Role of esophageal manometry in decision making in patients with early cardiac achalasia

Khaled A. El Fiky, Hisham A. Raouf Al Akkad, Mohammed M. Mohamed, Mohamed A. M. F. Altager

Department of General Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Mohamed Alsayed Mohamed Farag Altager, MSC, MRCS, MD, 40, St Abo Hanefa, 7th Settlement, Nasr City, Cairo 11772, Egypt. Tel: +00201002340443; e-mail: dr.syco1990@gmail.com

Received: 15 September 2021
Revised: 24 September 2021
Accepted: 14 October 2021
Published: 10 October 2022

The Egyptian Journal of Surgery 2022, 41:90–96

Background
Achalasia is an incurable primary motor disorder of the esophagus. Its characteristic manometric features are esophageal body aperistalsis and insufficient relaxation of a frequently hypertensive lower esophageal sphincter in response to swallowing. As the pathogenesis of achalasia is not well understood, the treatment is palliative, aiming at relieving the obstruction at the gastroesophageal junction.
Aim
The aim of this study was to detect the role of preoperative manometry in the choice of the optimal method in the treatment of the early achalasia to be either Heller's cardiomyotomy (with or without antireflux procedures) or endoscopic balloon dilatation.
Patients and methods
This cohort observational study included 30 patients presented with cardiac achalasia to Ain Shams University hospitals. Patients were assessed with preoperative manometry to determine a proper solution, which was done with a follow-up of at least 6 months starting from October 2018 till October 2020.
Results
All patients were assessed through high-resolution manometry, and symptomatic assessment was done through the Demeester grading score. Both laparoscopic heller myotomy (LHM) and pneumatic dilatation (PD) showed complete success in 82 and 62%, respectively, whereas partial success in 12 and 15%, respectively. Failure was recorded in 6% of LHM and 23% of PD patients.
Conclusion
High resolution manometry proved to be a reliable modality in choosing the optimal method in the treatment of early achalasia based on the following conclusions of our results: LHM is a favorable decision for patients with type I [young age, high Demeester score (>7), and severe elevation in lower esophageal sphincter (LES) pressure ≥35 mmHg], type II, and type III, whereas PD was fit for patients with type I achalasia (old age, low Demeester score, and elevation in LES pressure <35 mmHg).

Keywords:
achalasia, esophageal manometry, lower esophageal sphincter

Egyptian J Surgery 2022, 41:90–96

1110-1121

Introduction

Achalasia is a chronic condition without a cure. Current treatment options in achalasia are aimed at reducing the hypertonicity of the lower esophageal sphincter (LES) by pharmacologic, endoscopic, or surgical means. No intervention significantly affects esophageal peristalsis [1].

The goals in treating achalasia are to relieve patients' symptoms, improve esophageal emptying, and prevent further dilation of the esophagus. To achieve these goals, the available therapeutic option must be tailored to patients with achalasia [2].

Dynamic investigations, mainly esophageal manometry, are needed for the diagnosis and follow-up after treatment. Three findings are commonly recorded: increase in lower esophageal sphincter pressure, lack of relaxation, and absence of peristalsis, the latter being indispensable for the diagnosis of achalasia [3].

Manometry is an objective method of assessing the effectiveness of treatment, that is, surgical myotomy or balloon dilatation [4].

A new achalasia classification – obtained using high resolution manometry (HRM), which records

the pressure readings from 36 sensors placed 1 cm apart and enables pressure topography plotting – has recently been proposed, which considers three different manometric patterns [5]: type I, achalasia with minimal esophageal pressurization; type II, achalasia with esophageal compression; and type III, achalasia with spasm. Most importantly, the authors also suggested a correlation between the manometric subtype and the final outcome of treatment [6].

Aim

The aim of this study was to detect the role of preoperative manometry in the choice of the optimal method in the treatment of early achalasia.

Patients and methods

This cohort observational study included 30 patients with achalasia presented to Ain Shams University hospitals. Patients were assessed with preoperative manometry to determine a proper solution, which was done with a follow-up of at least 6 months starting from October 2018 till October 2020.

This research was performed at the Department of General Surgery, Ain Shams University Hospitals. Ethical Committee approval and written, informed consent were obtained from all participants. All patients were fully informed about the procedure they would undergo, its possible sequelae, and its complications.

