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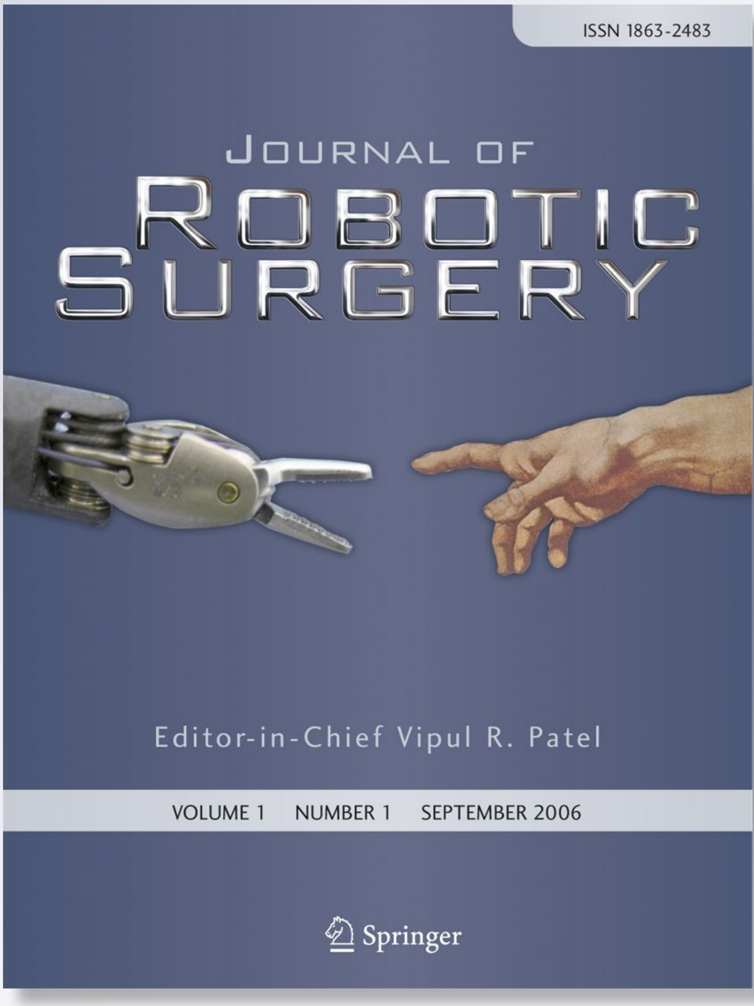

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ORIGINAL ARTICLE

Robotic-assisted Heller myotomy versus laparoscopic Heller myotomy for the treatment of esophageal achalasia: a case–control study

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Abstract Minimally invasive surgery has become the gold standard for the treatment of achalasia. The incorporation of robotic technology can improve many limitations of laparoscopic surgery, through, for example, the availability of three-dimensional vision, increasing the degrees of movement, avoiding the fulcrum effect and optimizing ergonomics. The aim of this study was to compare robotic-assisted laparoscopic Heller myotomy (RAHM) with laparoscopic Heller myotomy (LHM) in terms of efficacy and safety. Thirty-one patients with diagnosis of achalasia confirmed by esophagogram and manometry were included. Dysphagia and weight loss were the main complaints in both groups. 18 patients were treated with LHM and 13 patients with RAHM. There was no difference in mean operative time (76 ± 13 vs. 79 ± 20 min; $P = 0.73$). Intraoperative complications were less frequent in the robotic-assisted procedures (5.5% vs. 0%); however, this was a non-significant difference. 94.5–100% of patients had relief of their symptoms. We conclude that RAHM is a safe and effective procedure. The operative time is no longer than in LHM, but it is necessary to evaluate the technique in randomized clinical trials to determine its advantages in terms of intraoperative complications.

Keywords Achalasia · Myotomy · Robotic surgery

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Introduction

Achalasia is the most common primary motor disorder of the esophagus, although infrequent, with an approximate incidence of 0.001%. While the etiology is unknown, studies suggest that it is due to destruction of the ganglion cells of Auerbach's myenteric plexus [1, 2].

