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Original Article

Robot-assisted Laparoscopic Esophagomyotomy Versus Laparoscopic Esophagomyotomy for Treatment of Esophageal Achalasia: Siriraj Experience

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Abstract

Background: **Laparoscopic esophagomyotomy (LEM) has become the standard treatment for achalasia. Recently, robot-assisted laparoscopic esophagomyotomy (RA-LEM) is emerging as a safe alternative to conventional LEM. We hypothesized that RA-LEM may reduce intraoperative complications compared with LEM.**

Objective: **To compare RA-LEM with LEM in terms of intraoperative complications for the treatment of achalasia.**

Patients and Methods: **A total of 42 patients underwent surgical treatment of achalasia at Siriraj Hospital between 1 December 2001 and 30 November 2013. A retrospective review of demographic data, perioperative course, complications, and hospital stay was performed. Patients were divided into 2 groups: group A (RA-LEM) consisted of 29 patients and group B (LEM) consisted of 13 patients. Operative time, estimated blood loss, duration of stay, intraoperative and postoperative complication were analyzed.**

Results: **We could not demonstrate significant differences in esophageal perforation (13.8 vs. 15.4%; $P = 0.999$), aspiration (6.9 vs. 0%; $P = 0.999$) and operative time (195 ± 42 vs 197 ± 45 minutes; $P = 0.999$) between RA-LEM and LEM groups. There were significant reductions in blood loss (26.90 ± 45.13 vs 74.62 ± 45.21 ml; $P < 0.001$) and postoperative length of stay (4.10 ± 1.18 vs 7.92 ± 6.43 days; $P < 0.001$).**

Conclusions: **There was no significant reduction in intraoperative and postoperative complication between RA-LEM and LEM. We concluded that robotic surgery is equivalent in feasibility and safety to conventional LEM. RA-LEM may be associated with less blood loss and shorter hospital stay.**

Keywords: **Esophageal achalasia, laparoscopic esophagomyotomy ,robotic-assisted esophagomyotomy, complications**

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Introduction

Achalasia is the most common primary motility disorder of the esophagus, even though this disease is relatively uncommon. From the critical review of epidemiological studies, a worldwide estimated incidence was 0.03 to 1.1 per 100,000 population per year[1]. Achalasia is characterized by absent peristalsis of the esophageal body and failure of relaxation of lower esophageal sphincter (LES). Unfortunately, its etiology remains unknown. Studies suggested that the majority of patients had no ganglion cells in the myenteric plexus of Auerbach, combined with a loss of postganglionic inhibitory neurons[2].

The traditional treatment for achalasia was palliative and mainly aimed to decrease the outflow obstruction at the level of LES. Over the years, several treatment alternatives have been proposed, starting with Willis in 1672 who reported the first patient treated with dilation of the esophagus by using a tapered whale bone[3]. In 1887, Russel described the initial balloon dilatation using a silk bag over a rubber balloon[3]. In 1913, Heller performed the first esophagomyotomy using an anterior and posterior esophageal myotomy[4]. Subsequently, modified Heller's operation, with a single anterior myotomy, was adapted and popularized by Zaaijer in 1923[5]. This procedure has also been performed via a transabdominal or transthoracic approach.

Pellegrini and Cuscheri demonstrated the benefits of the minimally invasive approach. They showed clear benefits of laparoscopic esophagomyotomy (LEM) on the reduction of morbidity, shorter postoperative hospital stay, and decreased postoperative pain[6,7]. Most recent meta-analyses comparing the efficacy and adverse event rates between LEM and pneumatic dilatation (PD) suggests that LEM may provide greater response rates as compared with graded PD in the treatment of newly diagnosed idiopathic achalasia, with lesser rates of major adverse events, in up to one year after treatment[8]. In addition, another meta-analysis that compared the safety and efficacy of endoscopic and surgical treatments for esophageal achalasia showed that LEM, when combined with an antireflux procedure, provided better symptom relief than all endoscopic and other surgical approaches, with low complication rates[9]. Currently LEM has become the first-line therapy and "gold standard" of achalasia treatment.

