Echocardiography, plain chest x- ray.
3. Esophageal manometry evaluating esophageal peristalsis and LES pressure.
4. Upper GIT endoscopy commenting on esophageal peristalsis.

5. Barium swallow showing smooth tapering of the lower esophagus leading to a ‘‘bird’s beak’’ appearance.

Study operation: laparoscopic Heller's cardiomyotomy was done to all patients.

Procedure

All patients underwent LHM+DF. The myotomy length covered all narrowed segments and extended from the distal esophagus (6-8 cm) to at least 2-3 cm to the gastric fundus.

Patient position — Patients were placed in a supine, split leg. The patient was positioned in a steep reverse Trendelenburg position.

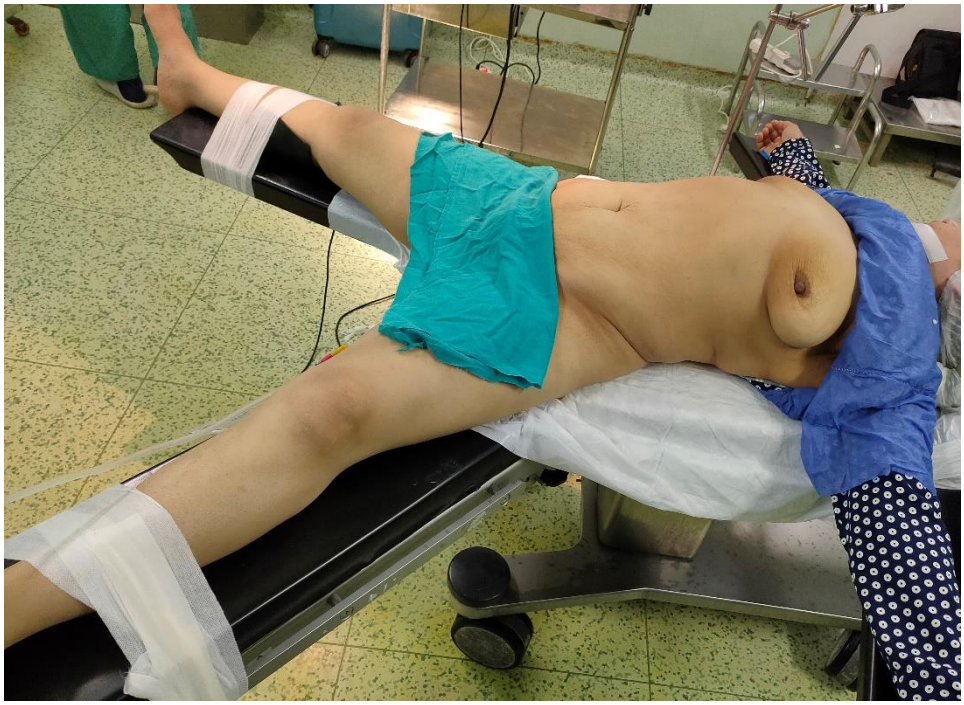

Figure 20 : position of the patient.

Four operative ports (two for the surgeon, one for the assistant, and one for the scope) were placed under direct vision after inflation of the abdomen with Veress needle, and liver retraction was then achieved by epigastric port retraction (S shaped).

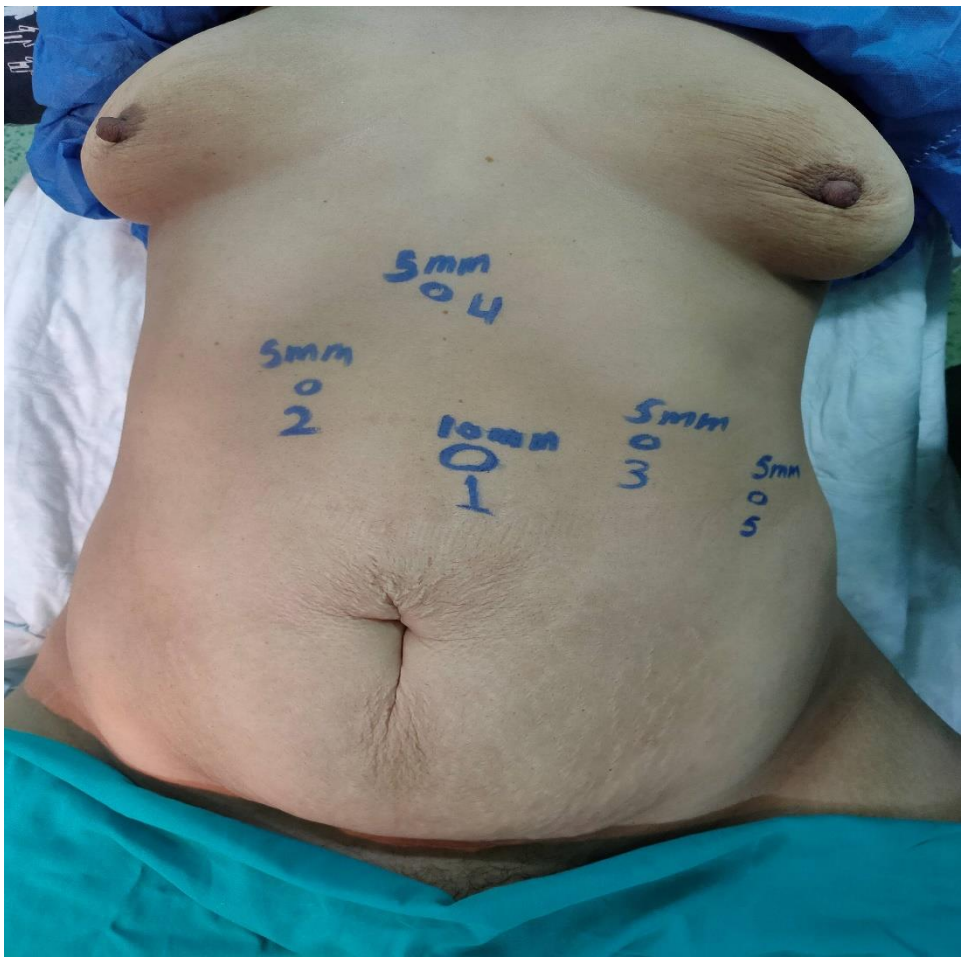

Figure 21 : sites of ports.

Mobilization of the gastric fundus: the initial dissection began on the right of the esophageal hiatus. The steps to mobilize the gastric fundus included:

- Incising the gastrohepatic ligament in an avascular plane.
- Preserving the nerve of Latarjet and avoiding injury to an accessory or replaced hepatic artery.

- Dividing the right anterior phrenoesophageal ligament and the peritoneum overlying the anterior abdominal esophagus.
- Preserving the anterior vagus nerve, which lies immediately posterior to the right anterior phrenoesophageal ligament.
- Dividing the left phrenogastric ligaments by dividing the short gastric arteries, starting at the inferior pole of the spleen to the exposed left crus of the diaphragm.

We used in dissection Harmonic or Ligasure scalpel.

