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Research Paper

Determining long-term outcome of transthoracic Heller's myotomy when other methods fail: A single centere cases series

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ABSTRACT

Objective: We aimed to estimate the long-term outcomes of transthoracic Heller's myotomy without fundoplication.

Methods: This single centere, retrospective study included patients followed up for signs of cure, recurrence of symptoms, and different aspects of quality of life estimated over several years. Data were obtained directly from the patients and the medical records. The scores of patients with early and late dysphagia were compared preoperatively and postoperatively to estimate the quality of life (QoL).

Results: A total of 48 patients (37 women and 11 men) who underwent surgery for achalasia between 2008 and 2018 were included. The mean age was 43.5 (19–68) years. The mean follow-up duration was 60.5 (1–120) months. Dysphagia, regurgitation, and heartburn were the most common symptoms, occurring in 100% of patients. The outcomes were an excellent success rate and estimation of QoL. After the first 6 months of follow-up, patients who underwent surgery developed grades 1–3 dysphagia. After 1–10 years of follow-up, 39 (81.25%) patients had grade 1 dysphagia, whereas 9 (18.75%) still had grade 2 dysphagia. During the long-term follow-up, only 77% of patients developed regurgitation, while 91.6% had heartburn. QoL changed according to dysphagia scores (from 5 to 1). However, the score of 26 patients (54.16%) decreased to 1; after 1 year of follow-up, 42 patients (87.5%) obtained a dysphagia score of 1. After 1–10 years of follow-up, 97.2% of patients underwent barium oesophagogram and showed a small-calibre oesophagus.

Conclusion: Transthoracic Heller's myotomy is a safe and durable procedure that is associated with a durable long-term success rate and less recurrence, without necessity for any type of anti-reflux surgery.

1. Introduction

Achalasia is a rare oesophageal motility disorder, characterized by impaired lower oesophageal sphincter (LES) relaxation, due to lack of peristaltic contraction resulting in an impaired bolus transport and stasis of food in the oesophagus [1]. Idiopathic achalasia is a primary motility disorder of the oesophagus that usually occurs in 10 among 100,000 individuals [2]. The aetiology remains unknown, but autoimmune, viral, and neurodegenerative factors have been proposed as potential causative or promoting factors [3–5]. The degenerative process, which is of unknown origin, involves the loss of ganglion cells in the myenteric (Auerbach's) plexus of the oesophagus and then local and systemic inflammation [6] and later loss of important neurotransmitters such as the vasoactive intestinal peptide and nitric oxide. The main presentation is chest pain; patients usually complain of dysphagia to both solid and liquid foods with regurgitation of food and saliva, which is followed by loss of weight and easy fatigability [7].

The complete work-up to confirm the clinical diagnosis of idiopathic achalasia includes the following: upper endoscopy, to exclude other differential diagnosis such as tumours and dilated oesophagus, which causes the retention of undigested food and saliva; barium oesophagram, which shows oesophageal dilatation, poor emptying, aperistalsis, and narrowed lower oesophagus

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("bird-beak sign"); and high-resolution manometry (HRM), which provides a more accurate diagnosis and helps to determine disease subtypes [3].

Recently, three manometric subtypes were identified based on the residual oesophageal wave pattern: type I, oesophageal body showing minimal contractility; type II, absence of peristalsis but with intermittent periods of compartmentalised oesophageal pressurisation; and type III, occurrence of spastic contractions in the distal oesophagus [8].

If achalasia is left untreated, it increases the risk of peptic oesophagitis, mega-oesophagus, oesophageal diverticulitis, and oesophageal cancer [9].

Achalasia can be treated by both biochemical and mechanical methods [10]. As the aetiology is unknown, the current treatment options are only aimed at relieving the functional spasm at the LES [11]. However, several therapeutic options have been proposed and tested. However, none of them were considered as the ideal management strategy. These options include medical treatment, Botulinum toxin injection, endoscopic pneumatic dilation (PD), peroral endoscopic myotomy (POEM), laparoscopic Heller's myotomy (LHM), and Heller's myotomy through thoracotomy or thoracoscopy [12].

This study aimed to highlight the outcome of patients who underwent Heller's myotomy through open thoracotomy for management of recurrent achalasia, especially when the other modalities failed.