Achalasia is characterized by two components: impaired peristaltism and inability to relax the lower esophageal sphincter. Progressive dysphagia is the primary clinical feature, with episodes of regurgitation and chest pain [1].

Treatment is intended to relieve dysphagia by diminishing the resistance of the lower esophageal sphincter. Therapeutic options include surgery, endoscopic pneumatic dilation, and botulinum toxin injection; the first of these offers the best long-term results [3, 4].

The first description of surgical treatment of achalasia goes back to 1913 when Heller described anterior and posterior esophageal myotomy [5], modified in 1923 by Zaaijer who proposed performing only anterior myotomy [6]. Current evidence suggests the necessity to perform a partial fundoplication in order to reduce the incidence of postoperative reflux [7].

Since the introduction of minimally invasive surgery in the treatment of achalasia by Pellegrini and Cuschieri [8, 9], laparoscopic Heller myotomy has become the gold standard, because it is an effective and safe procedure. It improves the symptoms in 77–95% of patients, with excellent, long-lasting results, and provides the benefits of laparoscopic surgery: decreased postoperative pain, shorter postoperative hospital stay, faster return to normal activities and optimal cosmetic outcome. Esophageal perforation is the most frequent intraoperative complication, ocuring in 5–10% of the cases [6, 10].

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Incorporation of robotic technology achieves results comparable with those of the conventional laparoscopic approach, with lesser incidence of esophageal mucosal perforation [11].

The aim of this study was to compare laparoscopic Heller myotomy (LHM) with robotic-assisted Heller myotomy (RAHM).

Methods

A prospective, comparative study included all patients admitted to the Surgery Department III of the University Hospital of Caracas, with diagnosis of achalasia confirmed by esophagogram and manometry between January 2008 and November 2010. All the patients were treated by the same surgical team. The patients were assigned to robotic-assisted or laparoscopic group based in operating room availability; patient factors did not influence the choice.

Surgical technique

Robotic-assisted Heller myotomy

After induction of general anesthesia, the patient is placed in flat supine position. Pneumoperitoneum is performed by Hasson technique in the midline above the umbilicus and the rest of the ports are placed under direct vision. Ports for the first and second robotic arms are placed in the mid-clavicular line, two fingerbreadths below the right and left costal margins, respectively. The port for the third robotic arm is placed in the right anterior axillary line below the costal margin, as is an assistant port in the left side. Finally a fifth 5-mm port is placed in the subxyphoid area, where the liver retractor will be used (Fig. 1).

The robot setup is performed in a cephalocaudal fashion. The procedure begins with the dissection of the pars flaccida, until the entire anterior part of the phrenoesophagic membrane is dissected. At this point, the degrees of freedom given by the robot allow the surgeon to dissect and separate adequately the esophagus from the left pillar of the diaphragm.

The right pillar of the diaphragm is dissected to create a retroesophageal tunnel through which a Penrose drain is placed to retract the esophagus in the caudal direction with the third robotic arm. It allows us to expose the lower third of the esophagus and perform a myotomy of optimal length (8 cm).

The anterior part of the esophagus is now exposed and the myotomy is performed with traction and countertraction movements, tearing the longitudinal and circular muscle fibers of the esophagus. At this point, the extensive visibility provided by the da Vinci robotic system gives the surgeon great precision (Fig. 2). The myotomy extends 6 cm proximally and 2 cm distally from the gastroesophageal junction. The distal dissection is the point with a higher incidence of mucosal perforation, but it is fundamental for a good postoperative outcome.