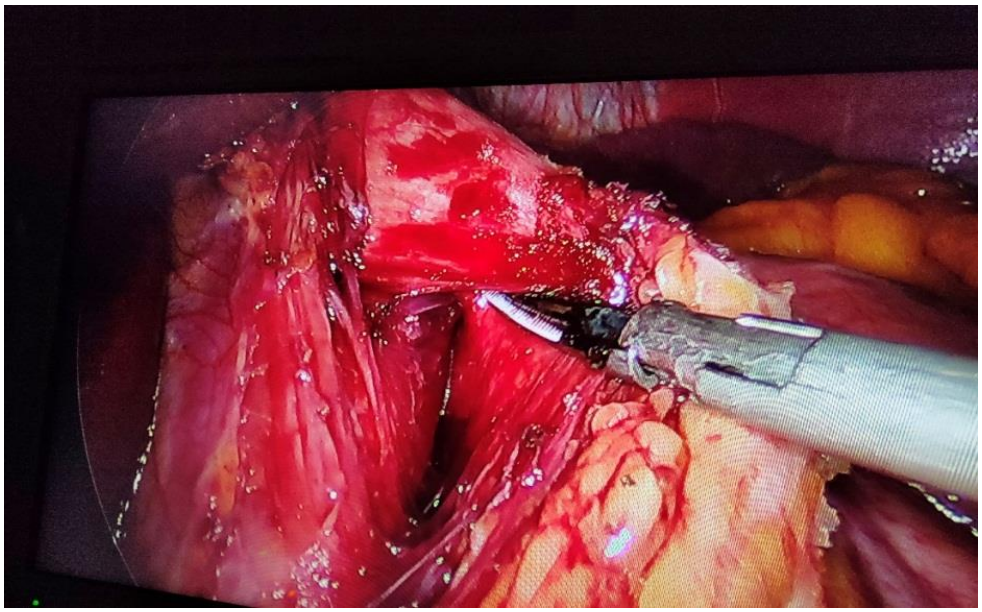

Figure 22 :Mobilization of the gastric fundus.

Mobilization of the mediastinal esophagus: The distal portion of the mediastinal esophagus was mobilized to achieve sufficient length to perform a myotomy incision that divided the entire length of the LES and permitted a tension-free fundoplication .

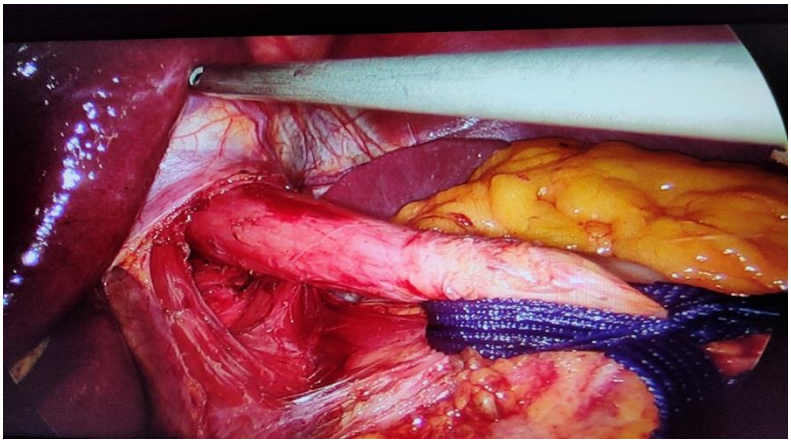

Figure 23: Mobilization of the mediastinal esophagus

Myotomy — It was critical when performing the myotomy that visualization and exposure were adequate to prevent inadvertent mucosal injuries. The cardioesophageal fat pad and the anterior vagus nerve must be cleared from the esophagus and the gastroesophageal junction. A continuous myotomy was performed for 6 cm on the esophagus and 3 cm onto the stomach **.**

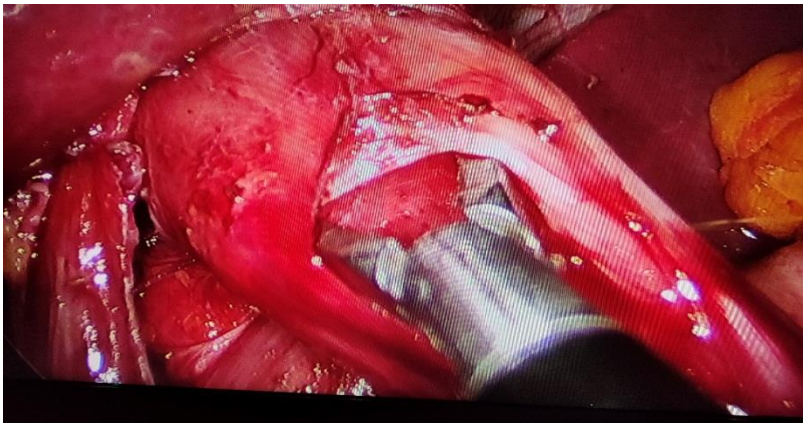

Figure 24: Myotomy.

We started the myotomy 1-2 cm above the gastroesophageal junction. Myotomy was performed longitudinally in the anterior esophageal axis using blunt dissection, electric hook, scissors, or the harmonic – Ligasure scalpel. Caution must be taken to avoid injury to the

esophageal mucosa. The longitudinal muscles were divided first then the circular one, revealing a bulging mucosal plane that should appear smooth and white **.**

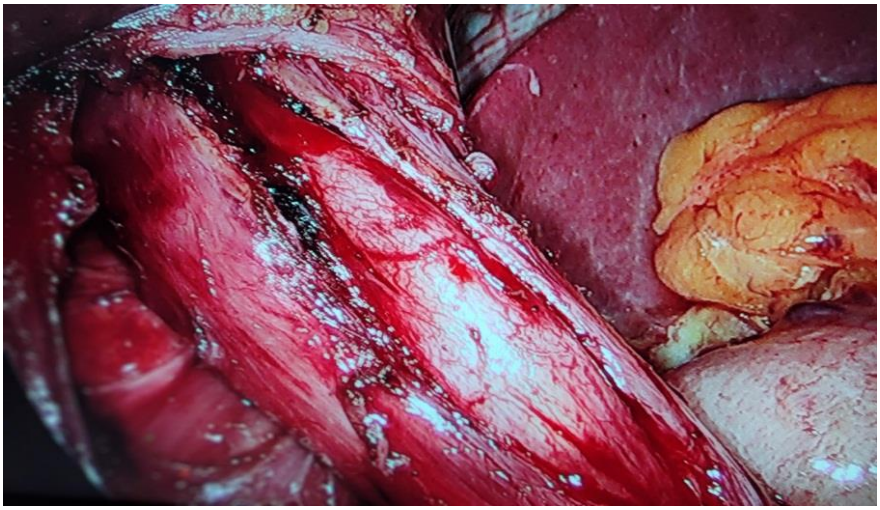

Figure 25: bulging mucosal plane.

Endoscopic inspection of the mucosa and the myotomy was performed in some cases prior to proceeding to the next steps to identify and repair any mucosal perforations.