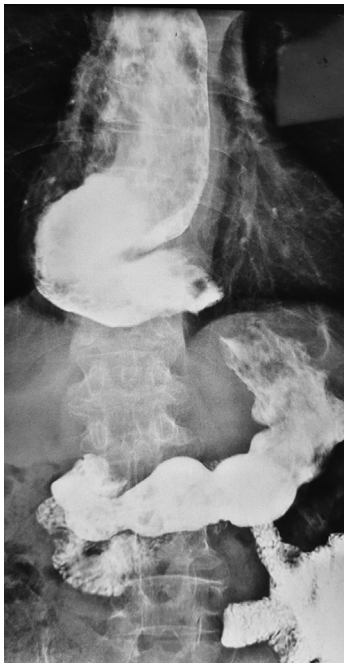

Fig. 1. Typical radiological appearance of achalasia of the cardia in a patient who had laparoscopic myotomy a year ago.

2. Patients and methods

A mono-centric, retrospective study was carried out for 10 years starting from January 1st, 2008 to December 31st, 2017. The data were obtained directly from the patients, patient's relatives, and medical records. This study was registered in the ResearchRegistry.com (registration number: researchregistry4725). All patients presenting with recurrent symptoms of achalasia after treatment who underwent other therapeutic modalities were included in this study. The following patients were excluded from the study:

1. Those with achalasia managed conservatively.
2. Those with achalasia managed successfully by laparoscopy.
3. Those with achalasia who refused to undergo thoracotomy.

This study was approved by the Institutional Review Board of Kurdistan Board for Medical Specializations (both scientific content and ethic committee). The work has been reported in accordance with the 2018 PROCESS criteria checklist [13]. All patients underwent surgery in the same public teaching hospital, and the procedure was performed by the same surgeon (with 15 years of experience as thoracic surgeon) and his team. The diagnostic workup included thorough history and physical examination; a previous Barium contrast study showed characteristic features of achalasia in most of the patients (Fig. 1) (Table 1). Chest computed tomography scan requested in case of suspicion of other pathologies. HRM and 24-hour oesophageal pH test were performed on all patients, and the results are presented in Table 2.

All the procedures were performed under general anaesthesia, with selective right lung ventilation. A single dose of third-generation cephalosporin as prophylactic antibiotic was administered 30 minutes before induction of anaesthesia. Left muscle sparing lateral thoracotomy was performed in the 7th or 8th intercostal space (Fig. 2). Minimal oesophageal mobilisation was performed, and the oesophagus was encircled with a Foley's catheter. Modified Heller's myotomy was performed in the gastric cardia and within 2 cm from the stomach to the inferior pulmonary vein (range; 8–20 cm) (Fig. 2). Thoracoscopy was not performed in this patient group. Air insufflation was performed to assess for micro-perforation, and no perforation occurred in any of the patients. None of the patients underwent anti-reflux surgery. The thoracic incisions were closed in a standard manner, the chest tube was removed in postoperative day 2 or 3, and oral intake was resumed in postoperative day 2. The mean duration of the procedure was 63.2 (range: 45–120) minutes. The mean duration of hospitalisation was 3.58 (range: 2–14) days. All the patients were kept under proton pump inhibitor therapy for 12 weeks postoperatively.

3. Statistical analysis

The data were collected and entered into an excel sheet; after coding, they were transferred to Statistical Package for the Social Sciences (SPSS), version 22, IBM Corporation. Descriptive and quantitative analyses were performed. The relationship between initial findings and subsequent morbidity and mortality were determined using chi-square test for nominal variables and t-test for quantitative variables.

4. Results

A total of 48 patients underwent Heller's myotomy through a left posterolateral thoracotomy between January 1st, 2008 and December 31st, 2017. Of the total patients, 37 (77%) were women and 11 (22.91%) were men. The mean age was 43.5 (range: 19–68) years.

Dysphagia, regurgitation, and heartburn were the most common symptoms, which occurred in 100% of patients. The mean

Table 1
Preoperative radiological Rezende's classification.

Grades	No.	Percent %
I	1	2.08
II	7	14.58
III	40	83.33
IV	0	0

Table 2
Pre- and post-operative symptoms.

