Original Article

Short term safety and efficacy of robot-assisted laparoscopic redo hiatal hernia repair without mesh: a retrospective cohort study

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Background: Recurrent hiatal hernia remains a challenging clinical problem. Failure rates after primary repair can be as high as 59%. Symptomatic patients often require reoperation. Although minimally invasive laparoscopic surgery is the standard approach, the reported outcomes of robot-assisted redo hiatal hernia repair performed without mesh reinforcement remains limited. This study reports the safety and efficacy of robot-assisted laparoscopic redo repair without mesh.

Methods: We conducted a retrospective cohort study of consecutive adult patients who underwent elective robot-assisted laparoscopic redo hiatal hernia repair across a multicentered health system from April 2016 to March 2025. Baseline demographics, comorbidities, preoperative testing, operative findings, repair technique, postoperative complications, and follow-up outcomes were collected through chart review. Primary efficacy outcomes were radiographic and symptomatic recurrences. Statistical analyses were conducted using Chi-squared for categorical variables and *t*-test for continuous variables.

Results: Fifty-two patients were included in the final analysis. Mean age was 63±9.7 years, 60% were women, and the mean body mass index (BMI) was 30±5 kg/m^2 at the time of reoperation. Most common preoperative symptoms were reflux (83%) and dysphagia (46%). The most common intraoperative finding was crural repair breakdown (73%). All procedures were completed robotically without mesh and without any conversions or intraoperative complications. The mean operative time was 224±55.1 min. The median length of stay was 2 days with interquartile range of 1 day. At a mean follow-up of 29.3±20.8 months, 88% reported improvement of symptoms, 13% completely discontinued antacid therapy, radiographic or endoscopic recurrence was observed in 38% and symptomatic recurrence in 27% with average time of discovery at 17.3±12.3 months. Only 4% required additional reoperation.

Conclusions: Robot-assisted laparoscopic redo hiatal hernia repair without mesh is safe and demonstrates favorable short-term outcomes. Further comparative prospective studies are needed to clarify long term durability relative to conventional laparoscopy and mesh usage.

Keywords: Robot-assisted; hiatal hernia repair; redo repair; without mesh; patient outcomes

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Introduction

Hiatal hernia is estimated to afflict 9.9% to 26% of adults in the United States (U.S.) population, with incidence increasing with age (1-3). Laparoscopic hiatal hernia repair is the standard of care for medically refractory gastroesophageal reflux disease (GERD) associated with symptomatic sliding and paraesophageal hernias (4). However, recurrence rates after primary repair can be as high as 59% (5). More recent conservative estimates report radiographic recurrence rates of 25.5% to 27% at 1 year, and 33.9% at 3 years, with 16% of patients becoming symptomatic (6-9). These findings appear independent of mesh use (8,9). Reoperation is indicated for patients with persistent or refractory symptoms. U.S. data showed a 5.2% reoperation rate at 5 years and 6.9% at 10 years following initial repair, consistent with European reports of a 7.49% reoperation rate at 10 years (10,11).

As the volume of initial hiatal hernia repair continues to rise, the number of candidates for redo surgery grows larger (10,12). While redo laparoscopic hiatal hernia repair is generally safe and achieves similar postoperative outcomes to primary repair, it is technically more challenging and associated with higher complication rates (13-19). In a systemic review, van Beek *et al.* reported gastrointestinal perforations in 14%, hemorrhages in 1.4%, and conversions to open laparotomy in 7.4% of cases (17). These risks are largely attributable to dense adhesions, disrupted tissue planes, and the complexity of revising prior fundoplications (17,20).

Highlight box

Key findings

- There were no intraoperative complications or conversions following robot-assisted redo repairs without mesh.
- Rate of recurrence for hiatal hernia repairs without mesh is low at short-term follow-up.
- Most recurrences can be managed medically without reoperation.

What is known and what is new?

- Among primary repairs, robot-assisted hiatal hernia repairs may yield similar outcomes to conventional laparoscopy, but data on redo repairs is limited and the use of mesh is debated.
- Robot-assisted redo hiatal hernia repairs without mesh are safe in the redo setting in high volume centers, and recurrence rate is low.

What is the implication, and what should change now?

- This supports the use of robotic surgery in large redo hiatal hernia repairs.
- Mesh use in redo repairs is not necessary for favorable outcomes.

