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ORIGINAL ARTICLE

Laparoscopic Heller-Dor myotomy in elderly achalasia patients: a single center experience with PSM analysis

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ABSTRACT

Introduction: Achalasia is a rare esophageal motility disorder of unknown etiology. With the ageing of the general population, treatment in elderly patients has become increasingly common; however, the gold standard treatment in this population remains unclear. The aim of this study was to evaluate the outcomes of laparoscopic Heller-Dor myotomy (LHM) in geriatric patients.

Material and methods: In this study, consecutive achalasia patients undergoing LHM at the University Hospital 'Federico II' of Naples from November 2018 to November 2022 were prospectively enrolled. Patients were divided into two groups based on their age at intervention: elderly (≥70 years) and younger (<70 years). The two study groups were compared by minimizing the different distribution of covariates through a propensity score matching analysis (PSM).

Results: In both populations, there was a significant improvement in terms of manometric parameters and symptoms after surgery. After applying one-on-one PSM, we obtained a total population of 48 achalasia patients divided into two groups (24 patients each). No significant differences were found in terms of demographic characteristics as well as preoperative and intraoperative variables between two groups. At 12 months from surgery, integrated relaxation pressure (IRP) was significantly lower in patients ≥ 70 years ($p = 0.032$), while younger patients scored significantly less at the post-operative Eckardt score ($p = 0.047$).

Conclusions: Laparoscopic Heller-Dor myotomy is a safe and effective treatment even in elderly patients with rapid post-operative recovery, improvement of symptoms and manometric parameters.

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Achalasia; Heller-Dor laparoscopic; elderly surgery; propensity score matching analysis; geriatric surgery; geriatric patients; fundoplication; myotomy

Introduction

Achalasia is a rare esophageal motility disorder characterized by impaired relaxation of the lower esophageal sphincter (LES) [1,2]. The etiology of this disease remains unknown. Common symptoms include dysphagia, chest pain, regurgitation, weight loss; however, symptoms may mimic and be confounded with those of gastro-esophageal reflux disease in several cases. This, in turn, may result in a significant delay in diagnosis [3]. Furthermore, when left untreated, the disorder can increase the risk of squamous esophageal carcinoma [3–5].

The incidence of achalasia has a bimodal distribution with peaks at 30 and 70 years [6–8]. The number of patients with achalasia increases in parallel with the aging of the population. A study from Northern Italy showed that achalasia was more common in the elderly, with the highest incidence seen among patients >75 years [9]. The goal of treatment is to improve symptoms and increase quality of life, but for these patients the choice remains unclear [6,10]. It becomes important for these patients to find an effective and safe treatment.

The improvement of minimally invasive techniques over the past 20 years has made laparoscopic Heller myotomy with partial (Dor) fundoplication (LHMDF) highly effective for control of symptoms in Chicago type I and type II achalasia, particularly in younger patients [11–13]. There is still an open debate on the primary treatment of choice for elderly patients. The current guidelines do not provide clear indications [8,11,14–16].

The aim of this study was both to evaluate the efficacy and safety of LHMDF in elderly patients (>70 years) and to compare this population with younger patients in terms of perioperative outcomes

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and after 12 months of follow-up. To our knowledge, this is the first study comparing these populations using a propensity score-matched analysis.

Material and methods

Consecutive achalasia patients undergoing laparoscopic Heller myotomy with anterior partial (Dor) fundoplication (LHMDF) at the Surgery Unit of the 'University Hospital Federico II of Naples' from 1 November 2018 to 1 November 2022 were prospectively enrolled in this study. Patients with a history of abdominal surgery, body mass index (BMI) >40, American Society of Anesthesiology (ASA) score >4, mega-esophagus (maximum esophageal diameter ≥ 6 cm), Achalasia type III and previously treated for achalasia (e.g. endoscopic dilations, peroral endoscopic myotomy or botulinum toxin injections) were excluded from the study.

Patients were divided into two groups: elderly (≥70 years) and younger (<70 years).