Symptoms	Dysphagia grades				Regurgitation grades				Heartburn grades			
Grades	I	II	III	IV	I	II	III	IV	I	II	III	IV
Pre-operative	0 (0%)	2 4.16%	12 25%	34 70.8%	23 47.91%	23 47.91%	2 4.16%	0 (0%)	40 83.3%	4 8.3%	4 8.3%	0 (0%)
Post-operative first 6 months	11 22.91%	21 43.75%	14 29.16%	2 4.16%	28 58.3%	15 31.25%	5 10.4%	0 (0%)	44 91.6%	3 6.25%	1 2.08%	0 (0%)
Post-operative 1–10 years	39 81.25%	9 18.75%	0 (0%)	0 (0%)	37 77.08%	11 22.91%	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

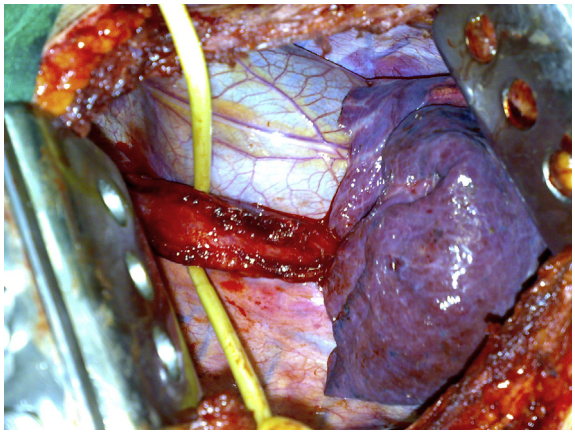

Fig. 2. Left thoracotomy, oesophagus encircled by a Foley catheter for traction, and long myotomy of the oesophagus and cardia.

duration of symptom occurrence was 5.5 (range: 1–10) years. Weight loss was reported in 83% of patients with a mean weight loss of 14.5 (range: 2–27) kg. Preoperative chest x-ray showed mediastinal widening in 44 patients (91.6%) and was normal in 4 patients (8.3%). According to Rezende's classification, only 1 patient (2.08%) had grade I, 7 (14.58%) had grade II, 40 (83.33%) had grade III, and none of the patients had grade IV (Table 1).

About 34 (70.8%) patients had grade 4 dysphagia, 12 (25%) had grade 3 dysphagia, and 2 (4.16%) had grade 2 dysphagia. Approximately 2 (4.16%) patients had grade 3 regurgitation, 23 (47.91%) had grade 2 regurgitation, and 23 (47.91%) had grade 1 regurgitation. A total of 4 (8.3%) patients had grade 3 heartburn, 4 (8.3%) had grade 2 heartburn, and 40 (83.3%) had grade 1 heartburn. Within 1–10 years of follow-up, barium oesophagogram was performed. Results showed that the calibre of the oesophagus had decreased from grade 2 to grade 1 in 35 (97.2%) patients, while one patient remained at grade 2. All patients were discharged from the hospital; the mean follow-up time was 60.5 months (range: 1 month to 10 years). Within the first 6 months of follow-up, all patients developed grades 1–3 dysphagia; at 1–10 years of follow-up, 39 (81.25%) patients had grade 1 dysphagia, while 9 (18.75%) still had grade 2 dysphagia. Occurrence of regurgitation was assessed in the first 6 months of follow-up and the results were as follows: 5 (10.4%) patients had grade 3, 15 (31.25%) had grade 2, and 28 (58.3%) had grade 1. Within 1–10 years of follow-up, 11 (22.9%) patients had grade 2 regurgitation and 37 (77%) had grade 1 regurgitation. Heartburn was assessed in the first 6 months of follow-up and the results were as follows: 1 (2.08%) patient had grade 3, 3 (6.25%) had grade 2, and 44 (91.6%) had grade 1.

In the first 6 months of follow-up, patients were satisfied from results of their surgeries and even the satisfaction increased after several years (Table 2).

About 25 (52%) patients underwent preoperative PD, 5 (10.41%) underwent laparoscopic myotomy, 3 (8.3%) underwent Botulinum injection, 13 (27%) underwent abdominal myotomy, and 1 (2.08%) underwent transthoracic Heller's myotomy (Table 3).

Oesophagocardiomyotomy was performed 8 cm into the oesophagus and 2 cm into the stomach (range: 8–20 cm).