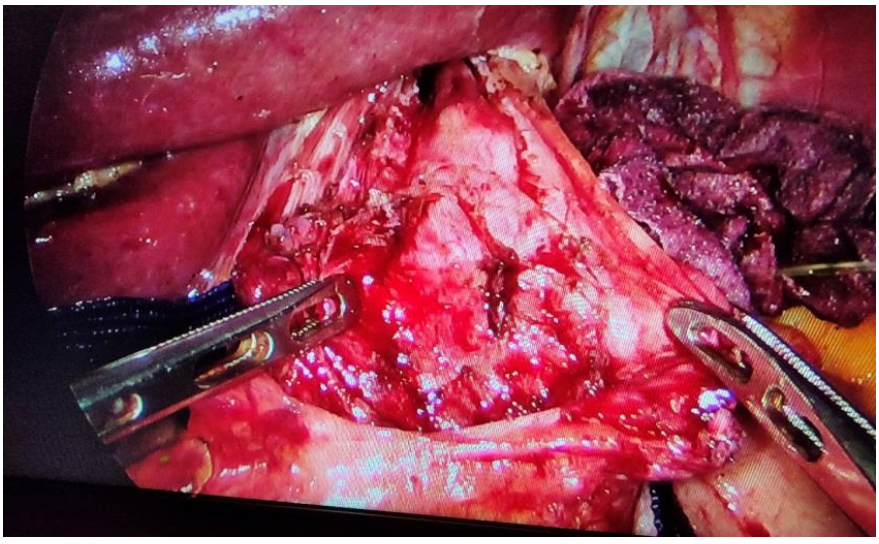

Figure 26: Inspection Of Mucosa After Myotomy.

Dor Fundoplication — The following is a brief description of the technique:

- The fundus was mobilized by dividing the short gastric vessels and all fundal attachments starting approximately at the inferior pole of the spleen, approximately 10 to 15 cm inferior to the angle of His.
- The retroesophageal window was developed by further dissection along the base of the left crus.
- Following mobilization of the mediastinal esophagus, the gastroesophageal hiatus was closed posteriorly with interrupted sutures, but leaving laxity of the hiatus was preferred **.**

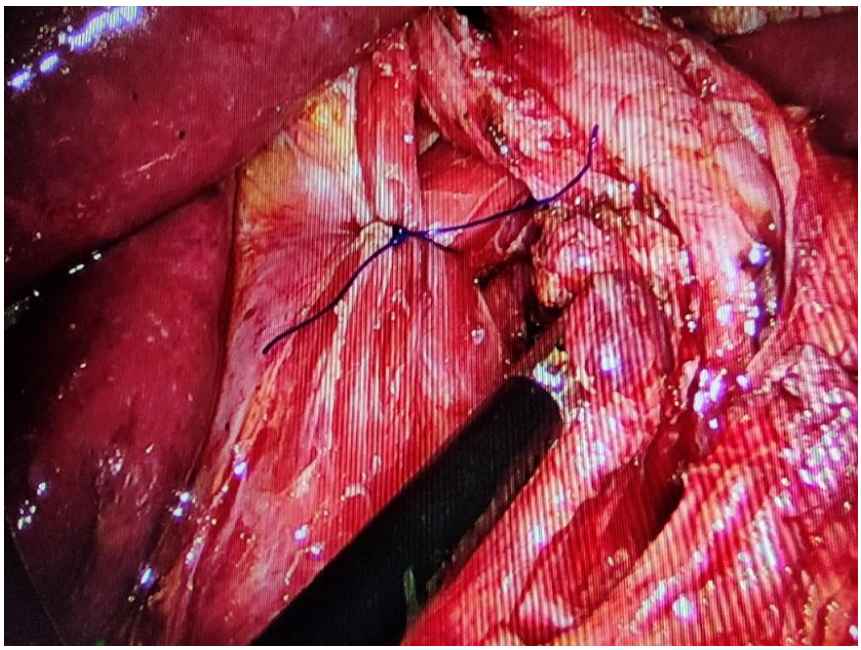

Figure 27 : Repair of the hiatus by one suture.

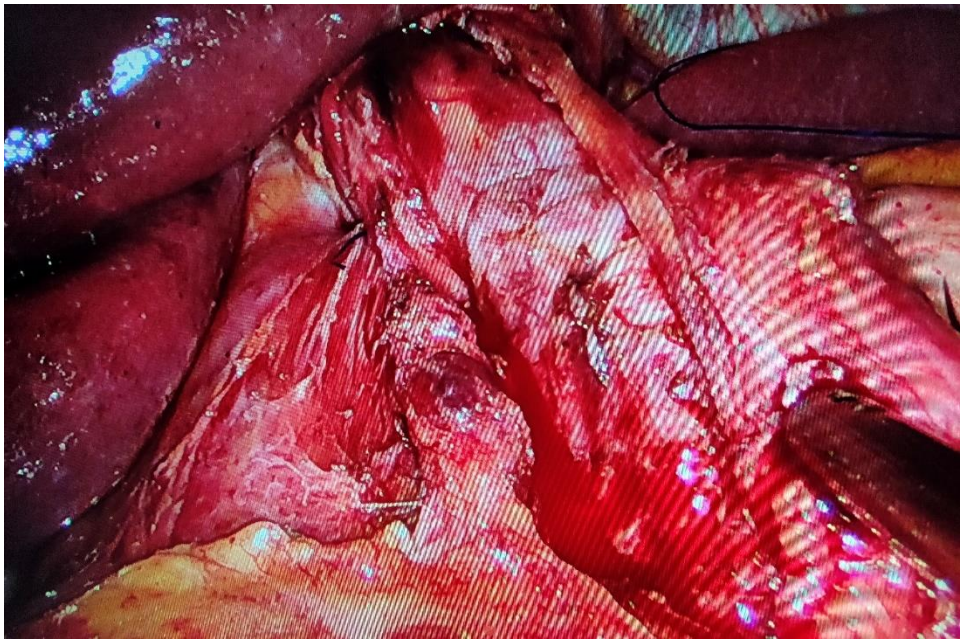

Figure 28: Repair of the hiatus by two sutures.

A Dor (anterior) fundoplication was done by grasping the greater curve of the fundus and placing it anteriorly to the right side of the gastroesophageal hiatus. The following is a brief description of the technique:

- An inner row of interrupted sutures was used to secure the medial aspect of the fundus to the left side of the myotomy, which began to recreate the angle of Hiss.
- The anterior fundus was folded over the esophagus, and a coronal suture to the right crus and right side of the esophagus was performed.
- A second row of interrupted sutures was placed to fix the leading edge to the right side of the myotomy . A final suture from the apex of the gastroesophageal hiatus to the fundus completed the fundoplication.

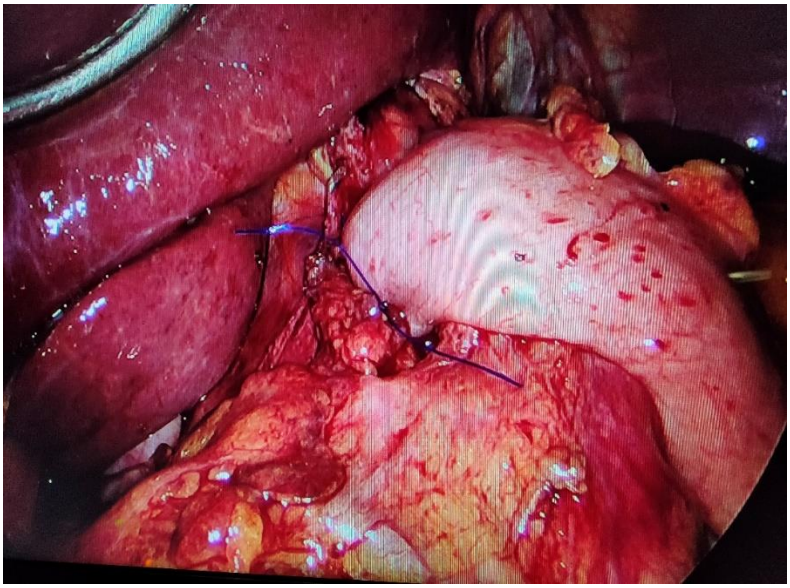

Figure 29: Dor Fundoplication.