Collected demographic and clinical data included age, sex, BMI, onset of symptoms, Achalasia subtype at high-resolution manometry according to Chicago Classification and ASA score. The following perioperative outcomes were analyzed: Eckardt score before surgery, preoperative mean basal LES pressure, and integrated relaxation pressure (IRP), conversion rate, length of stay (in day), intraoperative or postoperative complications (based on Clavien-Dindo classification) [17]. The outcomes analyzed 12 months after surgery were: Eckardt score, mean basal LES, BMI, and IRP. This prospective study was performed according to the Declaration of Helsinki principles and approval was obtained from the Institutional Review Board and Ethics Committee and each patient through specific informed consent.

We compared these outcomes both between the individual groups (elderly before surgery vs after 12 months and younger before surgery vs after 12 months) and between the two populations (elderly vs younger).

All patients underwent a preoperative esophagogastro-duodenoscopy (EGDs) to rule out organic disease that could account for symptoms (pseudoachalasia) and barium esophagography to evaluate esophageal diameter and morphology. The diagnosis was confirmed by esophageal high-resolution manometry (HRM). Esophageal manometry is the gold standard for diagnosing achalasia, HRM being superior to conventional [8,18]. HRM was performed using a catheter with 36 pressure sensors traversing the esophagus and the LES [13,19,20]. We used the standardized Chicago classification version 4.0 to analyze HRM data and to distinguish between the three different achalasia subtypes: type I characterized by absent peristalsis, type II with pan-esophageal pressurizations and type III with spastic/premature contractions [8,21]. All patients underwent a post-operative HRM 12 months after surgery.

The standardized Eckardt score was used to assess the severity of symptoms (weight loss, dysphagia, retrosternal pain, and regurgitation) before and after 12 months after surgery [18]. Treatment failure was defined by a post-operative Eckardt score > 3 [18].

Surgical technique

We performed a laparoscopic Heller myotomy with Dor fundoplication [22]. After phrenoesophageal ligament dissection, we performed a myotomy on the anterior wall. The length of the myotomy was 6 to 8 cm long, with a 2-3 cm dissection extending also below the esophagogastric junction. The longitudinal and circular muscle fibers were carefully cut and separated from the mucosal plane. We performed an anterior fundoplication according to Dor, by suturing the fundus of the stomach with the edges of the myotomy and with the proximal diaphragmatic pillar. We used intraoperative endoscopy to evaluate mucosal integrity and exclude the presence of residual muscle fibers after myotomy. We generally did not place an intra-operative nasogastric tube. On the first postoperative day, all patients underwent an X-ray with water-soluble contrast (Gastrografin®) to exclude post-operative leaks. A semisolid diet was started on the second postoperative day, in the absence of complications.

Statistical analysis

Categorical data were reported as frequencies and percentages and comparisons between groups were performed using the $\chi 2$ test with Yates' correction or the Fisher's exact test when appropriate. Continuous variables were reported as mean ± SD (ranges) and were compared using the two-sided Student's t test.

The two study groups were compared by minimizing the different distribution of covariates through a propensity score matching analysis (PSM) with a caliper width of 0.20, obtaining a one-to-one match, and excluding patients in whom the PSM analysis was not applicable. The model was based on logistic regression, by using the single nearest neighbor matching

method without replacement (no repetition of a patient in either group), until all possible matches had been formed. The two groups were matched for age, sex, BMI, ASA score, and type of Achalasia. Statistical significance was set at $p < 0.05$.

Statistical analysis was performed using the IBM SPSS Statistics for Windows, version 20.0. Armonk, NY, IBM Corp. IBM SPSS Statistics version 26 (SPSS Inc. Chicago, IL, USA).

Table 1. Variables of the total cohort of patients at the time of diagnosis and before surgery.

Number of patients	87
Sex (M/F)	38/49
Age onset, years	42 (15–82)
Age surgery, years	53 (17–83)
BMI onset, Kg/m^2	27.67 ± 5.28
BMI preoperative, Kg/m^2	24.88 ± 5.36
Weight onset, Kg	78.66 ± 12.79
Weight preoperative, Kg	70.65 ± 13.88
Weight loss, Kg	5 (0–29)
ASA score	
I	7 (8%)
II	43 (49.5%)
III	37 (42.5%)
Achalasia type	
1	9 (10.4%)
2	78 (89.7%)
Preoperative basal tone, mmHg	45.9 (15.3 – 121.2)
Preoperative IRP, mmHg	28.5 (15.0 – 70.5)
Eckardt score	6.6 ± 3.0

Table 2. Intraoperative and postoperative variables of the total cohort of patients.