The success of oesophagomyotomy was evaluated according to the degree of relief of symptoms postoperatively.

The mean preoperative LES pressure (LESP) was 32.5 mmHg (range: 25 mmHg and 40 mmHg), while the mean postoperative LESP was <15 mmHg. QoL improved as the dysphagia score decreased (from 5 to 1) within 1–10 years of follow-up (Table 4). Recurrence and re-operation were not performed during the 10-year follow-up.

Table 3
Previous operations performed for Achalasia.

Previous operations	No. of patients	Percentage
Pneumatic dilation	25	52%
Abdominal myotomy	13	27%
Laparoscopic myotomy	5	10.41%
Botulinum injection	4	8.3%
Transthoracic Heller myotomy	1	2.08%
Total	48	100%

5. Discussion

Motility in oesophageal achalasia could not be cured with current medical or surgical therapies. The principle of treatment is symptomatic relief by decreasing the LESP [14]. Treatment strategies for primary achalasia are Botulinum toxin injection, PD, POEM, and surgical cardiomyotomy (trans-abdominal or transthoracic; open or laparoscopic) [3]. According to different treatment outcomes, the technique of choice should be based on patient's desire and the surgeon's ability and familiarity with techniques. The treatment is selected based on the patient's oesophageal sphincter pressure; few trials have compared the effectiveness of several treatments in patients with achalasia [15].

In this study, several patients failed to respond to other treatment modalities. Most of the current literature deals with non-complicated achalasia, but the treatment of recurrent dysphagia due to achalasia is not well discussed in the literature. A relatively easy and effective method for treating recurrent achalasia was re-described in this study.

All achalasia patients in this study had been previously treated with different modalities but high-grade dysphagia recurred after 2 years. About 25 (52%) patients had PD, 5 (10.41%) had laparoscopic myotomy, and 4 (8.3%) had Botulinum injection. About 13 (27%) patients underwent open abdominal myotomy, while only 1 (2.08%) underwent transthoracic Heller's myotomy. Most of these patients were young and had low risk for thoracotomy. All patients who had PD underwent thoracotomy as both the surgeon and patients refused laparoscopic myotomy. The risks of laparoscopic myotomy were explained to all patients in this category.

Table 4
Pre- and post-operative estimation of quality of life (QoL).

QoL	Score 5	Score 4	Score 3	Score 2	Score 1
Preoperative	38 (79.16%)	10 (20.83%)	0 (0%)	0 (0%)	0 (0%)
Postoperative at first 6 months	0 (0%)	0 (0%)	8 (16.6%)	14 (29.16%)	26 (54.16%)
Postoperative 1–10 years	0 (0%)	0 (0%)	0 (0%)	6 (12.5%)	42 (87.5%)

One of the indicators of successful treatment of achalasia is the decrease in LESP [16]. The LESPs of our patients who underwent surgery were >35 mmHg preoperatively and decreased to <15 mmHg postoperatively.

A decrease in dysphagia score is an important indicator of success in any treatment provided to patients with achalasia. The dysphagia score used by Mineo et al. [17] was used in this study.

In our study, the dysphagia score decreased in 83.3% of patients immediately after surgery. Two years after surgery, 87.5% of patients garnered a lower dysphagia score. The follow-up period was 10 years.

The surgical treatment for recurrent and/or persistent symptoms of achalasia after laparoscopic myotomy is not well detailed in the current literature.

However, we attempted to address this sensitive question. The failure rate of the trans-abdominal approach for the treatment of achalasia is currently 17%.

Nowadays, most of the trans-abdominal approaches used to treat patients with achalasia are accomplished laparoscopically. However, the risk of micro-perforations is high despite the decrease in the incidence of tissue trauma and lower risk of gastroesophageal reflux [15].

Rawlings et al. conducted a multi-centric prospective randomised trial in patients who underwent LHM with fundoplication. They concluded that the postoperative gastroesophageal reflux disease (GERD) incidence was between 21% and 41.9%; however, our study reported a decreased incidence of postoperative GERD [18]. Bhayani et al. found that the incidence of GERD was 32% in patients who underwent LHM with fundoplication and 39% in those who underwent POEM [19].

Bagheri and colleagues performed a comparative study to compare the effectiveness between the trans-abdominal and transthoracic approaches; they concluded that trans-abdominal approach has a higher rate of morbidity [15]. Thus, they recommended the transthoracic approach.

