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Comparing Outcomes of Robotic-Assisted versus Conventional Laparoscopic Hiatal Hernia Repair

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ABSTRACT

Introduction. Robotic-assisted laparoscopic surgery for anti-reflux and hiatal hernia surgery is becoming increasingly prevalent. The purpose of this study was to compare hospital length of stay and outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair.

Methods. A retrospective review was conducted of 58 patients who underwent robotic-assisted laparoscopic (n = 16, 27.6%) or conventional laparoscopic (n = 42, 72.4%) hiatal hernia repair.

Results. Patient characteristics and comorbidities were similar between groups. The robotic-assisted group had a significantly higher use of fundoplication (81.3% vs. 38.1%; p = 0.007). Complications observed between the robotic-assisted and conventional laparoscopic groups were pneumothorax (6.3% vs. 11.9%; p = 1.000), infection (0% vs. 4.8%; p = 1.000), perforation (0% vs. 2.4%; p = 1.000), bleeding (6.3% vs. 2.4%; p = 0.479), ICU admission (31.3% vs. 11.9%; p = 0.119), and mechanical ventilation (18.8% vs. 2.4%; p = 0.60). There were no reported complications of dysphagia, deep vein thrombosis/pulmonary embolus, myocardial infarction, or death in either group. Hospital length of stay was similar for robotic versus conventional patients (3.0 vs. 2.5 days; p = 0.301).

Conclusions. Robotic-assisted versus conventional laparoscopic hiatal hernia were compared, which demonstrated similar post-operative complication rates and hospital length of stay. The results showed robotic-assisted or conventional laparoscopic hiatal hernia repair can be performed with similar outcomes. ***Kans J Med 2022;15:365-368***

INTRODUCTION

Patients with medically refractory gastroesophageal reflux disease (GERD) or hiatal hernia may undergo surgical repair to treat their symptoms. Anti-reflux surgery has a satisfactory outcome in 85-96% of patients with these conditions.[1] Prior to minimally invasive techniques, a traditional open approach was used for hiatal hernia repair. This approach eventually was replaced by conventional laparoscopic repair, with reduced rates of perioperative morbidity and shorter hospital stays.[2,3] However, there were some pitfalls to conventional laparoscopic surgery, including unstable video-camera, limited motion of straight laparoscopic instruments, and 2-D imaging.[3,4] More recently, robotic-assisted laparoscopic surgery has become increasingly prevalent.

Robotic surgery overcomes many of the pitfalls of conventional laparoscopic surgery, including steady state, 3-D cameras, improved dexterity of robotic instruments, and superior ergonomics for the surgeon.[3-5] After a thorough search of the surgical literature, there were very few studies that directly compared the outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair. Soliman et al.[5] performed a retrospective review of data collected from The Society of Thoracic Surgery database comparing outcomes of conventional laparoscopic versus robotic surgery for hiatal hernia repairs, whereas Tolboom et al.[1] used a single institute cohort to compare laparoscopic versus robotic redo hiatal hernia repairs. Those studies demonstrated statistically significant decreases in hospital length of stay (LOS) from 1.8 to 1.3 days[5] and from 4 to 3 days.[1] Soliman et al.[5] also found a statistically significant decrease in post-operative events (i.e., intensive care unit [ICU] admission, pneumonia, respiratory failure, deep vein thrombosis [DVT], urinary tract infection [UTI], surgical site infection, and need for ventilatory support), from 29 to 9 with robotic-assisted hiatal hernia repair. However, in a retrospective population-based analysis by Ward et al.,[3] robotic-assisted hiatal hernia repair had a significantly increased risk of complications, such as respiratory failure and esophageal perforation (2.4% vs. 1.6%; p = 0.003 and 0.6% vs. 0.3%; p = 0.01, respectively). This study also demonstrated a longer hospital LOS for the robotic-assisted group, although this was not statistically significant. The purpose of this study was to add to the existing literature of outcomes of robotic-assisted versus conventional laparoscopic hiatal hernia repair.

