Heller Myotomy Perforation: Robotic Visualization Decreases Perforation Rate and Revisional Surgery is a Perforation Risk

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INTRODUCTION

Minimally invasive surgery (MIS)

MIS techniques have improved surgical access to the foregut. The advantages of the robotic platform may result in better clinical outcomes due to safer dissection, better visualization, and more instrument mobility.

Esophageal Disorders

- Achalasia is an esophageal motility disorder characterized by failure of lower esophageal sphincter (LES) relaxation and an absence of esophageal peristalsis with an incidence of 1 in 100,000.
- Nutcracker esophagus, otherwise known as hypercontractile esophagus in the Chicago classification, is a coordinated hypertensive peristalsis in the distal esophagus, often painful, especially when intra-esophageal pressure exceeds systolic blood pressure.
- Esophageal spasm is characterized by uncoordinated esophageal contractions, usually symptomatic with chest pain. It is five times less common than achalasia and can progress to achalasia.

The gold standard for diagnosing esophageal motility disorders is manometry, with high resolution manometry preferred.

Myotomy

Heller myotomy is the division of esophageal and high gastric muscle layers at the LES, and is the treatment of choice for achalasia, as well as other motility disorders which have failed medical management.

Prior studies have established that robotic Heller myotomies have no significant difference in blood loss, length of surgery, length of stay (LOS), morbidity, intensive care unit admission, and 30 day readmission when compared to laparoscopic approaches. Specifically for the Heller myotomy procedure, the robotic platform has been published in multiple studies to have a lower perforation rate in de novo surgery.

METHODS

A retrospective review of prospectively collected perioperative data of a single surgical practice from 2001 to 2019 was conducted for the rate of perforation during Heller myotomy laparoscopically compared to robotically. From 2001 through February 2012, a laparoscopic approach was employed and from October 2008 through October 2019, a robotic approach was employed. All perforations were recorded, as well as secondary outcomes of perforation location (gastric or esophageal), postoperative imaging for evidence of leak, length of stay, and complications. Chi-square and simple t-test were employed for data analysis with a $p < 0.05$ as significant.

RESULTS

- During the 11 years of laparoscopic Heller myotomy, 14 cases resulted in 7 instances of perforation (50%). During the 11 years of robotic Heller myotomy, 45 cases resulted in 11 instances of perforation (24%) (p value = 0.06).
- All perforations in both groups were tiny, recognized, and repaired immediately.
- The length of stay (LOS) trended higher in the laparoscopic perforation group (3.4 days) compared to the laparoscopic non-perforation group (1.2 days) (p value = 0.06).
- LOS for robotic was not significantly longer in the perforation group (2.8 days) compared to the robotic non-perforation group (1.5 days) (p value = 0.18).
- First time Heller myotomies showed a higher rate of perforation with laparoscopic (50%) vs robotic (11%) approach (p value = 0.023).
- In subgroup analysis of revisional procedures, all ten were performed robotically (p value = 0.0003) with a 60% perforation rate (p value = 0.001) and one associated leak, confirmed radiographically.

Table 1. **Patient Characteristics**

	Laparoscopic		Robotic		P value
	N (range)	%	N (range)	%	
Total	14		45		
Gender, n					
Female	5	36%	28	62%	0.08
Mean age, y	42 (20-79)		54 (31-82)		**0.04**
Mean LOS, d	2.3 (1-10)		1.84 (1-11)		0.47
No Perforation group	1.28 (1-2)		1.5 (1-5)		0.35
Perforation group	3.4 (1-10)		2.8 (1-11)		0.68
Diagnosis					
Achalasia	13	93%	37	82%	0.21
Nutcracker	1	7%	5	11%	0.67
Esophageal spasm	0	0%	3	7%	0.32
Perforation	7	50%	11	24%	0.06
Esophageal	4	57%	6	54%	0.91
Gastric	3	43%	5	45%	0.91
De Novo surgery	14	100%	35	77%	**<0.001**
Perforation	7	50%	5	14%	**0.023**
Redo surgery	0	0%	10	22%	**0.05**
Perforation			6	60%	
Preop dilation			1	9%	
Sigmoid Esophagus			1	9%	
Preop Botox	4	29%	4	9%	0.06
Perforation	2	50%	0	0%	0.10
Leak on postop imaging	0	0%	1	9%	0.57

LOS Length of stay, *Preop* Preoperative

Table 2. **Perforation Rates**

	Laparoscopic	Robotic Primary	Redo	P value
Perforation	7	5	6	0.001
No Perforation	7	30	4	
Total	14	35	10	
Percentage	50%	14%	60%	