Postoperative Management

Patients were transferred from post anesthesia recovery unit to the ward for vital data follow up and follow up of bowel movements. After 8 hours, patients might be started on a clear liquid diet if there was no perforation of the esophagus during the myotomy.

On postoperative day number two, a soft mechanical diet may be instituted. In the case of the patient in whom there was a perforation which was repaired intraoperatively, it was prudent to order a gastrografin esophagram on the first postoperative day to ensure that there was no leak; if none was seen, the patient might begin a clear liquid diet with progression to the soft diet the following day.

Most of patients were able to be discharged from the hospital on the second or third day after surgery after removing the drain. Generally, patients were maintained on the soft diet for 2–3 weeks after the operation, and if they were not experiencing any significant dysphagia at that time, they might fully liberalize their diet as tolerated.

Outcome assessment

The results of the patients were compared as regards the eckardet score.

Table (5) : The eckardet score.

TABLE 1. Severity of dysphagia assessed by the dysphagia score and the Eckardt score

Eckardt score	Weight loss, kg	Dysphagia	Retrosternal pain	Regurgitation
0	None	None	None	None
1	<5	Occasional	Occasional	Occasional
2	5-10	Daily	Daily	Daily
3	>10	Each meal	Each meal	Each meal

Outcome Measures:

Primary outcome:

Operative time, intra-operative complications (perforation and bleeding), postoperative infection, reflux esophagitis and postoperative stay.

Secondary outcome:

Quality of life

Beneficiaries

All patients who will be involved in this study will have direct benefit from the operation in the form of quick healing time , early return to daily life , low complication and recurrence rate.

Dissemination of results

The results and recommendations will be sent to library of our faculty and our university,as well as the corresponding departments in the other universities. Lastly our outcome and recommendations will be published in the reviewed journals.

Statistical analysis:

The collected data was coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp., Chicago, USA, 2013 and Microsoft Office Excel 2007.

Descriptive statistics were done for quantitative data as minimum& maximum of the range as well as mean±SD (standard deviation) for quantitative normally distributed data, while it was done for qualitative data as number and percentage.

Inferential analyses were done for quantitative variables using Shapiro-Wilk test for normality testing, independent t-test in cases of two independent groups with normally distributed data. In qualitative data, inferential analyses for independent variables were done using Chi square test for differences between proportions and Fisher's Exact test for variables with small expected numbers. The level of significance was taken at P value < 0.050 is significant, otherwise is non-significant.

RESULTS

Table (6): socio demographic data of the patients:

		No.= 30
Age (years)	Mean±SD	40.60 ± 9.24
	Range	30 – 50
Sex	Female	16 (53.0%)
	Male	14 (47.0%)

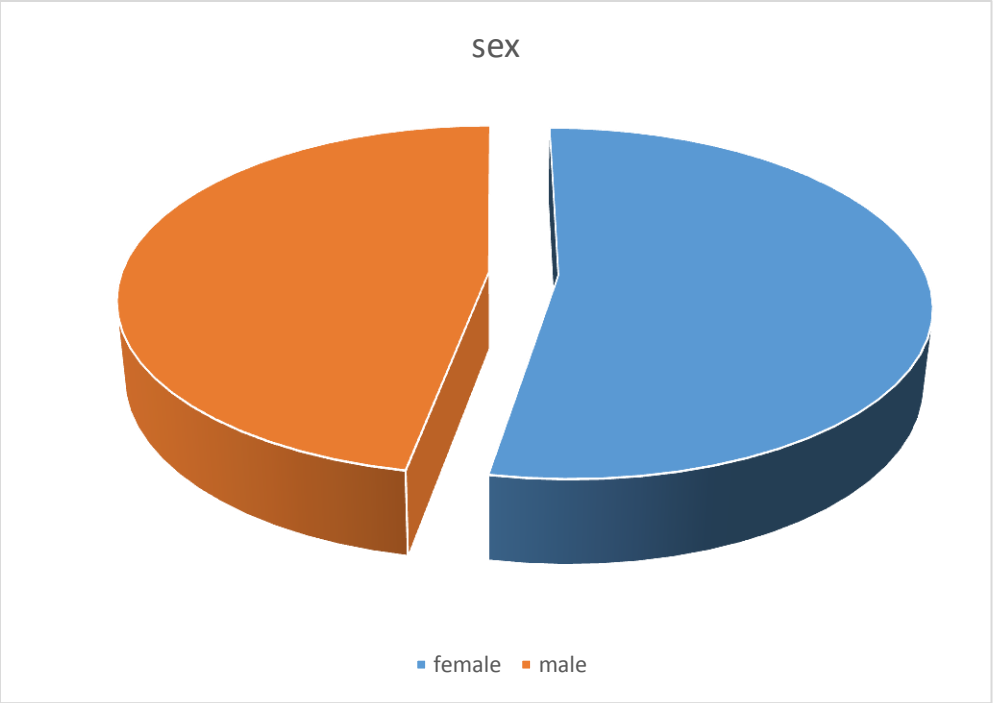

Figure (30): Descriptive for sex of the studied patients.

Table (6) and Figure (30) show demographic data which revealed that age range from 30-50 years old (Mean±SD= 40.6). 53% of patients are female.

Table (7): Comorbidities data of the patients:

		No.= 30
Diabetes mellitus	No	28 (93.0%)
	Yes	2 (7.0%)
Hypertension	No	27 (90.0%)
	Yes	3 (10.0%)
Ischemic heart disease	No	29 (96.0%)
	Yes	1 (4.0%)
History of deep venous thrombosis	No	28 (93.0%)
	Yes	2 (7.0%)
BMI	Mean±SD	20.50 ± 3.24
	Range	17 – 23

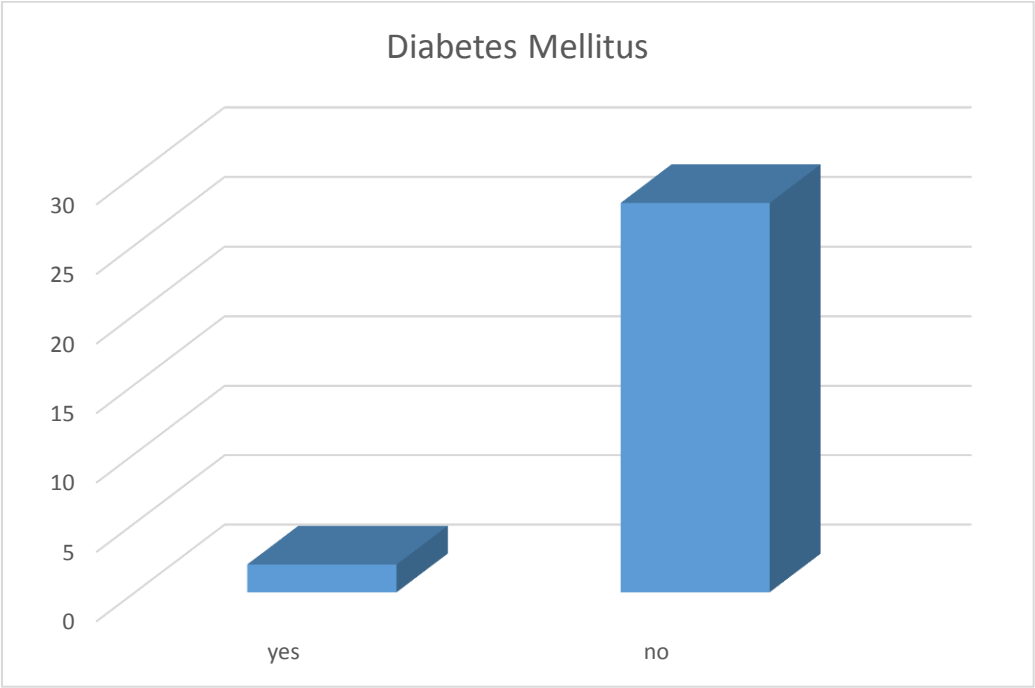

Figure (31): Diabetes mellitus.