METHODS

This study was approved for implementation by the Ascension Via Christi Hospitals Wichita, Inc Institutional Review Board. A three year retrospective review was conducted of all patients, ≥ 18 years of age, who underwent robotic-assisted or conventional laparoscopic hiatal hernia repair at a single tertiary-care hospital. The medical records utilized covered the time period from January 1, 2014 through December 31, 2016. All patients were followed for three years, with the follow-up period ending December 31, 2019.

Data collected included patient demographics (age, sex, height, weight, body mass index [BMI]), American Society of Anesthesiologist (ASA) physical status class, and the presence of co-morbidities (GERD, hypertension, diabetes, coronary artery disease, and chronic obstructive pulmonary disease [COPD]). Medical records also were reviewed for procedure performed (conventional laparoscopic versus robotic-assisted laparoscopic), use of fundoplication and type, use of mesh, conversion to open procedure, post-operative complications (i.e., pneumothorax, infection, bleeding, perforation, dysphagia, DVT/pulmonary embolus [PE], myocardial infarction [MI], and other), ICU admission and LOS, need for mechanical ventilation and ventilator days, hospital LOS, 30-day readmission rate, mortality, and discharge to hospice.

The primary outcome variables were hospital LOS and post-operative complications between the two groups. In addition, patient age, BMI, ASA class, as well as specific co-morbidities that may have affected the primary outcomes were evaluated.

Data Analysis. A total of 58 cases met inclusion criteria. Data were summarized and presented as frequency and counts for categorical data, mean ± standard deviation for parametric continuous data, or median and interquartile range for nonparametric continuous data.

Pearson's Chi-Square was used to compare all categorical variables, though Fisher's Exact Test was used when the cell count was less than 5. The t-test and Mann-Whitney U test were used to compare continuous parametric and nonparametric data, respectively. Analyses were considered significant when the p value was ≤ 0.05. All analyses were conducted using IBM SPSS release 19.0 (IBM Corp., Armonk, NY).

RESULTS

Patient Demographics and Comorbidities. A total of 58 patients were included in the final analyses after exclusions were applied. Patient demographics (age, sex, height, weight, BMI) and ASA class were similar between study groups (Table 1). The average patient age was 63.9 years and average BMI was 30.9. Female sex was most common (70.7%). ASA class 2/3 was most common (91.4%). Patient comorbidities also were similar between the two groups with GERD being the most common comorbidity observed (82.8%). Hypertension was observed more commonly in patients undergoing conventional laparoscopic repair (71.4% vs. 43.8%; p = 0.050).

Procedure Comparisons. Conventional laparoscopic hiatal hernia repair was performed more commonly than robotic-assisted repair (72.4% vs. 27.6%; Table 2). Fundoplication was used twice as often in the robotic-assisted group than in the conventional group (81.3% vs. 38.1%; p = 0.007). In those patients that underwent a fundoplication, the Nissen was the most common type of fundoplication performed in both the robotic-assisted (84.6%) and conventional laparoscopic groups (68.8%). Use of mesh was not different between the robotic-assisted and conventional laparoscopic groups (37.5% vs. 28.6%; p = 0.511) nor was conversion to open procedure (0% vs. 16.7%; p = 0.173).

Post-operative Complications. No patients in either group had a reported complication of dysphagia, DVT/PE or MI (Table 3). The robotic-assisted group had no reported complications of infection or perforation, and only one reported complication of pneumothorax (6.3%) and bleeding (6.3%). The conventional laparoscopic group had five reported cases of pneumothorax (11.9%), two reports of infection (4.8%), one for bleeding, and one for perforation (2.4% each). Other complications included acute hypoxia that required new home oxygen, acute kidney injury, atrial fibrillation, supraventricular tachycardia, urinary retention, ileus, immediate hiatal hernia recurrence, and retained surgical foreign body. There were no differences between the two groups for these complications.