Robot-assisted laparoscopic surgery has gained popularity in complex abdominal and thoracic procedures (21,22). While its safety and outcomes in primary hiatal hernia repair have been established as comparable to conventional laparoscopy, limited data exist regarding its application in redo hiatal hernia repairs performed without mesh (23,24). This study aims to evaluate the safety and outcomes of robot-assisted laparoscopic redo hiatal hernia repairs without mesh, with particular focus on recurrence rates and symptomatic outcomes. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-2025-1206/rc).

Methods

We conducted a retrospective cohort study across a multicentered health system. The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The study was approved by the Institutional Review Board of Northwell Health (No. 22-0911). The Northwell Health system oversees all the participating medical centers. Individual consent for this retrospective analysis was waived. Consecutive adult patients who underwent elective robot-assisted laparoscopic hiatal hernia repair by the thoracic surgery service between April 2016 and March 2025 were identified through institutional procedure logs. We included all patients who underwent robot-assisted redo hiatal hernia repairs with history of hiatal hernia repairs, and excluded patients with prior esophagectomy, gastrectomy, intraoperative findings of an intact hiatus not requiring revision, hiatal hernia requiring transthoracic approach.

Patient demographic and clinical baseline factors were collected, which included age, sex, body mass index (BMI), comorbidities, preoperative symptoms, prior mesh use, preoperative imaging and physiologic testing including esophageal motility. Procedure safety was evaluated by the occurrence of intraoperative complications, postoperative morbidity, or mortality. Postoperative imaging performed within the health system was reviewed regardless of clinical symptoms. Efficacy was assessed based on whether there was development of radiographic or symptomatic recurrence during follow-up. Radiographic recurrence was defined as any evidence of herniation above the diaphragm on computed tomography (CT), esophagram, or endoscopy. Symptomatic recurrence was defined as radiographic recurrence accompanied by clinical symptoms such as

Table 1 Patient demographics

Patient demographics	Values
Total subject	52
Age (years)	63±9.7
Female	31 [60]
Weight at reoperation (kg)	80±13.6
BMI at reoperation (kg/m^2)	30±5
Hypertension	29 [56]
Hyperlipidemia	25 [48]
Diabetes mellitus	5 [10]
Coronary artery disease	7 [13]
Heart failure	1 [2]
Atrial fibrillation	3 [6]
History of cancer	11 [21]
COPD	3 [6]
No smoking history	34 [65]
Quit smoking greater than 2 months ago	15 [29]
Current smoker	3 [6]
History of abdominal surgery prior to primary repair	22 [42]
History of thoracic surgery prior to primary repair	4 [8]
Proton pump inhibitor use prior to reoperation	40 [77]
H2 blocker use prior to reoperation	14 [27]
Antacid medication prior to reoperation	41 [79]
Steroid use prior to primary repair	2 [4]
Chemotherapy active prior to primary repair	1 [2]

Data are presented as n, mean ± standard deviation or n [%]. BMI, body mass index; COPD, chronic obstructive pulmonary disease.

reflux, dysphagia, or chest discomfort. If patients reported any dysphagia or reflux, repeat barium swallow or upper endoscopy were used to assess for stricture or recurrences.

Technique

All procedures were performed using the Da Vinci Xi robotic system (Intuitive Surgical©, Sunnyvale, CA, USA). The key operative steps included adhesiolysis, resection of residual hernia sac, mobilization of the stomach and esophagus to the inferior pulmonary veins to achieve at least 3 cm of tension-free intra-abdominal esophagus. Occasionally, collis gastroplasty was employed to "lengthen" the esophagus if it is foreshortened. The crural defect was repaired using permanent 0-V-loc™ barbed sutures (Medtronic, North Haven, CT, USA) with silk anchoring stitch. No synthetic or biologic mesh was used. The fundoplication wrap was assessed intraoperatively and either revised or left intact based on surgeon's discretion. Operative time was recorded from skin incision to sterile field undraping. All patients underwent a barium esophagram on postoperative day one prior to discharge. Diet was advanced to clear liquid and slowly titrated up to full liquid then pureed. Patients were then seen in the office in 2 weeks with a chest X-ray to assess wound healing as well as symptoms of dysphasia and reflux. Their next follow-up typically occurred 6 months later and then annually on an as needed basis. The total length of follow-up was determined by the date of the last recorded office visit or telephone/virtual visit.

Statistical analysis

Data were summarized using frequencies and percentages for categorical variables. Continuous variables were reported as averages with standard deviations, apart from length of stay, which was reported as a median with an interquartile range. Continuous variables were analyzed with *t*-tests, and categorical variables with Chi-squared tests. A P value <0.05 was considered significant. Statistical analysis was performed using RStudio© (2020 PBC, Boston, MA, USA).