Number of patients	87
Intraoperative variables	
Operative time, min mean (range)	70 (60–150)
Blood loss, mL mean (range)	20 (0–200)
Intraoperative complications, number (%)	3 (3.5%)
Postoperative complications, number (%)	6 (6.9%)
LOS, days mean (range)	3 (2–7)
Postoperative variables at 12 months	
Basal tone, mmHg mean (range)	21.2 (7.0 – 40.0)
IRP, mmHg mean (range)	28.3 (15.0 – 70.5)
Eckardt score (mean)	1.7 ± 1.7

Results

During the study period, we performed a total of 87 LHMDF. All procedures were performed by the same experienced surgeon (G.A.). Sorting our population by age, fifty-four patients were younger than 70 years, while thirty-three patients were 70 or older. Patients' variables at the time of diagnosis, before surgery, intraoperative and postoperative are summarized in Tables 1 and 2. There were no statistically significant differences between the two patient groups in terms of preoperative and intraoperative variables (Tables 3 and 4). Intraoperative complications included three esophageal mucosal perforations successfully repaired during surgery.

In according to the Clavien-Dindo classification for postoperative complications, Grade I complications (nausea, $n = 2$; vomiting, $n = 2$; fever, $n = 1$) were observed in five patients. The only grade II postoperative complication was an esophageal perforation diagnosed on the first postoperative day and treated conservatively with total parenteral nutrition for six days (Table 4). There were no conversions to open surgery.

In terms of postoperative variables at 12 months, IRP was significantly lower in patients $\geq$ 70 years (12.6 ± 2.7 versus 10.5 ± 3.3, $p = 0.010$), while the Eckardt score was significantly lower in patients <70 years, respectively (1.3 ± 1.7 versus 2.9 ± 1.3, $p = 0.001$) (Table 4).

After applying a one-on-one PSM analysis, we obtained a total of 48 patients divided into two groups of 24 patients each. No significant differences between the two groups were found in terms of demographic characteristics, preoperative and intraoperative variables (Tables 3 and 4). Analogously to the unmatched analysis results, we observed a statistically significant difference in the postoperative IRP values at 12 months which was significantly lower in

Table 3. Preoperative variables stratified by age before and after the propensity-score matching (PSM).

	Preoperative patient characteristics before PSM ($n = 87$)			Preoperative patient characteristics after PSM ($n = 48$)		
	< 70 years	≥ 70 years	p	< 70 years	≥ 70 years	p
Number of patients	54	33	–	24	24	–
Sex (M/F)	26/28	15/18	0.807	10/14	11/13	>0.999
BMI, Kg/m^2	24.57 ± 5.32	25.34 ± 6.19	0.624	25.64 ± 6.15	24.33 ± 5.12	0.635
ASA score			0.880			>0.999
I	5 (9.3%)	2 (6%)		1 (4.2%)	1 (4.2%)	
II	27 (50.0%)	16 (48.5%)		10 (41.7%)	11 (45.8%)	
III	22 (40.7%)	15 (45.5%)		13 (54.1%)	12 (50.0%)	
Achalasia type			>0.999			>0.999
1	5 (9.25%)	4 (12.1%)		4 (16.6%)	2 (8.3%)	
2	49 (90.75%)	29 (87.9%)		20 (83.3%)	22 (91.7%)	
Preoperative basal tone, mmHg	48.8 ± 18.8	52.9 ± 23.7	0.470	44.8 ± 12.5	52.2 ± 24.1	0.520
Preoperative IRP, mmHg	33.3 ± 13.6	29.4 ± 9.0	0.350	29.8 ± 12.1	30.9 ± 9.7	0.734
Eckardt score	7.1 ± 2.9	6.1 ± 3.1	0.226	6.1 ± 3.3	6.4 ± 3.1	0.769

Table 4. Intraoperative and postoperative variables stratified by age after the propensity-score matching (PSM).