Lindenmann et al. concluded that if the incision into the stomach is of 2 cm or more, all patients might experience reflux postoperatively. After fundoplication, the incidence of GERD increased from 70% to 95%, and this procedure might even affect the oesophageal motility. Dysphagia persisted postoperatively in 50% of patients. Previous studies reported that the transthoracic approach is easier and more vigilant [20].

Gaissert and colleagues performed 64 myotomy procedures as treatment for achalasia using the transthoracic approach, which had a 91% success rate and very low mortality and morbidity. Meanwhile, anti-reflux surgery was seldom required [21].

The length of myotomy remained controversial; several studies reported that a longer myotomy is associated with better postoperative results and very low rate of postoperative dysphagia [20].

An extended cardiomyotomy (approximately 8–20 cm) was performed, at least 8 cm in the cephalad direction and 2 cm caudally onto the stomach, and very minimal postoperative symptoms of GERD were observed.

Lindenmann et al. concluded that transthoracic oesophagocardiomyotomy without additional fundoplication is associated with excellent long-term relief from dysphagia, better QoL, and lesser risk of postoperative GERD [20].

If symptoms of achalasia persist after transthoracic oesophagocardiomyotomy, resection of the oesophagus and appropriate reconstruction by gastric pull-up could be performed [22].

Whether anti-reflux surgery should be performed to prevent GERD remains controversial [14]. Although the incidence of GERD decreased in patients who underwent fundoplication, it still occurs in some patients after surgery (39%) [23]. Gaissert et al. [21] found that fundoplication did not decrease the incidence rate of late reflux symptoms, which was about 58%, and moderate to severe dysphagia may still recur later in life (incidence at approximately 36%). In their multivariable analysis, fundoplication procedure was not a significant predictor of postoperative outcome.

Vela et al. stated that fundoplication procedure did not prevent the impairing effect of GERD, as severe esophagitis and strictures were reported in many cases [24].

Botulinum toxin injection is a very good treatment for recurrent dysphagia. However, no previous study has showed the long-term efficacy of this treatment in patients with recurrent dysphagia due to achalasia [25]. After 1 year of follow-up, a single Botulinum toxin injection prevents the remission of symptoms in only 15% of patients. The second dose of Botulinum toxin injection increases the remission rate in only 60% of patients after 12 months [26].

PD causes interruption of oesophageal muscle that leads to unreliable healing. Such balloon dilatation causes substantial fibrosis in the lower oesophagus, which causes enormous difficulty in performing surgery in cases where PD failure occurs [27,28]. Eckardt et al. discovered in a long observation that clinical remission only occurred in 40% of patients and improved after one session of PD [29]. POEM is increasingly recognised and performed as a first-line therapeutic option for patients with achalasia; recurrence of achalasia after POEM is commonly discussed in the literature. The study by Van Hoeij et al. was a multicentre large case series evaluating the effectiveness of the treatment approach used in post-POEM patients with recurrent symptoms. In this study, the relapse rate of symptomatic achalasia in 9.8% of patients post-POEM was defined by an Eckhardt score of >3 and their high-resolution manometry or barium oesophagogram findings were consistent with the results of patients with persistent achalasia [30]. We concluded that the failure rate for primary POEM is 10%; based on the above fact, POEM was not recommended in any of our patients, and such facility was not available during the performance of the study.

The limitations of the study were as follows: small sample size, lack of comparison group, and single-centre experience.

6. Conclusion

Transthoracic Heller's myotomy is a safe procedure for recurrent achalasia. It is associated with less recurrence and durable long-term success rate, without the necessity to perform any type of anti-reflux procedures. An extended transthoracic myotomy could be performed, which gives a better result and lesser degree of postoperative dysphagia. The potential predictors of a successful transthoracic Heller's myotomy include high preoperative LESP, short duration of symptoms, and absence of sigmoid oesophagus. Larger prospective studies are required to confirm our findings.

Ethical approval

Obtained from Kurdistan board for medical specialization, reference no. 187/23/4/2018.

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Author contribution

Aram Baram: Surgeon in charge, study design, follow-up, data collection, manuscript revision, statistical analysis.

Rawand A. Essa: assisted in surgeries, follow-up, study design, data collection, drafting.