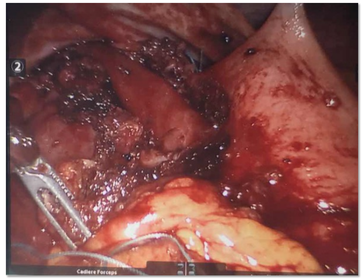


Figure 1. Robotic Heller Myotomy prior to partial fundoplication

DISCUSSION

Length of Stay

Other studies have shown no differences in LOS for robotic compared to laparoscopic Heller myotomies. Our study trended toward separation between LOS of laparoscopic non-perforation (1.2 days) and perforation (3.4 days) groups (p = 0.06). There was no significant difference in the robotic non-perforation (1.5 days) and perforation (2.8 days) groups.

Perforation Rates with Robotic Platforms

Horgan et al. in 2005 compared laparoscopic and robotic myotomies for achalasia, and found a 16% rate of esophageal perforations in the laparoscopic arm, which was significantly higher than the zero perforations in the robotic arm ($p < 0.01$). Some of the patients had previous endoscopic treatments, however none of these cases were redo surgeries.

In evaluating primary surgery cases, the laparoscopic group still had a rate of 50% and the robotic group was significantly less with only 14% perforation rate (p value = 0.023).

Revisional Surgeries

Rossetti et al. published results of laparoscopic reoperation for failed laparoscopic Heller myotomy with 2% requiring reoperation with no morbidities or mortalities reported. They concluded revisional laparoscopic surgery was safe with no mention of perforation.

In our study, all of the revisional procedures were done robotically (p value = 0.0003). The redo surgeries had the highest perforation rate of 60% (p value = 0.001) and the only leak was observed in this group. The authors believe previous surgery in the area of the GEJ has a potential for scarring, distorted anatomy, and increased risk for injury, even with the superior platform of robotic visualization.

Botox Application

Previous data showed concern for Botox injections making surgery more difficult and increasing the perforation rate. Our study shows no results to suggest preop Botox increased the risk of intraoperative perforation with either laparoscopic or robotic approaches.

CONCLUSIONS

Primary laparoscopic Heller myotomy corresponded to a higher rate of perforation than did robotic Heller myotomy, whether primary or reoperative. Reoperation in the area of the hiatus was found to be a separate risk factor for perforation during Heller myotomy. Robotic Heller myotomy is recommended for revisional surgery due to the increased technical difficulty and higher risk of perforation associated with redo operations.

REFERENCES

1. Arora Z, Thota PN, Sanaka MR. Achalasia: current therapeutic options. *Ther Adv Chronic Dis*. 2017;8(6-7):101-108. doi:10.1177/2040622317710010
2. Burmeister S. Review of current diagnosis and management of diffuse esophageal spasm, nutcracker esophagus/spastic nutcracker and hypertensive lower esophageal sphincter. *Curr Opin Otolaryngol Head Neck Surg.* 2013;21(6):543-547. doi:10.1097/MOO.0000000000000002
3. Maeso S, Reza M, Mayol JA, et al. Efficacy of the da vinci surgical system in abdominal surgery compared with that of laparoscopy: A systematic review and meta-analysis. *Ann Surg.* 2010;252(2):254-262. doi:10.1097/SLA.0b013e3181e6239e
4. Galvani C, Gorodner M V., Moser F, Baptista M, Donahue P, Horgan S. Laparoscopic Heller myotomy for achalasia facilitated by robotic assistance. *Surg Endosc Other Interv Tech.* 2006;20(7):1105-1112. doi:10.1007/s00464-005-0272-9
5. Shaligram A, Unnirevi J, Simorov A, Kothari VM, Oleynikov D. How does the robot affect outcomes? A retrospective review of open, laparoscopic, and robotic Heller myotomy for achalasia. *Surg Endosc.* 2012;26(4):1047-1050. doi:10.1007/s00464-011-1994-5
6. Horgan S, Galvani C, Gorodner M V., et al. Robotic-assisted Heller myotomy versus laparoscopic Heller myotomy for the treatment of esophageal achalasia: Multicenter study. *J Gastrointest Surg.* 2005;9(8):1020-1030. doi:10.1016/j.gassur.2005.06.026
7. Rossetti G, del Genio G, Maffettone V, et al. Laparoscopic reoperation with total fundoplication for failed Heller myotomy: is it a possible option? Personal experience and review of literature. *Int Surg.* 2009;94(4):330-334.
8. Horgan S, Hudda K, Eubanks T, McAllister J, Pellegrini CA. Does botulinum toxin injection make esophagomyotomy a more difficult operation? *Surg Endosc.* 1999;13(6):576-579. doi:10.1007/s004649901044