	Intraoperative and postoperative patient characteristics before PSM ($n = 87$)			Intraoperative and postoperative patient characteristics after PSM ($n = 48$)		
	< 70 years ($n = 54$)	≥ 70 years ($n = 33$)	p	< 70 years ($n = 24$)	≥ 70 years ($n = 24$)	p
Intraoperative variables						
Operative time	72.5 (60–150)	70 (60–120)	0.848	85 (60–100)	75 (60–120)	0.571
Blood loss	20 (0–200)	10 (0–80)	0.499	20 (0–90)	20 (0–80)	0.839
intraop. Complications	2 (4.7%)	1 (3%)	>0.999	0	0	>0.999
postop. Complications	4 (7.4%)	2 (6%)	>0.999	1 (4.2%)	1 (4.2%)	>0.999
length of stay	3 (2–7)	4 (2–7)	0.522	3 (2–7)	3 (2–7)	0.734
Postoperative variables at 12 months						
Basal tone, mmHg	22.3 ± 7.5	20.7 ± 9.2	0.599	21.2 ± 6.9	19.9 ± 8.2	0.640[a]
IRP, mmHg	12.6 ± 2.7	10.5 ± 3.3	0.010	13.0 ± 2.5	10.3 ± 3.6	0.032[b]
Eckardt Score	1.3 ± 1.7	2.9 ± 1.3	0.001	1.2 ± 1.7	2.4 ± 1.6	0.047[c]

[a]IC 95% = [-4.544–7.258].
[b]IC 95% = [0.25–5.15].
[c]IN 95% = [-2.553–0.019].

Table 5. Comparison between pre- and postoperative Eckardt Score variables before the application of propensity-score matching (PSM).

	Preoperative patient characteristics before PSM ($n = 87$)			Postoperative patient characteristics before PSM ($n = 87$)		
	< 70 years ($n = 54$)	≥ 70 years ($n = 33$)	p	< 70 years ($n = 54$)	≥ 70 years ($n = 33$)	p
Dysphagia			0.338			>0.001
0 Points	0	0		35 (64.8%)	5 (15.2%)	
1 Points	6 (11.1%)	2 (6%)		17 (31.5%)	6 (18.2%)	
2 Points	13 (24%)	15 (45.5%)		2 (3.7%)	19 (57.6%)	
3 Points	35 (64.9%)	16 (48.5%)		0	3 (9%)	
Regurgitation			>0.999			0.389
0 Points	18 (33.3%)	12 (36.4%)		39 (72.2%)	20 (60.1%)	
1 Points	9 (16.7%)	5 (15.2%)		10 (18.5%)	9 (27.3%)	
2 Points	15 (27%)	7 (21.2%)		5 (9.3%)	4 (12.1%)	
3 Points	12 (22.2%)	9 (27.3%)		0	0	
Chest pain			0.766			0.986
0 Points	17 (31.5%)	11 (33.3%)		33 (61.1%)	19 (57.6%)	
1 Points	10 (18.5%)	8 (24.5%)		9 (16.7%)	9 (27.3%)	
2 Points	15 (27.8%)	7 (21.2%)		8 (14.8%)	4 (12.1%)	
3 Points	12 (22.2%)	7 (21.2%)		4 (7.4%)	1 (3%)	
Weight loss			0.532			0.897
0 Points	12 (22.2%)	15 (45.5%)		53 (98.1%)	32 (97%)	
1 Points	6 (11.1%)	5 (15.2%)		1 (1.9%)	1 (3%)	
2 Points	15 (27.8%)	6 (18.1%)		0	0	
3 Points	21 (38.9%)	7 (21.2%)		0	0	

patients $\geq$ 70 years (13.0 ± 2.5 versus 10.3 ± 3.6, $p = 0.032$), while the Eckardt score was significantly lower in patients $<$ 70 (1.2 ± 1.7 versus 2.4 ± 1.6, $p = 0.047$) (Table 4). When analyzing the post-operative Eckardt score results, dysphagia improved the most in younger patients (Tables 5 and 6).