Results

A cohort of 64 patients underwent robot-assisted redo hiatal hernia repair. Of these, 12 patients were excluded for the following reasons: prior esophagectomy (n=4), prior sleeve gastrectomy (n=1), prior Roux-en-Y gastric bypass (n=1), definitive hiatal hernia repair following emergent hernia reduction (n=1), inability to achieve adequate esophageal length requiring transthoracic repair (n=1), and fundoplication revisions without hernia recurrence performed for intractable dysphagia without reflux (n=4). The final analysis included 52 patients.

Patient demographics and history are summarized in *Table 1*. The mean age at reoperation was 63±9.7 years, and 60% of patients (n=31) were female. The mean BMI at reoperation was 30±5 kg/m^2. Preoperative antacid use was reported in 79% of patients. The most common presenting symptoms were gastroesophageal reflux (83%)

Table 2 Preoperative symptoms

Preoperative symptoms	Values
Reflux	43 [83]
Nausea	12 [23]
Vomiting	11 [21]
Abdominal pain	18 [35]
Early satiety	7 [13]
Dysphagia	24 [46]
Dyspnea/cough	8 [15]
Bloating	7 [13]
Obstipation	1 [2]

Data are presented as n [%].

Table 3 Preoperative EGD findings

Preoperative EGD findings	Values
Esophagitis	22 [42]
Barret's esophagus	12 [23]

Data are presented as n [%]. EGD, esophagogastroduodenoscopy.

Table 4 Preoperative work up

Preoperative work up	Values
CT scan	45 [87]
Esophagram	42 [81]
EGD	41 [79]
Manometry	35 [67]
Dysmotility	12 [23]
pH test	16 [31]

Data are presented as n [%]. CT, computed tomography; EGD, esophagogastroduodenoscopy.

and dysphagia (46%) (*Table 2*). Esophagitis was identified in 42% of patients (n=22), 55% of whom had Barrett's esophagus (*Table 3*).

Hiatal hernia was diagnosed using a combination of preoperative imaging and diagnostic procedures, including CT scan (87%), barium esophagram (81%), upper endoscopy (79%), esophageal manometry (67%), and Bravo pH testing (31%) (*Table 4*). All patients who underwent upper endoscopy had confirmation of a hiatal hernia. In two cases, CT scan was negative; diagnosis was established by positive findings on either esophagram or upper endoscopy. Among patients who underwent manometry, esophageal dysmotility was identified in 23% (*Table 4*).

Table 5 Operative data

Operative data	Values
Total procedure time (min)	224±55.1
Wrap type (kept previous wrap)	14 [27]
Wrap type (Nissen)	9 [17]
Wrap type (Toupet)	28 [54]
Wrap type (Dor)	1 [2]
EBL (mL)	20±29.4
V-loc suture use	49 [94]
Mesh use	0 [0]
Gastropexy	6 [12]
Collis gastropexy	2 [4]
Elective procedure	51 [98]
Conversion to open	0 [0]
Intraoperative complication (bowel/stomach injury)	0 [0]
Intraoperative finding (cura opened/broken crural stitch)	38 [73]
Intraoperative finding (slipped wrap)	4 [8]
Intraoperative finding (incompetent wrap)	2 [4]
Intraoperative finding (crural dehiscence and slipped wrap)	7 [13]
Intraoperative finding (unspecified/other reason for reherniation)	1 [2]

Data are presented as mean ± standard deviation or n [%]. EBL, estimated blood loss.

Operative data and intraoperative findings are summarized in *Table 5*. The mean operative time was 224±55.1 min. The most common intraoperative findings included failure of the prior crural repair with re-herniation through the thoracic hiatus (73%), slipped fundoplication (8%), incompetent fundoplication (4%), crural dehiscence and slipped wrap (13%), and one case (2%) without reported findings. Wrap revision was performed in 73% of patients, predominantly with Toupet fundoplication (54%) or Nissen (17%) fundoplication. No mesh was utilized. There were no intraoperative complications or any conversions to open surgery. During the postoperative hospitalization, three patients required reoperation: one

Table 6 Postoperative data

Postoperative data	Values
Length of hospital stay (days)	2; 1
Postoperative complication (return to OR within same admission)	3 [6]

Data are presented as median; interquartile range or n [%]. OR, operating room.