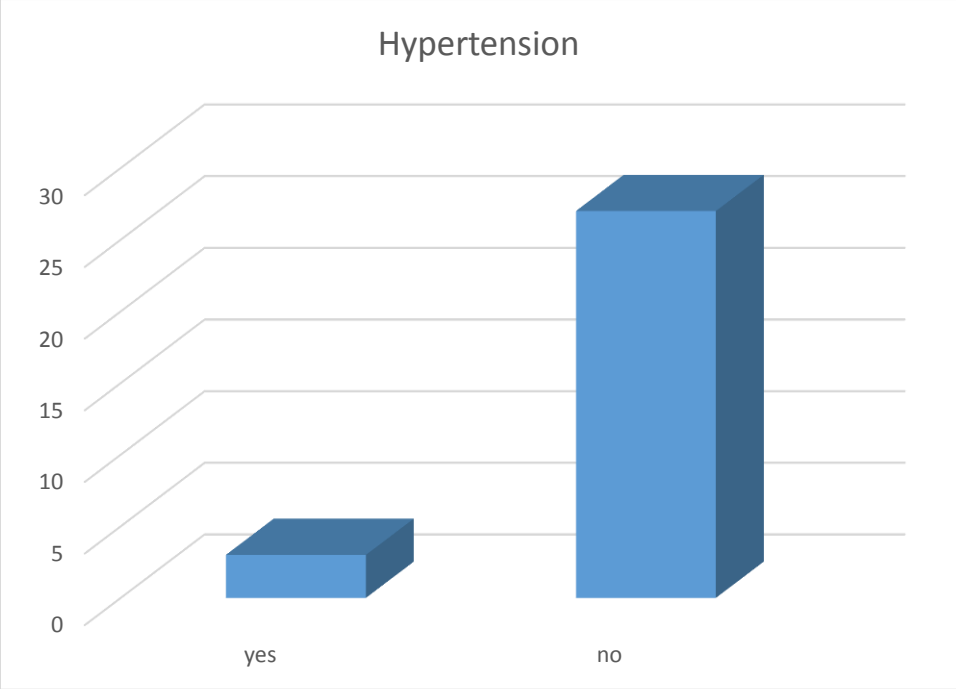

Figure (32): Hypertension.

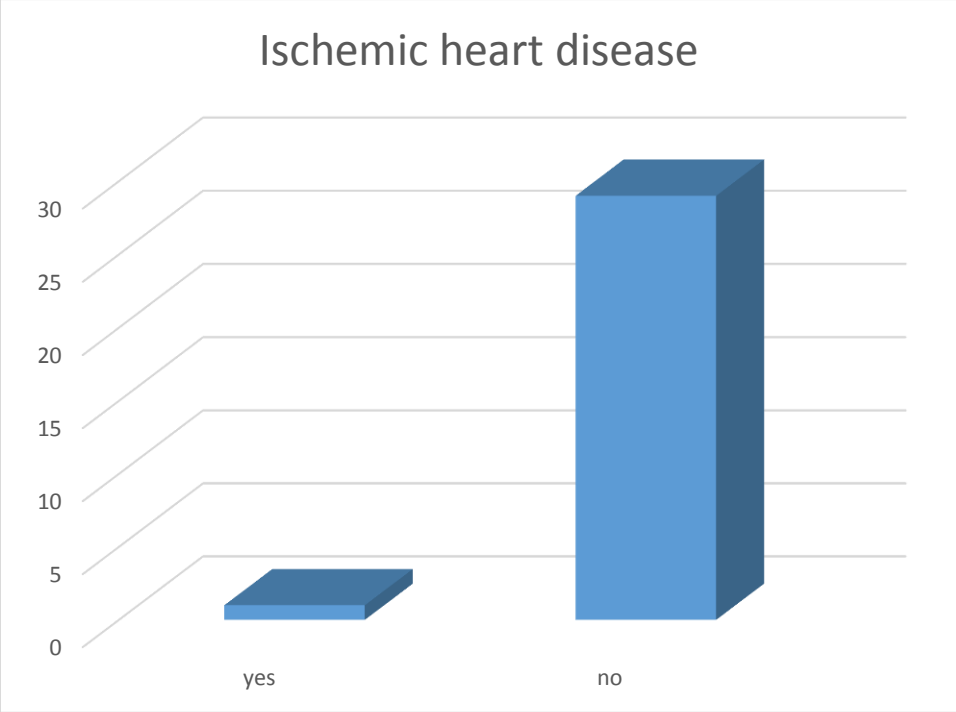

Figure (33): Ischemic heart disease.

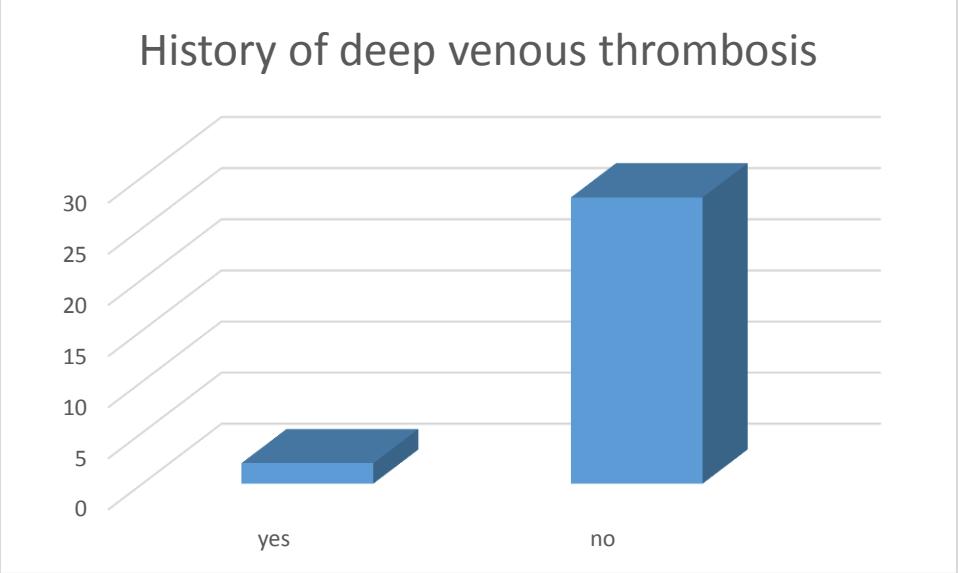

Figure (34): History of deep venous thrombosis.

Table (7) and Figure (31, 32,33,34) show that 2 patients had DM , 3 patients had HTN , 1 patient had IHD and 2 patients had history of deep venous thrombosis.