Finally, the comparison of the pre- and postoperative variables before and after propensity score matching analysis, within the individual populations, showed a significant improvement of manometric parameters and symptoms after surgery (Tables 7 and 8).

Discussion

Achalasia is a rare esophageal disorder characterized by an impaired relaxation of the LES [1]. The etiology remains unclear, with infectious, autoimmune, and genetic factors contributing to its development [23–26]. Common symptoms are dysphagia, chest pain, regurgitation, weight loss [3]. In addition, this disease can increase a risk of esophageal carcinoma [3–5]. The latency from the onset of symptoms and diagnosis can last several years due to the non-specificity of the symptoms [6].

Epidemiologically, this disorder shows two peaks of incidence, the first around 30 years of age and the second above 70 years [6–8,27]. In Italy, 23.8% of achalasia patients are over 65 years old and nearly 45% of these patients are treated with surgery [28,29]. A 2011 study from northern Italy showed that the incidence of achalasia was more common in patients >75 years [9]. With the ageing of the population, there is an increasing number of elderly achalasia patients (>70 years) seeking surgical treatment.

As reported from the international guidelines, LHMDF is very effective in reducing symptoms and improving manometric parameters [8,11]. LHMDF

Table 6. Comparison between pre- and postoperative Eckardt score variables after the application of propensity-score matching (PSM).

	Preoperative patient characteristics after PSM ($n = 48$)			Postoperative patient characteristics after PSM ($n = 48$)		
	< 70 years ($n = 24$)	≥ 70 years ($n = 24$)	p	< 70 years ($n = 24$)	≥ 70 years ($n = 24$)	p
Dysphagia			0.632			<0.001
0 Points	0	0		16 (66.7%)	1 (4.2%)	
1 Points	3 (12.5%)	0		7 (29.1%)	6 (25%)	
2 Points	8 (33.3%)	11 (45.8%)		1 (4.2%)	16 (66.7%)	
3 Points	13 (54.2%)	13 (54.2%)		0	1 (4.2%)	
Regurgitation			>0.999			0.385
0 Points	8 (33.4%)	7 (29.2%)		17 (70.9%)	13 (54.2%)	
1 Points	6 (25%)	6 (25%)		7 (29.1%)	11 (45.8%)	
2 Points	5 (20.8%)	6 (25%)		0	0	
3 Points	5 (20.8%)	5 (20.8%)		0	0	
Pain			0.185			>0.999
0 Points	11 (45.8%)	8 (33.3%)		16 (66.7%)	15 (62.5%)	
1 Points	1 (4.2%)	11 (45.8%)		3 (12.5%)	3 (12.5%)	
2 Points	7 (29.2%)	2 (8.4%)		3 (12.5%)	5 (20.8%)	
3 Points	5 (20.8%)	3 (12.5%)		2 (8.3%)	1 (4.2%)	
Weight loss			0.988			0.525
0 Points	8 (33.3%)	9 (37.5%)		24 (100%)	23 (95.8%)	
1 Points	5 (20.8%)	5 (20.8%)		0	1 (4.2%)	
2 Points	7 (29.2%)	6 (25%)		0	0	
3 Points	4 (16.7%)	4 (16.7%)		0	0	

Table 7. Comparison between pre- and postoperative variables before the application of PSM

	Patients < 70 years			Patients ≥ 70 years		
	Preoperative	Postoperative	p	Preoperative	Postoperative	p
Basal Tone, mmmHg	48.8 ± 18.8	22.1 ± 7.3	<0.001	52.9 ± 23.7	20.8 ± 9.1	<0.001
IRP, mmHg	33.3 ± 13.6	12.5 ± 2.7	<0.001	29.4 ± 9.0	10.3 ± 3.4	<0.001
Eckardt score	7.1 ± 2.9	1.2 ± 1.7	<0.001	6.1 ± 3.1	2.8 ± 1.4	<0.001

Table 8. Comparison between pre- and postoperative variables after the application of PSM