Table 1 Esophageal mucosa perforation rate among centers with large experience

	No. of Cases	Mucosal Perforation
Hunter et al., 1997[15]	40	6 (15%)
Patti et al., 1999[16]	133	6 (5%)
Finley et al., 2001[17]	98	1 (1%)
Zaninotto et al., 2001[18]	100	5 (5%)
Bloomston et al., 2001[19]	111	8 (7%)
Sharp et al., 2002[20]	100	8 (8%)

Despite the success of minimally invasive operative approaches, previous studies from centers with large case volumes report an intraoperative esophageal perforation rate between 1% and 15% (Table 1). In 2000, the Da Vinci operative telerobotic device (Intuitive Surgical Corporation, Sunnyvale, California, USA) was approved for clinical use by the US FDA. Several studies have demonstrated the safety and feasibility of robot-assisted esophagomyotomy (RA-LEM) with fewer complications (e.g. intraoperative esophageal perforation), and improved quality of life indices postoperatively when compared with conventional LEM[10-14].

We performed the first RA-LEM in 2007. So far, in Thailand, there has been no report comparing RA-LEM to conventional LEM for the treatment of esophageal achalasia. The aim of the present study was to compare RA-LEM with conventional LEM in terms of intraoperative complications and to demonstrate the feasibility and safety of RA-LEM for the treatment of esophageal achalasia at Siriraj Hospital.

Patients and Methods

A retrospective medical record review was performed on 42 patients who underwent minimally invasive esophagomyotomy for the treatment of esophageal achalasia at the Division of General Surgery, Department of Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, between 1 December 2001 and 30 November 2013. The data collection included demographics, perioperative course, complications and hospital stay. Patients were divided into two groups: group A (RA-LEM) consisting of 29 patients, and group B (LEM) consisting of 13 patients. Operative time (skin to skin time), estimated blood loss, duration of hospital stay, intraoperative and postoperative complications were analyzed. In the past, patients with achalasia were admitted to the hospital for preoperative nutritional support for several weeks, but remained in the hospital for just a few days after surgery. Thus, postoperative length of stay was analyzed instead of total hospital length of stay. Ethical approval was obtained from the Siriraj Institutional Review Board, Mahidol University, Thailand.

The groups were compared by using Chi-square test or Fisher's exact test for complication rates, and Mann-Whitney U test for continuous variables (e.g. operative time, estimated blood loss, and duration of stay). Results were summarized as proportions or mean ± standard deviation. Differences were considered significant at $P \leq 0.05$.

Results

Between December 2001 and November 2013, 42 patients with achalasia underwent minimally invasive esophagomyotomy. Twenty nine patients were treated by robotic assistance (Group A) and 13 patients were treated by the laparoscopic approach (Group B). Both groups were comparable with regard to demographics, which showed no significant differences between groups (Table 2).

Comparison between robot-assisted and laparoscopic groups demonstrated no significant differences in esophageal perforation (13.8 vs. 15.4%; $P = 0.999$), aspiration (6.9 vs. 0%; $P = 0.999$), operative time (195 ± 42 vs 197 ± 45 minutes; $P = 0.999$). But there were significant reductions in blood loss (26.90 ± 45.13 vs 74.62 ± 45.21 mL; $P < 0.001$) and postoperative length of stay (4.10 ± 1.18 vs 7.92 ± 6.43 days; $P < 0.001$) (Table 3).

