Robotic versus laparoscopic hiatal hernia repair and Heller myotomy: a systematic review and meta-analysis

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INTRODUCTION:

Laparoscopic surgery remains the mainstay of treating Hiatal hernias and achalasia. Robotic surgery, however, affords surgeons enhanced visualization and dexterity in the foregut, with recent studies showing improved patient outcomes compared to conventional laparoscopy. We conducted a systematic review and meta-analysis to compare operative and patient outcomes between robotic and laparoscopic hiatal hernia repairs (HHR) and Heller myotomy (HM).

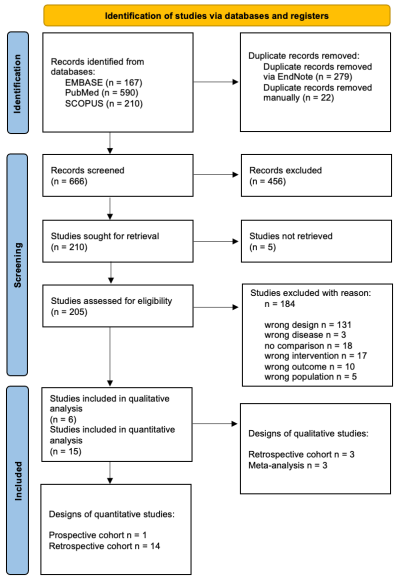


Figure 1. Study selection diagram.

METHODS:

PubMed, Embase, and Scopus databases were searched to identify studies published between 01/2010 and 05/2021. The risk of bias was assessed using the Cochrane ROBINS-I tool. Assessed outcomes included intraoperative and short-term postoperative patient outcomes for both procedures. We pooled the dichotomous data using the Mantel-Haenszel random effects model to report odds ratio (OR) and 95% confidence intervals (95% CIs) and continuous data to report mean difference (MD) and 95% CIs.

2A Morbidity

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Odds Ratio M-H, Random, 95% CI
Gehrig 2013	1	12	2	17	3.7%	0.68 [0.05, 8.50]
Gerull 2021	4	830	6	1024	9.7%	0.82 [0.23, 2.92]
Giovanetti 2019	5	32	5	32	9.1%	1.00 [0.26, 3.86]
Hosein 2021	16	835	250	6774	17.8%	0.51 [0.31, 0.85]
Howell 2020	6	44	10	84	11.4%	1.17 [0.39, 3.46]
Soliman 2020	9	142	29	151	14.6%	0.28 [0.13, 0.63]
Tolboom 2020	0	45	9	30	3.0%	0.02 [0.00, 0.45]
Ward 2021	1253	9897	17522	158432	21.2%	1.17 [1.10, 1.24]
Wilhelm 2021	13	36	4	19	9.5%	2.12 [0.58, 7.74]
Total (95% CI)		**11873**		**166563**	**100.0%**	**0.72 [0.42, 1.24]**
Total events	1307		17837			

Heterogeneity: Tau² = 0.35; Chi² = 30.17, df = 8 (P = 0.0002); I² = 73%
Test for overall effect: Z = 1.19 (P = 0.24)

Odds Ratio M-H, Random, 95% CI
0.01 0.1 1 10 100
Favors Robotic Favors Laparoscopic

2B Length of Stay

Study or Subgroup	Robotic Mean	Robotic SD	Robotic Total	Laparoscopic Mean	Laparoscopic SD	Laparoscopic Total	Weight	Mean Difference IV, Random, 95% CI
Gehrig 2013	7.8	3.9	12	6.5	1.6	17	3.3%	1.30 [-1.03, 3.63]
Gerull 2021	1.8	0.6	830	2.9	1.4	1024	22.9%	-1.10 [-1.19, -1.01]
Giovanetti 2019	2	1.9	32	3	5.4	32	4.3%	-1.00 [-2.98, 0.98]
Hosein 2021	3.44	5.01	835	3.9	5.22	6774	20.2%	-0.46 [-0.82, -0.10]
Howell 2020	1.5	0.38	44	1.7	1.5	84	20.5%	-0.20 [-0.54, 0.14]
Soliman 2020	1.3	1.8	142	1.8	1.5	151	20.0%	-0.50 [-0.88, -0.12]
Tolboom 2020	3.3	2.3	45	4.7	3.1	30	8.1%	-1.40 [-2.70, -0.10]
Wilhelm 2021	11.2	13.1	36	9	8.8	19	0.6%	2.20 [-3.63, 8.03]
Total (95% CI)			**1976**			**8131**	**100.0%**	**-0.59 [-1.04, -0.13]**

Heterogeneity: Tau² = 0.23; Chi² = 45.59, df = 7 (P < 0.00001); I² = 85%
Test for overall effect: Z = 2.52 (P = 0.01)

Mean Difference IV, Random, 95% CI
-10 -5 0 5 10
Favors Robotic Favors Laparoscopic

2C Morbidity

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Odds Ratio M-H, Random, 95% CI
3.3.2 Experience Not Reported						
Gehrig 2013	1	12	2	17	3.7%	0.68 [0.05, 8.50]
Gerull 2021	4	830	6	1024	9.7%	0.82 [0.23, 2.92]
Giovanetti 2019	5	32	5	32	9.1%	1.00 [0.26, 3.86]
Hosein 2021	16	835	250	6774	17.8%	0.51 [0.31, 0.85]
Howell 2020	6	44	10	84	11.4%	1.17 [0.39, 3.46]
Ward 2021	1253	9897	17522	158432	21.2%	1.17 [1.10, 1.24]
Subtotal (95% CI)	11650		166363		72.9%	0.88 [0.57, 1.36]
Total events	1285		17795			