Table (8): Descriptive for type of achalasia, preoperative lower esophageal sphincter pressure :

		No.= 30
Type of achalasia	Type I	9 (30.0%)
	Type II	16 (53.0%)
	Type III	5 (16.0%)
Pre LESP	Mean±SD	42.20 ± 9.81
	Range	33 – 52

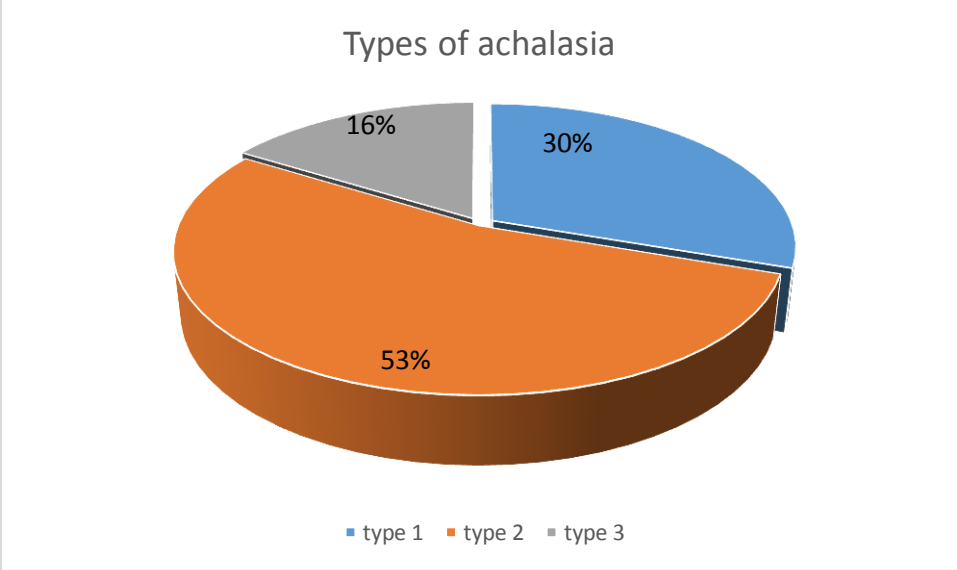

Figure (35): Types of achalasia.

Table (8) and Figure (35) show that 53% of patients are grade 2 with 16% grade 1. preoperative Lower Esophageal Sphincter Pressure (LESP) range (33-52) with mean of 42.2.

Table (9): Descriptive for operative time, post and intra operative complications:

		No.= 30
Operative time	Mean±SD	86.00 ± 23.00
	Range	63 – 109
Intraop. Bleeding	No	28 (93.0%)
	Yes	2 (7.0%)
Perforation	No	28 (93.0%)
	Yes	2 (7.0%)
Post.op hospital stay	Median (IQR)	2 (2 – 3)
	Range	2 – 5
Postop. wound infection	No	29 (96.6%)
	Yes	1 (3.4%)
Postop. reflux esophagitis	No	29 (96.6%)
	Yes	1 (3.4%)

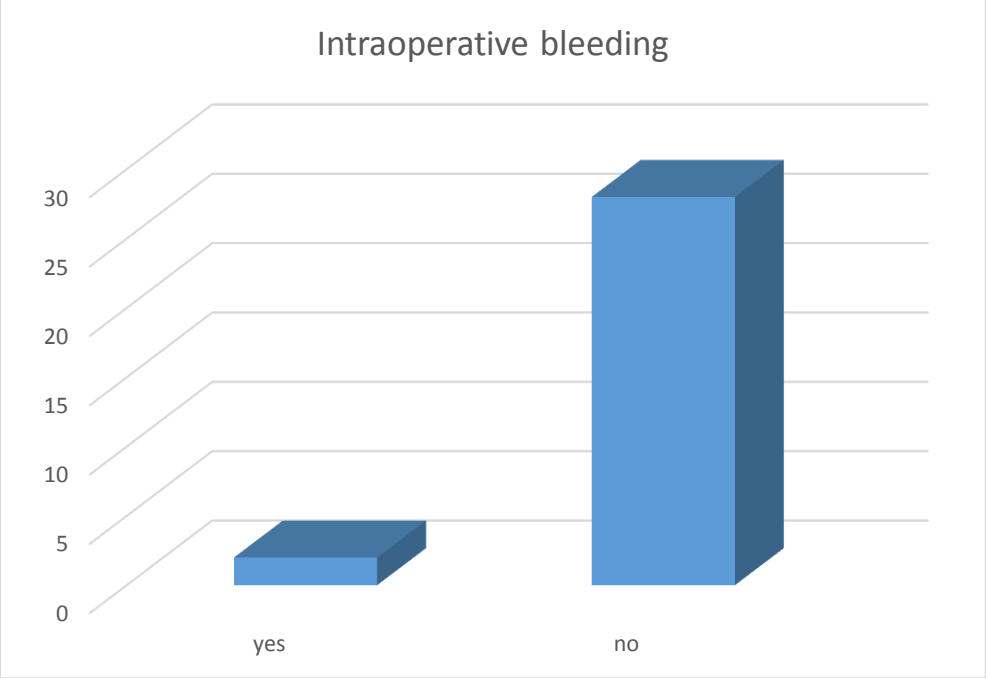

Figure (36): Intraoperative bleeding.

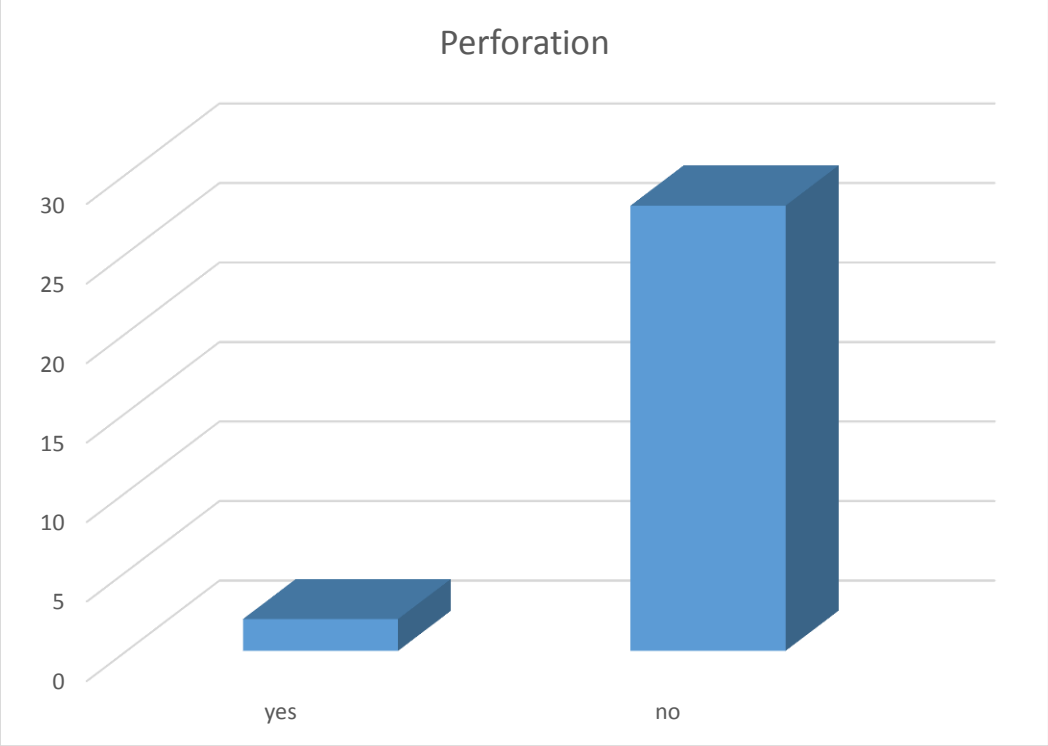

Figure (37): Intraoperative perforation.