Inclusion criteria

The following were the inclusion criteria:

(1) Adult patients between 18 and 65 years.
(2) Male and female patients.

Exclusion criteria

The following were the exclusion criteria:

(1) Extremes of age less than 18 and more than 65 years.
(2) Patients who were unfit for general anesthesia.
(3) Pregnant women.
(4) Patients with prolonged achalasia (sigmoid esophagus).

Patients were assessed clinically via history and examination:

(1) Dysphagia for solids and liquids.
(2) Regurgitation of undigested food.
(3) Heartburn.
(4) Chest pain.

This assessment was numerically evaluated through the modified Demeester score to be more objective. For each symptom, a score from 0 to 3 was attributed, depending on its severity. Then, for each patient, a clinical score equal to the sum of the symptom scores was finally assessed and the reduction of each symptom severity after the surgery was then investigated; the maximum value was 9, whereas the minimal value was 3. The patients with score below 2 without dysphagia were excluded (Table 1).

Investigations

(1) Preoperative:
    (a) Upper gastrointestinal endoscopy: comments on esophageal peristalsis, dilatation, LES, any residual food were noted.
    (b) HRM: it was used for evaluation of esophageal peristalsis, LES pressure, integral resting pressure (IRP), and ineffective contractions and to differentiate between achalasia types through the infusion method.
(2) Postoperative: HRM after 6 months was done.

The choice of either pneumatic dilatation (PD) or laparoscopic heller myotomy (LHM) was made upon the surgeon's preference after revising the manometry results with a tendency to do PD in cases of a low Demeester score, moderately elevated LES pressure, and elder patients, whereas performing Heller's myotomy in cases of a high Demeester score, severe elevation in LES pressure, and young patients. This study was aimed to find out if a more objective method for decision making could depend on the preintervention manometry primarily and possibly if other objective parameters like Demeester score as a secondary finding.

As an observational retrograde study, comparison between preinterventional and postinterventional

Table 1 Modified Demeester score

Symptoms	Score	Description
Dysphagia	0	None
	1	Occasional transient episodes
	2	Require liquids to clear
	3	Impaction requiring medical attention
Heartburn	0	None
	1	Occasional brief episodes
	2	Frequent episodes requiring medical treatment
	3	Interference with daily activities
Regurgitation	0	None
	1	Occasional episodes
	2	Predictable by posture
	3	Interference with daily activities

manometry and symptomatic improvement showed that the preintervention decision made according to the surgeon preference was feasible depending on certain manometric measures in decision making in patients with early achalasia.

Manometry

(1) Patients were instructed to stop any medication that may influence esophageal motility (calcium channel blocker, nitrates, loperamide, prokinetics, beta-blocker, and opioids).
(2) Patients were instructed for complete fasting for 12 h before procedure.
(3) An HRM catheter was introduced transnasally in the supine position and positioned by observing the appearance of a high-pressure zone at the distal end of the LES.
(4) Patients were instructed not to swallow for 30 s to detect the resting pressure among esophagus.
(5) Patients were then instructed to take 5 ml of water in each swallow of 10 successive swallows separated by 30 s interval for assessment of esophageal body peristalsis.

Endoscopic pneumatic dilatation

Patients were instructed to fast for 12 h; the procedure was done under general anesthesia with endotracheal intubation to avoid aspiration.

After that, a guide wire was inserted through the working channel of the endoscopy, and the level of gastroesophageal junction was marked on the skin with a radiopaque marker. The endoscope was removed, and insertion of rigiflex balloon dilators (35 and 40 mm as available) over the guide wire was done, and its middle radiopaque marker was positioned at the skin marker under fluoroscopy.

The balloon was then inflated slowly with sufficient pressure (10 psi) and remained inflated for 1 min. After deflation of the balloon, the dilator was withdrawn. Endoscopy was repeated to exclude any perforation.

Surgical operative steps

Laparoscopic technique

(1) Patient position: the patient is placed in a supine, split leg position. The patient was positioned in the reverse Trendelenburg position.
(2) Ports placement: 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 a Veress needle, and a liver retractor was inserted in the epigastrium.

Mobilization of the gastric fundus

(1) Incision of the gastrohepatic ligament was done in an avascular plane.
(2) Division of the right anterior phrenoesophageal ligament and the peritoneum overlying the anterior abdominal esophagus was done.
(3) Division of the left phrenogastric ligaments was done by dividing the short gastric arteries exposing left crus of the diaphragm.
(4) We used harmonic or Ligasure devices for dissection.