Conflict of interest statement

None to declare.

Guarantor

Aram Baram.

Research registration number

At http://www.researchregistry.com the UIN is UIN: researchregistry4725.

Consent

Verbal and written consent obtained from all participants.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijso.2019.05.003.

References

[1] Roman S, Zerbib F, Quenehervé L, Clermidy H, Varannes SB, Mion F. The Chicago classification for achalasia in a French multicentric cohort. Dig Liver Dis 2012 Dec;44(12):976–80. https://doi.org/10.1016/j.dld.2012.07.019.

[2] Sadowski DC, Ackah F, Jiang B, Svenson LW. Achalasia: incidence, prevalence and survival. A population-based study. Neuro Gastroenterol Motil 2010 Sep;22(9):e256–61. https://doi.org/10.1111/j.1365-2982.2010.01511.x.

[3] Furuzawa-Carballeda J, Torres-Landa S, Valdovinos MÁ, Coss-Adame E, Martín Del Campo LA, Torres-Villalobos G. New insights into the pathophysiology of achalasia and implications for future treatment. World J Gastroenterol 2016 September 21;22(35):7892–907.

[4] Pandolfino JE, Kwiatek MA, Nealis T, Bulsiewicz W, Post J, Kahrilas PJ. Achalasia: a new clinically relevant classification by high-resolution manometry. Gastroenterology 2008 Nov;135(5):1526–33. https://doi.org/10.1053/j.gastro.2008.07.022.

[5] Gockel I, Bohl JR, Doostkam S, Eckardt VF, Junginger T. Spectrum of histopathologic findings in patients with achalasia reflects different etiologies. J Gastroenterol Hepatol 2006 Apr;21(4):727–33.

[6] Furuzawa-Carballeda J, Aguilar-León D, Gamboa-Domínguez A, Valdovinos MA, Nuñez-Álvarez C, Martín-del-Campo LA, et al. Achalasia- an autoimmune inflammatory disease: a cross-sectional study. J Immunol Res 2015;2015:729217. https://doi.org/10.1155/2015/729217 [Epub 2015 May 2].

[7] Boeckxstaens GE. Novel mechanism for impaired nitrergic relaxation in achalasia. Gut 2006 Mar;55(3):304–5.

[8] Rohof WO, Salvador R, Annese V, Bruley des Varannes S, et al. Outcomes of treatment for achalasia depend on manometric subtype. Gastroenterology 2013;144:718–25.

[9] Ott DJ, Hodge RG, Chen MY, Wu WC, Gelfand DW. Achalasia associated with esophageal diverticula. Prevalence and potential implications. J Clin Gastroenterol 1994;18(4):343–6.

[10] Lo Wai-Kit, Mashimo Hiroshi. In: Fisichella Piero Marco, Herbella Fernando AM, Patti Marco G, editors. Pathophysiology of achalasia. Chapter: 2. Springer International Publishing; Januray 2016. p. 9–14. https://doi.org/10.1007/978-3-319-13569-4_2.

[11] Richter JE, Boeckxstaens GE. Management of achalasia: surgery or pneumatic dilation. Gut 2011 Jun;60(6):869–76. https://doi.org/10.1136/gut.2010.212423.

[12] Teitelbaum EN1, Rajeswaran S, Zhang R, Sieberg RT, Miller FH, Soper NJ, et al. Peroral esophageal myotomy (POEM) and laparoscopic Heller myotomy produce a similar short-term anatomic and functional effect. Surgery 2013 Oct;154(4):885–91. https://doi.org/10.1016/j.surg.2013.04.051. discussion 891-2.

[13] Agha RA, Borrelli MR, Farwana R, Koshy K, Fowler AJ, Orgill DP, PROCESS Group. The PROCESS 2018 statement: updating consensus preferred reporting of CasE series in surgery (PROCESS) guidelines. Int J Surg 2018 Dec;60:279–82. https://doi.org/10.1016/j.ijsu.2018.10.031. Epub 2018 Oct 22.

[14] Mineo TC, Ambrogi V. Long-term results and quality of life after surgery for oesophageal achalasia: one surgeon's experience. Eur J Cardiothorac Surg 2004 Jun;25(6):1089–96.