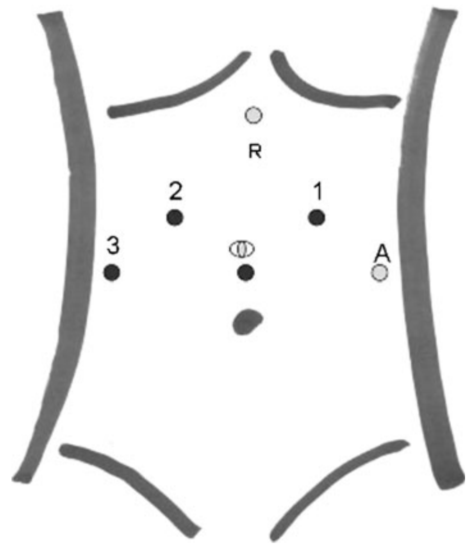

Fig. 1 Port location (*1,2,3* robotic arms, *A* assistant, *R* retractor)

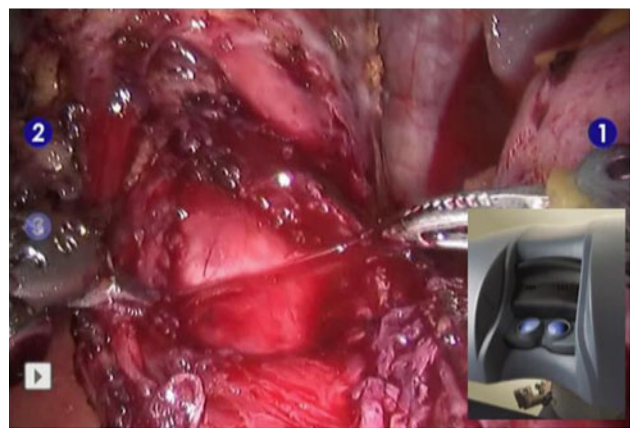

Fig. 2 Anterior myotomy

The procedure is concluded with the performance of a Dor partial fundoplication, placing three stitches on each side.

The operative time of the procedure in both cases, robotic and laparoscopic, was measured from time of incision to closure of the wounds.

Follow-up

Patients were followed up 1 week, 1 month and every 4 months after surgery during the first year. After this, patients were seen or contacted by phone interview every 6 months. Objective parameters evaluated were postoperative complications and recurrence of the symptoms.

Results

The operation was performed on a total of 31 patients, 18 of which underwent LHM and 13 RAHM. The average ages were 40.7 (LHM) and 38 (RAHM). The male:female ratio and body mass index showed no difference between groups. One patient in each group had previous upper abdominal surgery, requiring adherence dissection. One patient in the LHM group was treated with pneumatic dilation one year prior to the surgery; this was the only case with previous non-surgical treatment. Dysphagia and weight loss were the main symptoms in both groups (Table 1).

Operative and postoperative course

Operative time was shorter in the LHM group (76 ± 13 min) compared to the RAHM group (79 ± 20 min), with no statistically significance ($P = 0.73$) (Fig. 3).

Conversion to an open procedure was not necessary in either of the groups. There were no complications in the RAHM group (0%) and one esophageal perforation in the LHM group (5.5%); it was resolved intraoperatively with intracorporeal suturing. This difference was not statistically significant (Fig. 4).

The recovery of patients was satisfactory, initiating liquid diet in 24 h and being discharged in 48 h, with the exception of the patient with the esophageal perforation who remained hospitalized for 5 days.

After surgery, 94.5% of the patients in the LHM group and 100% of those in the RAHM group experienced relief of the symptoms in an 18-month follow-up period. These were considered good and excellent results, respectively.

Table 1 Comparison of LHM and RAHM

	LHM ($n = 18$)	RAHM ($n = 13$)	
Average age	40.7	38	NS
Previous treatment	1	0	NS
Dysphagia	100%	100%	NS
Weight loss	100%	100%	NS
Regurgitation	61%	69%	NS
Chest pain	5.5%	23%	NS
Operative time	76 ± 13 min	79 ± 20 min	NS
Perforation rate	5.5%	0	NS
Symptom relief	94.5%	100%	NS