	Patients < 70 years			Patients ≥ 70 years		
	Preoperative	Postoperative	p	Preoperative	Postoperative	p
Basal Tone, mmHg	44.8 ± 12.5	21.3 ± 6.9	<0.001	52.2 ± 24.1	19.9 ± 8.2	<0.001
IRP, mmHg	29.8 ± 12.1	13.0 ± 2.5	<0.001	30.9 ± 9.7	10.3 ± 3.6	<0.001
Eckardt score	6.1 ± 3.3	1.1 ± 1.7	<0.001	6.4 ± 3.1	2.4 ± 1.6	<0.001

currently is an effective therapeutic modality for type I and type II achalasia, especially in younger patients [8,11,15,16,30]. Peroral endoscopic myotomy (POEM) with fundoplication could be an alternative, but there is little data available to date [31]. However, the treatment of choice in the elderly remains controversial [13,32,33]. Mari et al. in their literature review proposed an algorithm for the therapeutic management of elderly achalasia patients [6]. In patients with type 1 and 2 achalasia, they suggested to choose between pneumatic dilation (PD), peroral endoscopic myotomy (POEM) and LHMDF, according to patient preference and surgeon expertise [6]. However, the authors did not consider short and long-term outcomes of the different procedures [6].

A recent multicenter survey evaluated achalasia treatment in patients $>$ 80 years, concluding that LHMDF seems to be safe in this population [34]. The survey, however, did not report endoscopic complications and/or follow-up outcomes [34].

There are also some retrospective studies analyzing LHMDF outcomes in elderly patients [10,13,32,35]. Roll et al. in their 2010 retrospective study with long follow-up, compared LHMDF between patients younger and older than 60 years [32]. These authors showed that LHMDF can be the first approach even in patients $>$ 60 years with greater benefits than for younger subjects [32]. Other studies also reached the same results [10,13,35].

According to these data, here we confirm that LHMDF is a safe and effective procedure, even in elderly achalasia patients. To our knowledge, this is the first prospective case-controlled study that matched achalasia patients aged less and over 70 years. Furthermore, we compared these two populations not

only for short-term surgical outcomes, but also in terms of post-operative symptoms and manometric parameters.

In terms of operative time, blood loss, length of stay, intraoperative and post-operative complications there were no differences between the two groups. These aspects are very important for a rapid recovery of older patients. In both groups, there was a statistically significant improvement in both symptoms and manometry parameters, as compared to pre-operative evaluation.

Interestingly, our data showed that the manometry parameters, namely the integrated relaxation pressure (IRP) were significantly lower in older patients. Despite this, younger patients showed a significantly lower total Eckardt score at 12 months (1.2 ± 1.7 versus 2.4 ± 1.6), with the symptom of dysphagia improving more in younger patients as compared to the elderly. Several factors can account for this apparent discrepancy. Firstly, dysphagia is a complex and subjective symptom and elderly patients may report a greater dysphagia burden independently from the outcome of the myotomy [36–39]. Secondly, patients often misidentify esophageal and oro-pharyngeal dysphagia. Finally, a decrease in muscle strength and contractility can lead to a reduction in the strength and function of the tongue, lips, veil, and jaw with an alteration in the efficiency and speed of the movement of the bolus in the oral cavity [36].

On the other hand, the postoperative difference in the postoperative IRP values, which were lower in elderly patients (13.0 ± 2.5 versus 10.3 ± 3.6), could be explained by the greater laxity of the LES in older patients undergoing esophageal myotomy [40]. The esophago-gastric junction has a complex structure, and its function depends on the LES, the diaphragm, the upper portion of the stomach and the phrenoesophageal ligament. With ageing, these structures can lose their barrier function, leading to a decrease in IRP values [41].

This study has some limitations: we only enrolled patients who were fit for surgery; furthermore, the number of recruited patients was low, both because achalasia is a rare disease and because there was severe impact on surgical activity during the Covid-19 pandemic (started in March 2020) [42]. Finally, randomized, comparative trials need to be carried out to definitively confirm the benefits and safety of this surgical approach in elderly patients.

Conclusion

According to our results, we can consider that LHMDF is a safe and effective treatment in elderly patients > 70 years with rapid post-operative recovery, improvement of symptoms and manometric parameters and low perioperative risk.

Disclosure statement

No potential conflict of interest was reported by the authors.

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