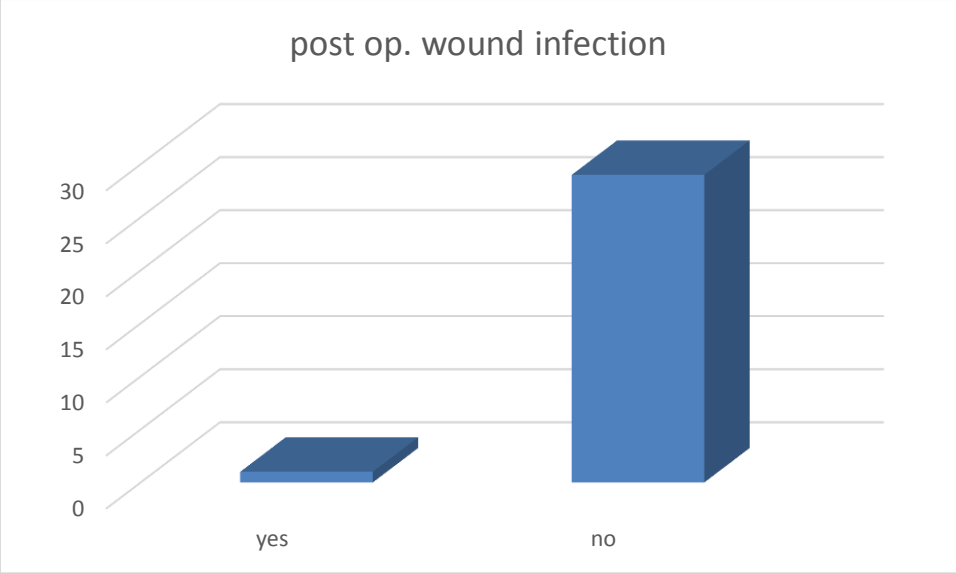

Figure (38): Postoperative wound infection.

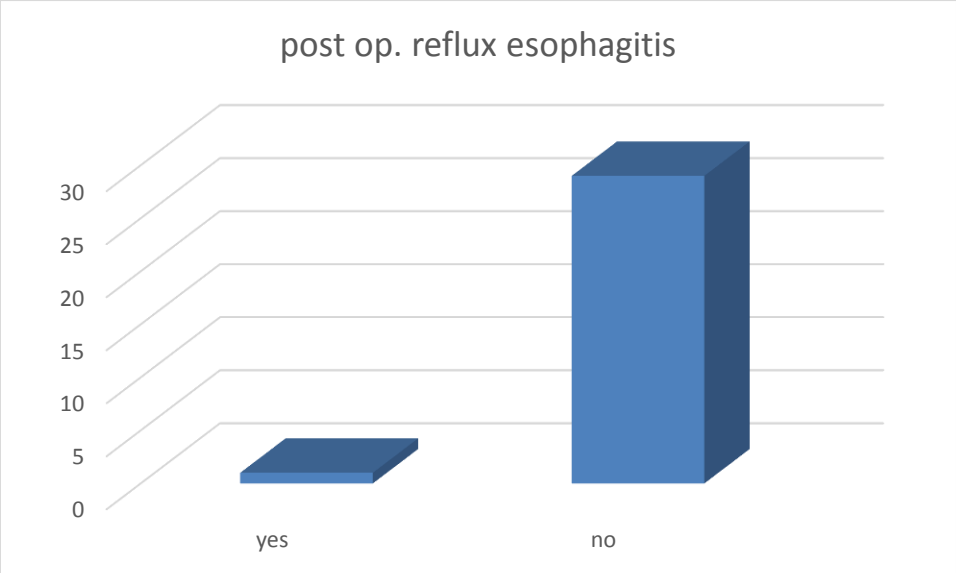

Figure (39): Postoperative reflux esophagitis.

Table (9) and Figure (36, 37,38,39) show that Operative mean time was 86 min with postoperative stay of 2 days. Regarding complications, 7% of patients had intra-operative bleeding, 7% had perforation, 3.4% had postoperative reflux esophagitis and 3.4% had postoperative wound infection.

Table (10): Descriptive for pre eckardt score and post eckardt score of the studied patients

		No.= 30
Pre eckardt score	Median (IQR)	5 (4 – 7)
	Range	2 – 9
Post eckardt score	Median (IQR)	1 (0 – 1)
	Range	0 – 3

DISCUSSION

Esophageal achalasia is a rare esophageal functional disorder characterized by discoordinated or absent esophageal peristalsis and incomplete relaxation of the lower esophageal sphincter (LES) during swallowing due to the destruction and loss of inhibitory myenteric ganglion cells in the Auerbach's plexus of the esophagus ***(Souma et al., 2017)***.

Effective methods for treating achalasia include endoscopic injection of botulinum toxin, endoscopic balloon inflation, per-oral endoscopic myotomy, and laparoscopic Heller myotomy and fundoplication ***(Lynch et al., 2012)***. Of these, the Heller–Dor procedure is based on two major concepts:
(1) relieving the disturbed passage through the lower esophageal segment by Heller myotomy and (2) fundoplication to prevent postoperative gastroesophageal reflux ***(Tsuboi et al., 2016)***.

Based on the excellent short-term success rates, laparoscopic myotomy with anti-reflux procedures (i.e., LHD) has been proposed as the preferred initial treatment approach for achalasia ***(Schoenberg et al., 2013)***.

We aimed in this study to assess the functional Outcome of laparoscopic heller cardiomyotomy in treatment of patients with achalasia of the cardia using the Eckardt score.

This prospective randomized study which will be conducted at the General Surgery Department in Benha University Hospital and Mansora university Hospital from december 2020 to march 2022 and performed

on total 30 patients who diagnosed with esophageal achalasia undergoing laparoscopic Heller's cardiomyotomy.

During this study, 38 patients were assessed for eligibility and 30 patients were included in the study. Of all eligible patients, 6 patients were excluded from the study based on the inclusion criteria and 2 patients refused to participate in of the study.

In the current study the mean operative time was 86.00 ± 23.00 minutes and this is better than the results of (**Lileswar et al.,2013)** who described that the mean operative time was 93 ± 29.00 minutes .

The intraoperative bleeding occurred in 2 patients in our study due to coagulopathy and this is better than the results of (**Lileswar et al.,2013)** who described that The intraoperative bleeding occurred in 3 patients and this result due to use of recent instruments in control of bleeding.

The intraoperative perforation in our study occure in 7% of the patients (2 patients) in comparison with (**Simon C et al.,2011)** the Intra-operative mucosal perforation was identified in 5.8% patients (7 patients)

The post operative hospital stay of the patients in our study is rang from 2 to 5 days and this matched with the results of (**Miloš B et al., 2013) .**

The post operative wound infection occurred in 1 patient in our study due to not following the instructions of dressing and medications and this is matched with the results of (**Radovanovic N et al .,2000)**

The post operative reflux esophagitis occurred in 1 patient in our study and managed by proton pump inhibitors and this is matched with the results of (**Omura N et al .,2006)**

Eckardt symptom score is the grading system for achalasia most frequently used for the evaluation of symptoms (dysphagia, regurgitation, retrosternal pain and weight loss), stages and efficacy of achalasia treatment. A symptom score of 0-1 corresponds to clinical stage 0, a score of 2-3 to stage I, a score of 4-6 to stage II, and a score >6 to stage III. Stages 0 and I indicate remission of the disease. On the other hand, stages II and III represent failure of treatment ***(Torresan et al., 2015)***.