[15] Bagheri R, Haghi SZ, Noorshafiee S. Surgical treatment of achalasia: transabdominal versus transthoracic cardiomyotomy. Ann Thorac Cardiovasc Surg 2011;17:254–9.

[16] Eduardo Rodrigues Zarco Camara. Late evaluation of dysphagia after Heller esophageal myotomy with Dor fundoplication for achalasia. Arq Bras Cir Dig 2017 Jul-Sep;30(3):182–6. https://doi.org/10.1590/0102-6720201700030005.

[17] Mineo TC, Pompeo E. Long-term outcome of Heller myotomy in achalasic sigmoid esophagus. J Thorac Cardiovasc Surg 2004;128:402–7.

[18] Rawlings A, Soper NJ, Oelschlager B, Swanstrom L, Matthews BD, Pellegrini C, et al. Laparoscopic Dor versus Toupet fundoplication following Heller myotomy for achalasia: results of a multicenter, prospective, randomized controlled trial. Surg Endosc 2012 Jan;26(1):18–26. https://doi.org/10.1007/s00464-011-1822-y.

[19] Bhayani NH, Kurian AA, Dunst CM, Sharata AM, Rieder E, Swanstrom LL. A comparative study on comprehensive, objective outcomes of laparoscopic Heller myotomy with peroral endoscopic myotomy (POEM) for achalasia. Ann Surg 2014 Jun;259(6):1098–103. https://doi.org/10.1097/SLA.0000000000000268.

[20] Lindenmann J, Maier A, Eherer A, Matzi V, Tomaselli F, Smolle J, et al. The incidence of gastroesophageal reflux after transthoracic esophagocardiomyotomy without fundoplication: a long term follow-up. Eur J Cardiothorac Surg 2005 Mar;27(3):357–60.

[21] Gaissert HA, Lin N, Wain JC, Fankhauser G, Wright CD, Mathisen DJ. Transthoracic Heller myotomy for esophageal achalasia: analysis of long-term results. Ann Thorac Surg 2006;81:2044–9.

[22] Vaos G, Demetriou L, Velaoras C, Skondras C. Evaluating long-term results of modified Heller limited esophagomyotomy in children with esophageal achalasia. J Pediatr Surg 2008 Jul;43(7):1262–9. https://doi.org/10.1016/j.jpedsurg.2008.02.074.

[23] Kneist W, Sultanov F, Eckardt VF, Junginger T. Esophageal resection in treatment of achalasia. Four case reports and review of the literature. Chirurg 2002;73(3):223–9.

[24] Vela MF, Richter JE, Khandwala F, Blackstone EH, Wachsberger D, Baker ME, et al. The long-term efficacy of pneumatic dilatation and Heller myotomy for the treatment of achalasia. Clin Gastroenterol Hepatol 2006 May;4(5):580–7.

[25] Patel DA, Kim HP1, Zifodya JS1, Vaezi MF. Idiopathic (primary) achalasia: a review. Orphanet J Rare Dis 2015 Jul 22;10:89. https://doi.org/10.1186/s13023-015-0302-1.

[26] Mikaeli J, Fazel A, Montazeri G, Yaghoobi M, Malekzadeh R. Randomized controlled trial comparing botulinum toxin injection to pneumatic dilatation for the treatment of achalasia. Aliment Pharmacol Ther 2001 Sep;15(9):1389–96.

[27] Pellegrini CA, Leichter R, Patti M, Somberg K, Ostroff JW, Way L. Thoracoscopic esophageal myotomy in the treatment of achalasia. Ann Thorac Surg 1993 Sep;56(3):680–2.

[28] Moonen A, Annese V, Belmans A, Bredenoord AJ, Bruley des Varannes S, 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 May;65(5):732–9. https://doi.org/10.1136/gutjnl-2015-310602.

[29] Eckardt VF, Gockel I, Bernhard G. Pneumatic dilation for achalasia: late results of a prospective follow up investigation. Gut 2004 May;53(5):629–33.

[30] Van Hoeij FB, Ponds FA, Werner Y, Sternbach JM, Fockens P, Bastiaansen BA, et al. Management of recurrent symptoms after per-oral endoscopic myotomy in achalasia. Gastrointest Endosc 2018 Jan;87(1):95–101. https://doi.org/10.1016/j.gie.2017.04.036. Epub 2017 May 3.