All patients in the robot-assisted group with intraoperative esophageal perforation were treated immediately without conversion to the open or laparoscopic approach. But one patient in laparoscopic group had delayed esophageal perforation that required open repair on postoperative day 4, without any further morbidity and mortality. There was no operative conversion to open surgery, no hospital

Table 2 Demographic characteristics of patients in the study

Patient Characteristics	Group A (n = 29)	Group B (n = 13)	*P*-value
Age, year (mean ± SD)	48.28 ± 19.33	43.54 ± 14.37	NS
Female sex, n (%)	18 (62.1)	96 (69.2)	NS
BW, kg (mean ± SD)	51.93 ± 12.28	43.54 ± 14.37	NS
Dysphagia, n (%)	26 (89.7)	13 (100)	NS
Weight loss, n (%)	13 (44.8)	6 (46.2)	NS
Heart burn, n (%)	4 (13.8)	0 (0)	NS
Other symptoms, n (%)	2 (6.9)	0 (0)	NS
Previous treatment			
- Pneumatic balloon dilatation, n (%)	6 (20.7)	7 (53.8)	NS
- Botulinum injection, n (%)	4 (13.8)	1 (7.7)	NS
- Other treatment, n (%)	1 (3.4)	0 (0)	NS

Table 3 Comparison between group A (RA-LEM) and group B (LEM) in terms of intra-operative and postoperative data

Intraoperative and postoperative data	Group A (n = 29)	Group B (n = 13)	*P*-value
Operative time, min (mean ± D)	195.00 ± 42.31	197.31 ± 44.89	0.999
Estimated blood losses, mL (mean ± SD)	26.90 ± 45.13	74.62 ± 45.21	<0.001
Perforation, n (%)	4 (13.8)	2 (15.4)	0.999
Aspiration, n (%)	2 (6.9)	0 (0)	0.999
Postoperative stay, day (mean ± SD)	4.10 ± 1.18	7.92 ± 6.47	<0.001

mortality, and no 30-day readmission in both groups.

Discussion

The aim of treatment for achalasia is to relieve the resistance at the level of the lower esophageal sphincter and to improve esophageal emptying. For several decades, the first endoscopic treatment of achalasia was the use of pneumatic balloon dilation. Only patients who failed to have their symptoms resolved after dilation and those who experienced esophageal perforation during balloon dilation were referred for surgical treatment. However, long-term relief of symptoms is possible in only 40% of patients[21]. Since the introduction of laparoscopic management of esophageal achalasia in 1991[7], LEM has achieved rapid and widespread acceptance and has become the first-line therapy or "gold standard" for the treatment of achalasia[22]. Several studies suggested that LEM, when combined with an antireflux procedure, provided better symptom relief than all endoscopic and other surgical approaches with lower complication rates[8,9].

The most common intraoperative complication of LEM is esophageal mucosal perforation. Perforation rates are variable, ranging from 1% to 15% in centers with large experience[15-20]. The advantages of robot-assisted surgery include a stable surgical platform, a magnified 3-dimensional image, fine motor control of articulated instruments, and motion scaling. Previous studies from centers with large experience of RA-LEM reported no intra-operative esophageal mucosal perforation[10-14]. In the present study, mucosal perforation occurred in 2 (15.4%) patients in the laparoscopic group and 4 (13.8%) patients in the robotic group, but this difference, as well as that of other postoperative complications, was not statistically significant. The perforation rate in this study was higher when compared with those of previous studies, probably due to low volume of cases.

We found significant reduction of blood loss and shorter postoperative length of stay in the RA-LEM group. This may be due to certain advantages of robotic systems, such as fine motor control, three-dimensional magnification and motion scaling with better tissue handling and manipulation. Interestingly, there was no increase in operative time due to robotic set up.

The limitations of the present study included the retrospective design with small number of cases and no evaluation of postoperative clinical outcomes. Further studies regarding clinical outcomes and cost effectiveness will be considered.

Conclusion

There were no significant difference in intraoperative and postoperative complications between robotic-assisted esophagomyotomy and laparoscopic esophagomyotomy. Robotic-assisted surgery is equivalent in feasibility and safety to laparoscopic esophagomyotomy. In addition, RA-LEM may be associated with less blood loss and shorter length of hospital stay. Further study regarding clinical outcomes and cost effectiveness should be considered.

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