Our results revealed highly significant difference between the preoperative and postoperative eckardt scores among all patients in our study.

These results were in concordance with the data reported by ***Souma et al. (2017)*** which revealed that preoperative dysphagia improved in all patients postoperatively .

Tsuboi et al. (2018) revealed that there was no difference in postoperative symptoms based on the postoperative questionnaires completed 3 months after the surgery, with improved symptoms noted in all patients and Patient satisfaction was high.

The strength points of this study:

The strength points of this study are that it is prospective study design and having no patients lost to follow-up during the study. Most studies that have investigated the effect of laparoscopic heller cardiomyotomy in treatment of achalasia on surgical outcomes ***(Tsuboi et al., 2018).***

The limitations of the study:

The limitations of the study are worthy of mention including relatively smaller sample size relative to the previous studies, not being a

multicentric study and this represents a significant risk of publication bias. ***(Souma et al., 2017)***.

Therefore, further investigation with larger number of subjects is required to evaluate effect of laparoscopic heller cardiomyotomy in treatment of achalasia

CONCLUSION

As evident from the study, Laparoscopic Heller's cardiomyotomy achieved symptomatic improvement in all patients with Achalasia with least intraoperative and post operative complications .

RECOMMENDATIONS

The present study can burden the knowledge and shed some light on future prospective studies with larger number of subjects are required to evaluate the impact of Laparoscopic Heller's cardiomyotomy in management of achalasia of the cardia.

SUMMARY

Esophageal achalasia is an esophageal motility disorder of unknown etiology that results in impaired relaxation of the lower esophageal sphincter (LES) and loss of esophageal peristalsis.

The diagnosis of achalasia usually starts with a barium esophagram followed by esophageal manometry the latter being considered the "gold standard" for the diagnosis. On conventional manometry, absence of peristalsis sometimes with increased intra-esophageal pressure owing to stasis of food and saliva and incomplete relaxation of the LES on swallowing (residual pressure>8– 10 mmHg) are the hallmarks of achalasia.

Effective methods for treating achalasia include endoscopic injection of botulinum toxin, endoscopic balloon inflation, per-oral endoscopic myotomy, and laparoscopic Heller myotomy and fundoplication. Of these, the Heller–Dor procedure is based on two major concepts: (1) relieving the disturbed passage through the lower esophageal segment by Heller myotomy and (2) fundoplication to prevent postoperative gastroesophageal reflux.

Based on the excellent short-term success rates, laparoscopic myotomy with anti-reflux procedures has been proposed as the preferred initial treatment approach for achalasia.

In this study, we aimed to assess the functional Outcome of laparoscopic heller cardiomyotomy in treatment of patients with achalasia of the cardia using the Eckardt score.

This prospective study was conducted at the General Surgery Department in Benha University Hospital and Mansora university Hospital.

Enrollment of eligible patients will be throughout the period december 2020 to march 2022.

The present study includes 30 patients with achalasia of the cardia who randomly done laparoscopic heller cardiomyotomy and assessment of them postoperative according Eckardt score

Our study results revealed that there was no statistically significant difference among the studied patients regarding type of achalasia and preoperative Lower Esophageal Sphincter Pressure.

Our results revealed that there was lower operative time among the patients with less postoperative wound infection, intraoperative bleeding and postoperative hospital stay.

Regarding complications, our results revealed that there was few patients suffer from postoperative reflux esophagitis and perforation.

Our results revealed highly significant difference between the preoperative and postoperative eckardt scores among the patients

We concluded that Laparoscopic Heller’s cardiomyotomy achieved symptomatic improvement in all patients .

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الملخص العربي

تعذر الارتخاء المريئي هو اضطراب حركي في المريء مجهول السبب يؤدي إلى ضعف استرخاء العضلة العاصرة للمريء وفقدان التمعج المريئي.

يبدأ تشخيص تعذر الارتخاء المريئي عادةً بمريء الباريوم متبوعًا بقياس ضغط المريء، ويعتبر الأخير "المعيار الذهبي" للتشخيص. في قياس الضغط التقليدي، فإن غياب التمعج أحيانًا مع زيادة الضغط داخل المريء بسبب ركود الطعام واللعاب وعدم اكتمال ارتخاء العضلة العاصرة للمريء عند البلع (الضغط المتبقي> 8-10 مم زئبق) هي السمات المميزة لتعذر الارتخاء المريئي.

تشمل الطرق الفعالة لعلاج تعذر الارتخاء الحقن بالمنظار لتوكسين البوتولينوم، والتضخم بالبالون بالمنظار، واستئصال العضلة بالمنظار عن طريق الفم، واستئصال عضلات الترقق بالمنظار وثنية القاع. من بين هؤلاء، يعتمد إجراء هيلر دور على مفهومين رئيسيين: (1) تخفيف الممر المضطرب عبر الجزء السفلي من المريء عن طريق بضع عضلات هيلر و (2) تثنية القاع لمنع ارتداد المعدة بعد العملية الجراحية.

بناءً على معدلات النجاح الممتازة على المدى القصير، تم اقتراح بضع العضل بالمنظار مع الإجراءات المضادة للارتجاع كنهج العلاج الأولي المفضل لتعذّر الارتخاء.

في هذه الدراسة ، كنا نهدف إلى تقييم النتيجة الوظيفية لبضع عضلة القلب بالمنظار في علاج المرضى الذين يعانون من تعذر الارتخاء في المرىء باستخدام درجة إكاردت.

أجريت هذه الدراسة المستقبلية في قسم الجراحة العامة بمستشفى جامعة بنها ومستشفى جامعة المنصورة.

وكان تسجيل المرضى المؤهلين طوال الفترة من ديسمبر 2020 إلى مارس 2022.

تضمنت الدراسة الحالية 30 مريضًا يعانون من تعذر الارتخاء في القلب والذين أجروا عملية قطع عضلة القلب بالمنظار بشكل عشوائي وتقييمهم بعد الجراحة وفقًا لدرجة إيكاردت.

أوضحت نتائج دراستنا عدم وجود فروق ذات دلالة إحصائية بين المرضى الخاضعين للدراسة فيما يتعلق بنوع تعذر الارتخاء المريئي وضغط المصرة السفلية للمريء قبل الجراحة.

أظهرت نتائجنا أن هناك وقتًا أقل للعملية بين المرضى الذين يعانون من عدوى أقل للجروح بعد العملية الجراحية ، ونزيف أثناء العملية ومكوث في المستشفى بعد الجراحة.

فيما يتعلق بالمضاعفات ، أظهرت نتائجنا أن هناك عددًا قليلاً من المرضى يعانون من التهاب المريء الارتجاعي بعد الجراحة والانثقاب.

كشفت نتائجنا عن اختلاف كبير بين درجات إكاردت قبل الجراحة وبعد الجراحة بين المرضى

خلصنا إلى أن بضع عضلة القلب بالمنظار قد حقق تحسنًا في الأعراض في جميع المرضى.