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.

We start the myotomy 1–2 cm above the gastroesophageal junction. Myotomy is performed longitudinally in the anterior esophageal axis using an electric hook and a Ligasure scalpel. Caution must be taken to avoid injury to the esophageal mucosa. The longitudinal muscles are divided first and then the circular one, revealing a bulging mucosal plane that should appear smooth and white. A continuous myotomy was performed for 6 cm on the esophagus and 3 cm onto the stomach.

According to our unit standardization method, Dor fundoplication was done: the greater curve of the fundus was grasped, and the inner row of interrupted sutures was used to secure the medial aspect of the fundus to the left side of the myotomy.

(1) The anterior fundus was folded over the esophagus, and a coronal suture to the right crus and right side of the esophagus was performed.
(2) A second row of interrupted sutures was placed to fix the leading edge to the right side of the myotomy.

Outcome measures

Comparison of preintervention and postintervention (Demeester) scores and HRM was done. A score improvement by score 3 or less or dropping of resting LES to 10 mmHg or both was considered complete success. Score improvement by 3–5 or LES pressure of 11–15 mmHg was considered partial success; otherwise, the interventional procedure was considered a failure.

Statistical analysis

The data were collected, tabulated, and statistically analyzed. Description of quantitative variables was done as mean and standard deviation and qualitative

data as frequency. One-way analysis of variance test was used to compare two groups regarding quantitative variables in parametric data. The results were considered significant with *P* value less than 0.05, whereas being nonsignificant with *P* value less than or equal to 0.05. Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0 (IBM Corp., Armonk, NY, USA).

Results

As shown in Table 2, 13 patients had PD and were referred to as group A, whereas 17 patients had LHM and were referred to as group B.

High-resolution manometry

Achalasia subtypes are demonstrated in Table 3.

Regarding other manometric parameters, the mean LES pressure, IRP, and ineffective contractions before and after intervention showed significant decline in both study groups, as demonstrated in Table 4.

Symptomatic assessment through the Demeester scoring system was done before and after intervention with respect to dysphagia, regurgitation, heartburn, and the global score. All of them showed significant improvement after intervention, as shown in Figs 1–4 and Table 5.

According to our study parameters for success rates, the following results represented the outcome of the study.

Table 2 Demographic data of the study groups

	Balloon=13: group A	LHM=17: group B	*P* value	
Age	Mean age 39.7±10.7		0.001	S
	44.92±8.1	31.5±4.1		
Sex	18 female/12 male		0.880	NS
	5 male/8 female	7 male/10 female		

Table 3 Manometric types of achalasia of the study groups

	Group A [*n* (%)]	Group B [*n* (%)]	Total [*n* (%)]
Type I	4 (13)	1 (3)	5 (16)
Type II	9 (30)	14 (47)	23 (77)
Type III	0	2 (7)	2 (7)

In group A, complete success was achieved in eight (62%) patients, whereas partial success in two (15%) patients, whereas three (23%) patients were within failure parameters (two of them were type II achalasia and one was type I; one of them had a postdilatation score of 7, so laparoscopic Heller myotomy was planned, whereas the other two patients' score was 5, so another session of dilatation was done).

In group B, complete success was achieved in 14 (82%) of 17 patients, partial success was seen in two (12%) patients, whereas only one (6%) case was within failure parameters. This case was of type III achalasia with a Demeester score of 6, with an age of 44 years, planned for longer myotomy.

Discussion

Achalasia previously was defined as failure of LES relaxation upon swallowing causing dysphagia that was assessed by upper gastrointestinal tract endoscopy, featured with pin-hole lower esophageal sphincter accompanied with food remnants with or without proximal esophageal body dilatation according to the duration of complaint. Moreover, gastrografin swallow showed bird beak appearance with or without esophageal dilatation. According to these findings, treatment decision was taken in early decades of 20th century to improve the main symptom of the patient, which is dysphagia through either PD or LHM.

With several treatment options available, there is a growing demand for tailored treatment strategies for the individual patient with achalasia to reduce the risk of clinical failure, need for reintervention, or risk of adverse events [7].

Surgery is considered the treatment of choice for esophageal achalasia as it achieves better and longer-lasting symptomatic relief than that obtained with medical or endoscopic treatment [8,9].