Hospital Outcomes. There were no statistically significant differences between study groups for ICU admission or LOS, mechanical ventilator requirements, hospital LOS, 30-day readmission, mortality, or discharge disposition (Table 3). There was a trend for the conventional laparoscopic group to have a longer median ICU LOS (five vs. two days; p = 0.095). However, the robotic-assisted group tended to have more patients require mechanical ventilation (18.8% vs. 2.4%; p = 0.060). There were no mortalities in either group.

Table 1. Comparison of characteristics of patients undergoing hiatal hernia repair by a conventional laparoscopic or robot-assisted laparoscopic approach.*

Parameter	Composite	Study Group		p Value
		Conventional Laparoscopic	Robotic Assisted Laparoscopic	
Number of observations	58 (100%)	42 (72.4%)	16 (27.6%)	---
Age (years)	63.9 ± 14.2	64.9 ± 13.1	61.4 ± 16.9	0.406
Female sex	41 (70.7%)	28 (66.7%)	13 (81.3%)	0.347
Height (cm)	166.3 ± 9.9	166.1 ± 10.5	166.7 ± 8.4	0.824
Weight (Kg)	85.2 ± 19.2	83.4 ± 18.4	89.9 ± 20.9	0.251
Body mass index	30.9 ± 5.5	30.3 ± 5.4	32.3 ± 5.5	0.218
ASA class				0.929
1	4 (6.9%)	3 (7.1%)	1 (6.3%)	
2	33 (56.9%)	24 (57.1%)	9 (56.3%)	
3	20 (34.5%)	14 (33.3%)	6 (37.5%)	
4	1 (1.7%)	1 (2.4%)	0 (0.0%)	
Comorbidities				
GERD	48 (82.8%)	35 (83.3%)	13 (81.3%)	1.000
Hypertension	37 (63.8%)	30 (71.4%)	7 (43.8%)	0.050
Diabetes	8 (13.6%)	8 (19.0%)	0 (0.0%)	0.092
Coronary artery disease	4 (6.9%)	2 (4.8%)	2 (12.5%)	0.303
COPD	1 (1.7%)	1 (2.4%)	0 (0.0%)	1.000

*Presented as number (%) or mean ± standard deviation.
ASA = American Association of Anesthesiologists, GERD = gastroesophageal reflux disease, COPD = chronic obstructive pulmonary disease.

Table 2. Comparison of operative procedures of patients undergoing hiatal hernia repair by a conventional laparoscopic or robot-assisted laparoscopic approach.*

Parameter	Composite	Study Group		p Value
		Conventional Laparoscopic	Robotic Assisted Laparoscopic	
Number of observations	58 (100%)	42 (72.4%)	16 (27.6%)	---
Use of fundoplication	29 (50.0%)	16 (38.1%)	13 (81.3%)	0.007
Nissen fundoplication				0.410
Yes	22 (75.9%)	11 (68.8%)	11 (84.6%)	
No	7 (24.1%)	5 (31.3%)	2 (15.4%)	
Use of mesh	18 (31.0%)	12 (28.6%)	6 (37.5%)	0.511
Conversion to open	7 (12.1%)	7 (16.7%)	0 (0.0%)	0.173

*Presented as number (%).

Table 3. Comparison of complications and hospital outcomes of patients undergoing hiatal hernia repair by a conventional laparoscopic or robot-assisted laparoscopic approach.*