Heterogeneity: Tau² = 0.12; Chi² = 10.44, df = 5 (P = 0.06); I² = 52%
Test for overall effect: Z = 0.57 (P = 0.57)

3.3.3 0-5 Years						
Soliman 2020	9	142	29	151	14.6%	0.28 [0.13, 0.63]
Wilhelm 2021	13	36	4	19	9.5%	2.12 [0.58, 7.74]
Subtotal (95% CI)	178		170		24.1%	0.73 [0.10, 5.16]
Total events	22		33			

Heterogeneity: Tau² = 1.72; Chi² = 6.74, df = 1 (P = 0.009); I² = 85%
Test for overall effect: Z = 0.32 (P = 0.75)

3.3.4 5-10 Years						
Tolboom 2020	0	45	9	30	3.0%	0.02 [0.00, 0.45]
Subtotal (95% CI)	45		30		3.0%	0.02 [0.00, 0.45]
Total events	0		9			

Heterogeneity: Not applicable
Test for overall effect: Z = 2.51 (P = 0.01)

Total (95% CI)	11873		166563		100.0%	**0.72 [0.42, 1.24]**
Total events	1307		17837			

Heterogeneity: Tau² = 0.35; Chi² = 30.17, df = 8 (P = 0.0002); I² = 73%
Test for overall effect: Z = 1.19 (P = 0.24)
Test for subgroup differences: Chi² = 5.74, df = 2 (P = 0.06), I² = 65.1%

Odds Ratio M-H, Random, 95% CI
0.01 0.1 1 10 100
Favors Robotic Favors Laparoscopic

Figure 2A-C. Morbidity rates and length of stay in robotic versus laparoscopic hiatal hernia repairs.

3A Esophageal Perforation **Heller Myotomy**

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Odds Ratio M-H, Random, 95% CI
Ali 2020	0	44	6	40	22.7%	0.06 [0.00, 1.10]
Kim 2019	1	37	4	35	38.2%	0.22 [0.02, 2.03]
Perry 2014	0	56	3	19	21.2%	0.04 [0.00, 0.85]
Sanchez 2012	0	13	1	18	17.9%	0.43 [0.02, 11.47]
Total (95% CI)		**150**		**112**	**100.0%**	**0.13 [0.03, 0.52]**
Total events	1		14			

Heterogeneity: Tau² = 0.00; Chi² = 1.55, df = 3 (P = 0.67); I² = 0%
Test for overall effect: Z = 2.90 (P = 0.004)

Odds Ratio M-H, Random, 95% CI
0.01 0.1 1 10 100
Favors Robotic Favors Laparoscopic

3B Morbidity **Heller Myotomy**

Study or Subgroup	Robotic Events	Robotic Total	Laparoscopic Events	Laparoscopic Total	Weight	Odds Ratio M-H, Random, 95% CI
Ali 2020	1	44	0	40	6.3%	2.79 [0.11, 70.54]
Shaligram 2012	6	149	110	2116	93.7%	0.77 [0.33, 1.77]
Total (95% CI)		**193**		**2156**	**100.0%**	**0.83 [0.37, 1.87]**
Total events	7		110			

Heterogeneity: Tau² = 0.00; Chi² = 0.58, df = 1 (P = 0.45); I² = 0%
Test for overall effect: Z = 0.45 (P = 0.65)

Odds Ratio M-H, Random, 95% CI
0.01 0.1 1 10 100
Favors Robotic Favors Laparoscopic

Figure 3A-B. Esophageal perforation and morbidity rates in robotic versus laparoscopic Heller myotomy.

RESULTS:

We included 15 comparative studies (14 retrospective, 1 prospective) enrolling 181,388 patients. Ten (robotic n = 11993, laparoscopic n = 166864) studies assessed outcomes of hiatal hernia repair, while five (robotic n = 302, laparoscopic n = 2229) assessed the outcomes of Heller myotomy. Robotic HHR had a significantly shorter length of hospital stay (LOS) [MD -0.59, (95% CI -1.04, -0.13), p = 0.01] compared with laparoscopic procedure. Robotic procedures had a non-significant longer operative duration [MD 21.58 (95% CI -0.30, 43.46), p = 0.05], and a nonsignificant reduction in conversions to open [OR 0.19, (95% CI 0.02, 1.73), (p = 0.14)] compared with laparoscopic procedures. Subgroup analysis by surgeon experience and year of robot introduction to the hospital system, when the data was available, did not reveal any significant differences in morbidity between robotic and laparoscopic HHR. In robotic HM, the incidence of esophageal perforations [OR 0.13, (95% CI 0.03, 0.52), p = 0.04] was statistically significantly lower compared with laparoscopic HM. Robotic HM also had statistically nonsignificant reductions in conversions to open [OR 0.15 (95% CI 0.02, 1.25) p = 0.08], shorter LOS [MD -0.61 (95% CI -1.42, 0.20) p = 0.14], and longer operative time [MD 7.48 (95% CI -1.34, 16.30) p = 0.10] compared with laparoscopic procedures.

CONCLUSIONS:

Our results have demonstrated that the robotic approach to HM and HHR have similar safety profiles and overall outcomes, with significant improvements in LOS in robotic HHR and esophageal perforation in robotic HM. To our knowledge, this is the first meta-analysis comparing robotic and laparoscopic HHR. Limitations include low to moderate quality of included studies due to inadequate reporting of outcomes, follow-up, and experience with the robot. Further well-designed studies and RCTs are necessary to draw more definitive conclusions.