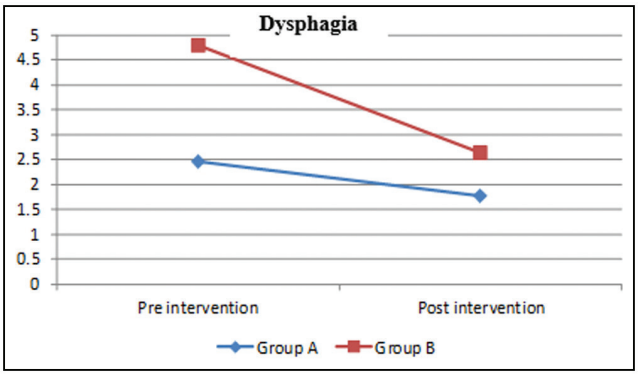
In our study, the start with manometric finding was optimum to the aim of the study. Regarding manometric achalasia subtypes, most of the cases were type II (77%) for both groups of patients collectively,

Table 4 Preintervention and postintervention manometric parameters of the study groups

	Before intervention	After intervention	*P* value	Significance
Group A LES pressure	37.53±9.45	10.38±2.18	0.001	S
Group B LES pressure	57.24±8.73	8.93±1.23	0.001	S
Group A IRP	25.16±6.36	14.24±2	0.027	S
Group B IRP	25.24±9.6	13.58±1.6	0.018	S
Group A ineffective contractions	65.3±11.53	34.69±21.17	0.001	S
Group B ineffective contractions	70±16.21	29.41±23.93	0.001	S

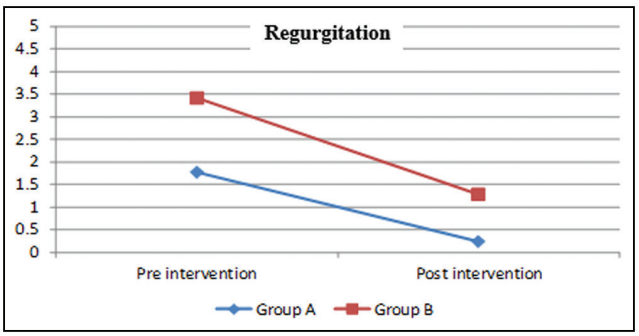
IRP: integral resting pressure.

Figure 1



Preintervention and postintervention status of the study groups regarding dysphagia.

Figure 2



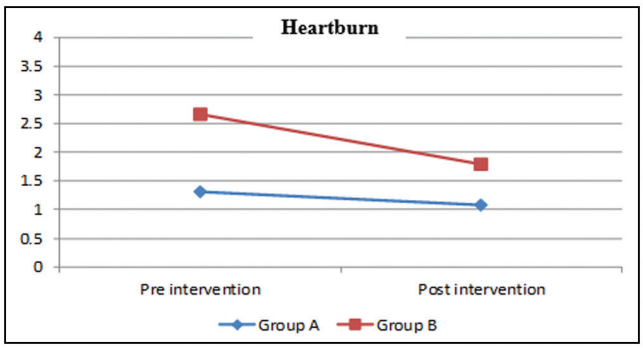
Preintervention and postintervention status of the study groups regarding regurgitation.

whereas type I was seen in 16% in comparison with type III (7%).

Abdel Mohsen and Imam [10] stated that type I was seen in 40%, whereas 47.5% had type II, whereas type III was seen in 12.5% of their study group, and this is concomitant with worldwide parameters.

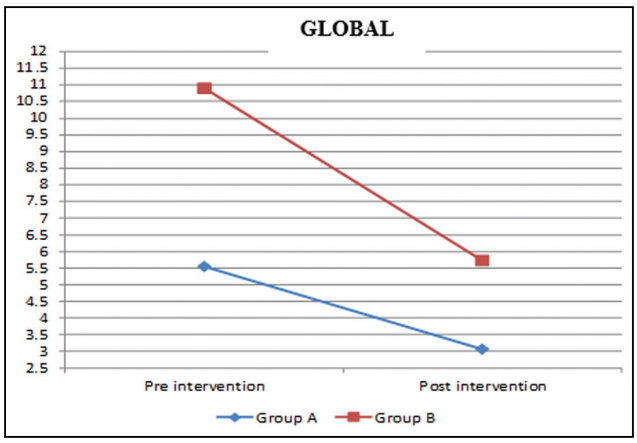
Regarding the treatment response in correlation with manometric subtypes, complete success rate in LHM was achieved in 82%, where most of them were type II patients (13/14), whereas the remaining case was type I, in comparison with patients with PD, where complete success was seen in 62%; most of them were type II represented by five patients, whereas three patients were type I. On the contrary, partial response rates were recorded in only two (12%) patients in LHM group, where one of them was type III and the other one was type II, whereas in PD group patients also, two patients only were classified as partial response, and both of them were type II. Finally, failure rates were 23 and 6% for PD and LHM patients, respectively. The 6% of LHM patients was represented as one patient with type III achalasia, whereas in PD patients, failure