NS not significant

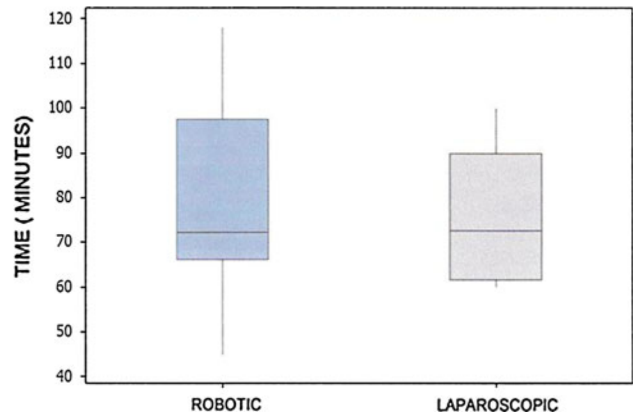

Fig. 3 Operative time: LHM versus RAHM

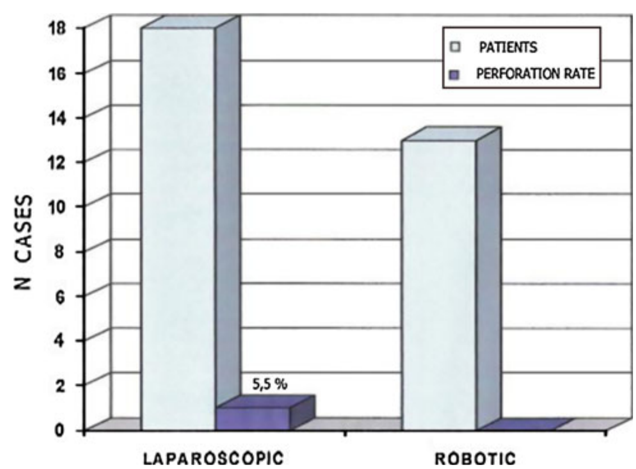

Fig. 4 Perforation rate: LHM versus RAHM

Discussion

The treatment of achalasia has evolved in the last few years. Endoscopic treatment with pneumatic dilation or botulinum toxin injection in the lower esophageal sphincter offers transient symptom improvement. Recurrence of symptoms needs additional sessions, increasing the risk of esophageal perforation [3].

Current evidence shows that LHM is a safe and effective method in the treatment of achalasia, with excellent long-term results, and providing the widely known advantages of laparoscopic surgery [4–6, 10, 12].

The incorporation of robotic-assisted surgery is designed to expand the surgeon's abilities, as it permits overcoming some of the difficulties through better vision (3D vision), increasing degrees of movement, avoiding the fulcrum effect and optimizing ergonomics [13].

Recent studies suggest that incidence of esophageal perforation is lower when the procedure is robotically assisted. Iqbal et al. [14] report a series of 19 cases of RAHM without this complication and Melvin et al. [15] report the same experience in 104 patients. More recently, Horgan et al. [11], in a multicenter comparative study, showed a significant difference between LHM and RAHM with perforation rates of 16% and 0%, respectively. There was only one case of esophageal perforation with LHM in our study (5.5%) and none with RAHM.

The optimal vision provided by the da Vinci robotic system, the elimination of tremor and the increase in degrees of freedom of the instruments explain the lower rate of esophageal mucosal perforation. These same factors facilitate the performance of the Dor fundoplication; as demonstrated by Chang et al. [16], the assistance of the robot leads the laparoscopy-trained surgeon to achieve a faster and safer intracorporeal suturing performance.

Among the disadvantages of incorporating robotic-assisted surgery in the treatment of achalasia is the increase in operative time given by the preparation and set-up of the robot. However, this variable can improve as experience is gained, and the surgical team can reach an operative time comparable to that in laparoscopic surgery [15], as shown in our study where a statistically significant difference was not found.

We believe that the lack of haptics, especially in the performance of the myotomy, is compensated by the 3D vision provided by the binocular system of the robot.

In conclusion, the results of RAHM are comparable to those of LHM regarding symptom control, with a lower rate of complications. Nevertheless, it is necessary to study larger series of patients in randomized clinical trials in order to establish definitive conclusions. It is important to remember that the surgeon must be trained in specific da Vinci system-related skills as well as know how to set up the robot in a rapid and safe way; the surgeon must have previous practice in animal or inert models with the aim of performing more effective and safe procedures.

Conclusion

The robotic-assisted minimally invasive treatment of acalasia is a feasible and safe procedure that seems to provide certain advantages over laparoscopic surgery by diminishing the rate of intraoperative complications.

Conflict of interest None.

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