Parameter	Composite	Study Group		p Value
		Conventional Laparoscopic	Robotic Assisted Laparoscopic	
Number of observations	58 (100%)	42 (72.4%)	16 (27.6%)	---
Patients with 1 or more complications	20 (34.5%)	15 (35.7%)	5 (31.3%)	0.749
Pneumothorax	6 (10.3%)	5 (11.9%)	1 (6.3%)	1.000
Infection	2 (3.4%)	2 (4.8%)	0 (0.0%)	1.000
Bleeding	2 (3.4%)	1 (2.4%)	1 (6.3%)	0.479
Perforation	1 (1.7%)	1 (2.4%)	0 (0.0%)	1.000
Dysphagia	0 (0.0%)	0 (0.0%)	0 (0.0%)	---
DVT/PE	0 (0.0%)	0 (0.0%)	0 (0.0%)	---
Myocardial infarction	0 (0.0%)	0 (0.0%)	0 (0.0%)	---
Other complications	16 (27.6%)	11 (26.2%)	5 (31.3%)	0.700
ICU admission	10 (17.2%)	5 (11.9%)	5 (31.3%)	0.119
ICU days	3.5 (1.75-5.5)	5.0 (2.5-8.5)	2.0 (1-2)	0.095
Mechanical ventilation	4 (6.9%)	1 (2.4%)	3 (18.8%)	0.060
Ventilator days	2.5 (1.0-4.0)	4.0	1.0	0.423
Hospital LOS	3 (2-4)	2.5 (1-4)	3 (2-5.75)	0.301
30-day readmission	7 (12.1%)	6 (14.3%)	1 (6.3%)	0.660
Mortality	0 (0.0%)	0 (0.0%)	0 (0.0%)	---
Discharged to hospice	1.7% (1)	1 (2.4%)	0 (0.0%)	1.000

*Presented as number (%) or median (IQR).
DVT = deep vein thrombosis, PE = pulmonary embolus, ICU = intensive care unit, LOS = length of stay.

DISCUSSION

GERD and hiatal hernias are a common complaint among many patients, and anti-reflux surgery has been reported to have a satisfactory outcome in 85-96% of patients with these conditions.[1] While a conventional laparoscopic approach is more common, robotic surgery is becoming common place in many general surgeons' practices. There were several studies that have compared robotic-assisted and conventional laparoscopic hiatal hernia repairs, with three studies demonstrating decreased hospital LOS and a decrease in the number of post-operative events,[1,5,6] whereas one study demonstrated increased hospital LOS and the number of post-operative complications in the robotic-assisted group.[3] This study aimed to add to the existing literature on comparing the outcomes of robotic-assisted and conventional laparoscopic hiatal hernia repair.

Hospital Length of Stay. The median hospital LOS for conventional laparoscopic hiatal hernia repair was 2.5 days and for robotic-assisted was 3.0 days (p = 0.301). Our data suggested that there was no statistically significant difference or trend in hospital LOS between the two groups. The study by Soliman et al.[5] showed a statistically significant reduction in hospital LOS when comparing conventional laparoscopic and robotic-assisted hiatal hernia repair (1.8 vs. 1.3 days; p = 0.003). Their study had a larger sample size (laparoscopic, n = 151; robotic-assisted, n = 142) compared to the study presented in this paper. The increased power of their study likely explained the statistically significant results. The single-center study by Vasudevan et al.[4] demonstrated a mean hospital LOS of 2.8 days (n = 29) for robotic-assisted hiatal hernia repair. Our study demonstrated similar median LOS of 3.0 days for the robotic-assisted group. The study by Tolboom et al.[1] demonstrated a significant reduction in hospital LOS for robotic-assisted redo hiatal hernia repair compared to laparoscopic redo hiatal hernia repair (three vs. four days; p = 0.042). Also, the retrospective observational cohort study performed by O'Connor et al.[6] showed a statistically significant decrease in hospital LOS favoring the robotic-assisted approach (3.3 vs. 2.3 days; p = 0.003). Ward et al.[3] demonstrated a longer hospital LOS in the robotic-assisted group, although this was not statistically significant.