Figure 3



Preintervention and postintervention status of the study groups regarding heartburn.

Figure 4



Preintervention and postintervention status of the study groups regarding Global.

was represented by three patients; one of them was type I and the other two patients were type II.

The selection of the best initial approach for achalasia also appears to be influenced by the Chicago Classification. However, in types I and II achalasia, PD and LHM appear to be the best optimal treatment, whereas type III achalasia seems to be better managed with per oral endoscopic myotomy, probably owing to the ability to perform a longer myotomy of the thoracic esophagus [11].

Rohof *et al.* [8] showed 44 (25%) patients had achalasia type I, 114 (65%) patients had type II, and 18 (10%) patients had type III. After a minimum follow-up period of 2 years, success rates were significantly higher among patients with type II achalasia (96%) than type I achalasia (81%) or type III achalasia (66%). The success rate of PD was significantly higher than that of LHM for patients with type I achalasia (100 vs. 93%), but

Table 5 Demeester score (preintervention and postintervention) of the study groups

Demeester score	Group A pre	Group A post	*P* value	Significance
Dysphagia	2.46 ± 0.52	1.77 ± 0.44	0.001	S
Regurgitation	1.77 ± 0.76	1.30 ± 0.63	0.042	S
Heartburn	1.31 ± 0.48	1.08 ± 0.76	0.031	S
Global	5.54 ± 1.33	3.15 ± 1.44	0.001	S
	Group B pre	Group B post		
Dysphagia	2.35 ± 0.49	0.88 ± 0.697	0.001	S
Regurgitation	1.65 ± 0.7	0.71 ± 0.69	0.024	S
Heartburn	1.35 ± 0.49	0.71 ± 0.69	0.015	S
Global	5.35 ± 1.49	2.25 ± 1.	0.001	S

LHM had a higher success rate than PD for patients with type III achalasia (86 vs. 40%; the difference was not statistically significant because of the small number of patients). For type II achalasia, LHM and PD had similar rates of successes (81 vs. 85%).

In our study, complete success was revealed in 22 (73%) of 30 patients featured with LES pressure lower than 10 mmHg; eight in PD group and 14 in LHM group. Partial response patients represented four (13.5%) of 30 patients with pressure range from 11 to 15 mmHg. Failure was recorded in four patients, represented as three in PD group and one in LHM group with pressure more than or equal to 15 mmHg after intervention by 6 months. Both LHM and PD patient showed statistically significant improvement of the LES pressure, integral relaxation pressure, and ineffective contractions.

In 2016, a study in which 200 achalasia patients were included, of which 58 underwent PD and 142 underwent LHM. At 2 months after treatment, there was significant improvement in basal LES pressure and LES-IRP in both PD and LHM groups. PD and LHM were all effective in improving esophageal function in achalasia at short term. There was no difference in efficacy between them [12].

Demographic predictors

Sex

Several high-quality studies reported on the association between sex and treatment response. The majority of included studies (90%) did not find an association for any treatment [13].

In this study, no statistical significance was found between the two treatment modalities and sex.

Age

In our study, elder patients showed favorable outcome with pneumatic dilatation with mean age of 44 ± 8.2 years, whereas most of the younger patients showed complete success response with Heller myotomy, with a mean age of 31.5 ± 4.1 years, with statistical significance (*P*=0.001).

The majority of studies that looked into age as a predictive factor for response to pneumatic dilatation found a positive association. Eckardt *et al.* [14] stratified for age and found higher failure rates for patients younger than age 40 years compared with older individuals (48 vs. 78%; *P*<0.05).

Symptomatic analysis

During the past 10 years, several RCTs comparing PD and LHM have been published [15–17]. The pooled analysis of these RCTs showed higher rates of symptom remission after LHM at 3 months and 1 year, whereas the outcomes at 2 and 5 years seemed to be equivalent (remission rate at 5 years was 85.3% after LHM and 78.2% after PD). Overall, 25% of patients required a retreatment, more frequently after PD. Postprocedural LES pressure and the rate of pathologic reflux did not significantly differ between the two treatment modalities. Our current study also showed significant improvement in the global Demeester score of both procedures. In addition, there was a statistically highly significant improvement in LES pressure, and there were ineffective esophageal contractions after our two procedures in favor of the LHM group.

Hamdy *et al*. [18], stated that the rate of symptoms relief was 76% in endoscopic pneumatic dilatation compared with 96% in LHM (*P*=0.04). There was a significant lowering of lower esophageal sphincter in the LHM group (*P*=0.0001). There was no significant difference between the two procedures regarding complications and response rate. Improvement of manometric features was better in the LHM group.

Ponds *et al*. [19], in a prospective randomized double-blind clinical trial, demonstrated that LHM with Dor fundoplication was superior to Heller alone for incidence of postoperative gastroesophgeal reflux disease (GERD) evaluated by 24-h pH monitoring after surgery. In addition, a large-scale meta-analysis including more than 3000 patients after LHM found the incidence of postoperative GERD was notably higher when no fundoplication was performed (32 vs. 9%). In this current study, 17.6% of patients who underwent LHM with Dor fundoplication based upon our department standardization method had regurgitation.

Sayed *et al*. [20] stated that regurgitation significantly improved in 89% of patients with LHM with Dor fundoplication.

Like our unit standards, Oelschlager *et al*. [21] support extending the myotomy up to 3 cm on the stomach, and they claim a reduction in the severity of dysphagia in patients with 3 cm myotomies. These patients showed a decline in lower LES resting pressure and a higher acid exposure in the distal esophagus at postoperative pH monitoring (although neither of these findings were statistically significant).

However, Salvador *et al*. [22] suggested that a myotomy extended 1.5–2 cm on the gastric side could provide sufficient palliation to dysphagia in patients with achalasia, provided that myotomy is diverted slightly to the left and is accurately performed, dividing the sling fibers.

Ahmed *et al*. [23] stated that using HRM, 14 (70%) patients with type I achalasia underwent Dor fundoplication, and in these, dysphagia and regurgitation improved significantly. Moreover, there were four (28.5%) patients with postoperative reflux. There was a significant reduction in LES pressure.

Conclusion

Laparoscopic Heller myotomy is a favorable decision for patients with type I [young age, high Demeester score (>7), and severe elevation in LES pressure ≥35 mmHg], type II, and type III (with longer myotomy), whereas balloon dilatation is suitable for type I achalasia (old age, low Demeester score, and with mild to moderate elevation in LES pressure <35 mmHg).

Financial support and sponsorship

Nil.

Conflicts of interest

No conflict of interest.

References

1 Amit P, Ami P, Faiz AM, Soudagar S, Sayuk G, Gyawali P. Achalasia symptom response after Heller myotomy segregated by high-resolution manometry subtypes. J Gastroenterol 2016; 51:112–118.

2 Michael FV, John EP, Marcelo FV. Diagnosis and management of achalasia. Am J Gastroenterol 2013; 108:1238–1249.

3 Froukje BH, Albert JB. Clinical application of esophageal high-resolution manometry in the diagnosis of esophageal motility disorders. J Neurogastroenterol Motil 2016; 22: 6–13.

4 Lee JY, Kim N, Kim SE, Choi YJ, Kang KK, Oh DH. Clinical characteristics and treatment outcomes of 3 subtypes of achalasia according to the Chicago classification in a tertiary institute in Korea. J Neurogastroenterol Motil 2013; 19:485–494.

5 Kahrilas PJ, Bredenoord AJ, Fox M, Gyawali C, Roman S, Smout A, *et al*. The Chicago classification of esophageal motility disorders, v3.0. J Neurogastroenterol Motil 2015; 27:160–174.

6 Renato S, Mario C, Giovanni Z, Morbin T, Rizzetto C, Zanatta L, *et al*. The preoperative manometric pattern predicts the outcome of surgical treatment for esophageal achalasia. J Gastrointest Surg 2010; 14:1635–1645.