While our study did not specifically divide first-time and redo hiatal hernia repairs, the results showed similar robotic-assisted hospital LOS of three days as the Vasudevan et al.[4] and Tolboom et al.[1] studies. Overall, the literature on robotic-assisted compared to conventional laparoscopic hiatal hernia repair was limited, with most studies showing statistically significant decreases in hospital LOS, favoring robotic-assisted over laparoscopic hiatal hernia repair. Our study did not demonstrate a statistically significant difference in hospital LOS between the two groups, however, the median hospital LOS for our robotic-assisted group was three days, which is very similar to other studies in the literature.

Complications. Post-operative complications were the other main outcome of interest in this study. Pneumothorax was the most common complication observed in our study. In our study, five patients in the conventional laparoscopic group and one patient in the robotic group had a pneumothorax (11.9% and 6.3%, respectively). Tolboom et al.[1] had two patients (4.4%) in the robotic group who had a pleural defect during surgery, one of which required a chest tube, while the conventional laparoscopic group had no patients with a pleural defect.

Our study had one patient (2.4%) in the conventional laparoscopic group with a perforation while the robotic group had no patients with a perforation. Tolboom et al.[1] had three patients (6.7%) in the robotic group and four patients (13.3%) in the conventional laparoscopic group having either an esophageal or gastric perforation; these were noted to be repaired and managed laparoscopically. Ward et al.[3] demonstrated a statistically significant difference in the number of esophageal perforations, favoring the conventional laparoscopic group over robotic-assisted (457 [0.3%] vs. 64 [0.6%]; p = 0.01).

Our rates of bleeding as a complication compared favorably to that reported in the literature with one patient in both the conventional laparoscopic and robotic groups (2.4% and 6.3%, respectively; p = 0.479). Soliman et al.[5] had three patients (2.0%) in the laparoscopic

group and two patients (1.4%) in the robotic group that had a need for post-operative transfusion of packed red blood cells. Tolboom et al.[1] had two patients (4.4%) in the robotic group that had bleeding as a minor complication that was able to be controlled during surgery; they had no patients in the laparoscopic group with a bleeding complication. As with our study, Ward et al.[3] demonstrated no difference in rates of post-operative bleeding between the two groups (2.5% conventional laparoscopic vs. 2.8% robotic-assisted; p = 0.39).

Two patients (4.8%) in the laparoscopic group and no patients in the robotic group had an infection as a complication in our study. In Soliman et al.[5], five patients (3.3%) in the laparoscopic group and two patients (1.4%) in the robotic group had an infection, either a urinary tract infection, surgical site infection, or other infection requiring intravenous antibiotics, as a post-operative complication. Ward et al.[3] showed a trend for the robotic-assisted group to have a higher rate of post-operative infections (1.5% vs. 1.1%; p = 0.08).

In our study, no patients in either the laparoscopic or robotic-assisted groups had dysphagia as a post-operative complication. In the literature, the rate of dysphagia as a complication was also low. Vasudevan et al.[4] found 1 patient out of 28 redo robotic-assisted hiatal hernia repairs (3.6%) had post-operative dysphagia. Tolboom et al.[1] found 2 patients out of 30 (6.7%) in the conventional laparoscopic group and 5 patients out of 45 (11.1%) in the robotic-assisted group had dysphagia as a post-operative complication.

Intensive Care Unit Utilization. This study demonstrated a trend for conventional laparoscopic hiatal hernia repair to have a higher number of ICU days (five vs. two days; p = 0.095); although the proportion of ICU admissions trended to be higher for the robotic-assisted group (31.3% vs. 11.9%; p = 0.119). In contrast, Soliman et al.[5] showed a trend for laparoscopic hiatal hernia repair patients to have higher initial ICU admissions compared to robotic-assisted repair patients (7/151 = 4.6% vs. 2/142 = 1.4%; p = 0.17). However, both our findings and that of Soliman et al.[5] were nonsignificant trends. Ward et al.[3] demonstrated a statistically significant difference in the number of post-operative respiratory failure events, favoring the conventional laparoscopic group (1.6% vs. 2.4%; p = 0.003). However, this study did not define what the post-operative complication of respiratory failure included (e.g., home oxygen, ICU admission, mechanical ventilation).