7 Rebecchi F, Giaccone C, Farinella E, Campaci R, Morino M. Randomized controlled trial of laparoscopic Heller myotomy plus Dor fundoplication versus Nissen fundoplication for achalasia: long-term results. Ann Surg 2008; 248:1023–1030.

8 Rohof WO, Salvador R, Annese V, Varannes S, Chaussade S, Costantini M, *et al*. Outcome of treatment achalasia depends on manometric subtype. Gastroenterology 2013; 144:718–725.

9 Salvador R, Savarino E, Pesenti E, Spadotto L, Voltarel G, Capovilla G. Effects of laparoscopic myotomy on the esophageal motility pattern of esophageal achalasia as measured by high-resolution manometry. Surg Endosc 2017; 31:3510–3518.

10 Abdel Mohsen E, Imam HMK. Clinical and manometric characteristics of untreated achalasia: an Egyptian cohort. Egypt J Gastroentrol 2016; 12:10.

11 Kumbhari V, Tieu AH, Onimaru M, *et al*. Peroral endoscopic myotomy (POEM) vs laparoscopic Heller myotomy (LHM) for the treatment of Type III achalasia in 75 patients: a multicenter comparative study. Endosc Int Open 2015; 3:E195–E201.

12 Sanaka MR, Hayat U, Thota PN, *et al*. Efficacy of peroral endoscopic myotomy vs other achalasia treatments in improving esophageal function. World J Gastroenterol 2016; 22:4918.

13 Nijhuis RA, Prins LI, Mostafavi N, Etten-Jamaludin F, Smout A, Bredenoord A. Factors associated with achalasia treatment outcomes: systematic review and meta-analysis. Clin Gastroenterol Hepatol 2020; 18:1442–1453.

14 Eckardt VF, Gockel I, Bernhard G. Pneumatic dilation for achalasia: late results of a prospective follow up investigation. Gut 2004; 53: 629–633.

15 Boeckxstaens GE, Annese V, Varannes SB, Costantini M, Cuttitta A, Elizalde J, *et al*. Pneumatic dilation versus laparoscopic Heller's myotomy for idiopathic achalasia. N Engl J Med 2011; 364: 1807–1816.

16 Moonen A, Annese V, Belmans A, Bredenoord A, Varannes S, Mario Costantini M, *et al*. Long-term results of the European achalasia trial: a multicentre randomised controlled trial comparing pneumatic dilation versus laparoscopic Heller myotomy. Gut 2016; 65:732–739.

17 Kostic S, Kjellin A, Ruth M, Johnsson E, Andersson M, Lundell L. Pneumatic dilatation or laparoscopic cardiomyotomy in the management of newly diagnosed idiopathic achalasia. Results of a randomized controlled trial. World J Surg 2007; 31: 470–478.

18 Hamdy E, El Nakeeb A, El Hanfy E, El Hemaly M, Salah T, Hamed H, El Hak NG. Comparative study between laparoscopic Heller myotomy versus pneumatic dilatation for treatment of early achalasia: a prospective randomized study. J Laparosendosc Adv Surg Tech 2015; 25: 460–464.

19 Ponds F, Fochens P, Lei A, Neuhaus H, Beyna T, Kandler J, *et al*. Effect of peroral endoscopic myotomy versus pneumatic dilation on symptom severity and treatment of naïve patients with achalasia: a randomized controlled trial. JAMA 2019; 322:134–144.

20 Sayed MM, Kamal A, Taha AM, Taher Zain MG, Sayed A, *et al*. Safety and efficacy of laparoscopic cardiomyotomy for esophageal achalasia: a prospective cohort study. Med J Cairo Univ 2018; 41:8.

21 Oelschlager BK, Chang L, Pellegrini CA. Improved outcome after extended gastric myotomy for achalasia. Arch Surg 2003; 138:490–497.

22 Salvador R, Caruso V, Costantini M, Parise P, Nicoletti L, Cavallin F, *et al*. Shorter myotomy on the gastric site (≤2.5 cm) provides adequate relief of dysphagia in achalasia patients. Dis Esophagus 2015; 28:412–417.

23 Ahmed MF, Abd Elmegeed M, Samir R, Elhefny A, Elfeky K. Role of preoperative oesophageal manometry in operative decision making in patients with cardiac achalasia. Ain Shams Med J 2020; 71:551–561.