Mortality. Similar to the studies by Tolboom et al.[1] and Soliman et al.[5], there were no deaths in hiatal hernia repair patients in either the laparoscopic or robotic groups. Vasudevan et al.[4] had one reported death in the immediate post-operative period out of 28 patients undergoing robotic-assisted hiatal hernia repair. The retrospective study by Ward et al.[3] demonstrated a trend for the robotic-assisted group to have a higher rate of mortality (0.4% vs. 0.3%; p = 0.08). Overall, the complication rates for both conventional laparoscopic and robotic-assisted hiatal hernia repair in the literature are very low, which was similar to the findings in our study.

Limitations. There were several limitations to this study. This study was performed at a single tertiary-care, Midwestern hospital over a three year time period, from January 2014 to December 2016, with a limited sample size. While robotic surgery was becoming more popular during this time, the application of robotic surgery has increased drastically since this time. Increasing the time frame for data collection to include more recent years would increase the sample size and power of this study. Also, adding additional institutions to the study would increase sample size and power. Another limitation encountered during data collection was that the single institution reviewed in this study had switched electronic medical records during the year 2014. This caused some of the patient data in the early parts of 2014 to be lost/missing during the conversion, and these patients had to be excluded from the study as details surrounding the operations and post-operative courses were unable to be located.

Another limitation of this study was that it did not differentiate elective, urgent, or emergent hiatal hernia repairs. During data collection, there was a trend for more of the urgent/emergent procedures to undergo open repair from the start of the operation, which excluded these from this study. There also seemed to be a trend that laparoscopic hiatal hernia repair was more common in urgent repairs for gastric volvulus, which likely contributed to the trend for the conventional laparoscopic group to have a higher number of ICU days (5.4 vs. 2.4 days; p = 0.095). Limiting the data collection to elective hiatal hernia repairs for GERD (done on day of admission and excluding repairs done for gastric volvulus) likely would make the two groups more equal and standardized.

CONCLUSIONS

Robotic-assisted versus conventional laparoscopic hiatal hernia were compared, which demonstrated comparable post-operative complication rates and hospital LOS. The results showed robotic-assisted or conventional laparoscopic hiatal hernia repair can be performed safely with similar outcomes. Further study is needed to illicit any statistically significant differences between the two groups.

REFERENCES

[1] Tolboom RC, Draaisma WA, Broeders IA. Evaluation of conventional laparoscopic versus robotic-assisted laparoscopic redo hiatal hernia and antireflux surgery: A cohort study. J Robot Surg 2016; 10(1):33-39. PMID: 25997926.
[2] Köckerling F, Trommer Y, Zarras K, et al. What are the differences in the outcome of laparoscopic axial (I) versus paraesophageal (II-IV) hiatal hernia repair? Surg Endosc 2017; 31(12):5327-5341. PMID: 28597286.
[3] Ward MA, Hasan SS, Sanchez CE, Whitfield EP, Ogola GO, Leeds SG. Complications following robotic hiatal hernia repair are higher compared to laparoscopy. J Gastrointest Surg 2021; 25(12):3049-3055. PMID: 33852128.
[4] Vasudevan V, Reusche R, Nelson E, Kaza S. Robotic paraesophageal hernia repair: A single-center experience and systematic review. J Robot Surg 2018; 12(1):81-86. PMID: 28374223.
[5] Soliman BG, Nguyen DT, Chan EY, et al. Robotic-assisted hiatal hernia repair demonstrates favorable short-term outcomes compared to laparoscopic hiatal hernia repair. Surg Endosc 2020; 34(6):2495-2502. PMID: 31385076.
[6] O'Connor SC, Mallard M, Desai SS, et al. Robotic versus laparoscopic approach to hiatal hernia repair: Results after 7 years of robotic experience. Am Surg 2020; 86(9):1083-1087. PMID: 32809844.

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