Table 7 Clinic follow-up data

Clinic follow-up data	Values
Initial symptomatic improvement	46 [88]
Complete resolution of symptoms	18 [35]
Post-reoperation failed repair requiring another surgery	2 [4]
Post-reoperation EGD (dilation)	11 [21]
Liberation from PPI/H2 at most recent office visit	7 [13]
Time between primary and reoperation (years)	6.7±9.3
Length of follow-up after reoperation (months)	29.3±20.8
Residual reflux symptoms	22 [42]
Follow-up imaging (esophagram, CT scan, endoscopy)	43 [83]
Time to radiographic/endoscopic discovery of recurrence	17.3±12.3
Recurrence (radiographic/endoscopic)	20 [38]
Persistent symptoms	22 [42]
Recurrence of symptoms with radiographic confirmation	14 [27]
Interval to recurrence (months)	17.3±12.3

Data are presented as n [%] or mean ± standard deviation. CT, computed tomography; EGD, esophagogastroduodenoscopy; PPI, protonix.

for bleeding related to left chest pigtail catheter placement for postoperative pneumothorax, one for hemoperitoneum due to a bleeding short gastric artery, and one for acute re-herniation of the fundoplication secondary to suture failure (*Table 6*). All patients were stabilized and subsequently discharged home. The median length of stay was 2 days (interquartile range, 1 day) (*Table 6*).

Clinical follow-up data and recurrence rates are summarized in *Table* 7. At follow-up, 88% of patients reported symptomatic improvement, with 35% experienced achieving complete resolution of symptoms. Additionally, 13% were able to discontinue antiacid therapy. Post-discharge surveillance with imaging or endoscopy was performed in 83% of patients. The radiographic recurrence rate was 38%, with an average time to detection at 17.3±12.3 months. Symptomatic recurrence, defined as new or persistent symptoms in conjunction with radiographic or endoscopic evidence of hiatal hernia, was observed in 27% of patients; 4% (n=2) required additional anti-reflux procedures. The mean duration of follow-up, either in person or via virtual visit was 29.3±20.8 months.

Chi-squared analysis revealed a significant association between symptomatic recurrence and antacid use at follow-up (P=0.04). Additionally, mesh usage during the initial surgery was significantly associated with postoperative chief complaints of nausea and vomiting, as well as the need for endoscopic dilations (P=0.02, 0.03, and <0.01, respectively). Interestingly, a *t*-test comparing patient age between those with and without recurrent hiatal hernia after reoperation showed a trend toward younger patients experiencing more symptomatic recurrences (mean age 59 *vs.* 65 years), though this did not reach statistical significance (P=0.07). There was a significant association between recurrence and the interval between the primary operation and reoperation, with a shorter mean interval observed in the recurrence group (3.7 years) compared to the non-recurrence group (7.8 years; P=0.04). Furthermore, longer follow-up duration was associated with a higher likelihood of symptomatic recurrence (27.8 *vs.* 14.0 months; P=0.001). BMI was not significantly associated with any recurrence.

Discussion

The use of robot-assisted laparoscopic hiatal hernia repair has increased substantially in recent years (25,26). While its advantages over standard laparoscopy in primary repair remain debated, emerging data suggest potential benefits in the redo setting (20,22,23,25,27-34). A systematic review by Tolboom *et al.* demonstrated significantly lower conversion-to-open rate (2.22% *vs.* 16.6%) and shorter hospital stays with robot-assisted laparoscopic redo repairs compared to standard laparoscopy (20,35). Similar findings were reported by Merten *et al.*, who observed a conversion-to-open rate of 2% and a single intraoperative gastric perforation among 151 patients undergoing robotic redo repair (33). O'Connor *et al.* also reported lower 1-year recurrence rate with robotic repair with variable use of mesh compared to standard

laparoscopy (36). Differences in complication rate between the two approaches were not significant across studies, though lower rates of major complications following robotic approach (2.6%) than standard laparoscopy (5.2%) has been observed (33). Our findings add to existing evidence reporting no conversion to open surgery, hemorrhages, or visceral injuries, underscoring the safety of robotic redo hiatal hernia repair in a high-volume center.

Redo hiatal hernia repairs are associated with higher recurrence rates than primary repairs (18,37,38). Wennergren *et al.* reported recurrence rates of 4% after primary repair (median follow-up of 120 days) and 12% after redo repairs with a median follow-up 269 days, despite mesh placement in all their redo cases (39). Awais *et al.* found that 11.2% of patients undergoing redo repair required an additional surgery after a median of 39.6 months (40). The role of mesh in reducing recurrence remains controversial. Some meta-analyses and systematic review studies suggest improved outcomes with mesh reinforcement, while others found no significant differences in early or late recurrence rates between mesh and suture-only repairs (5,41-46). A Swedish prospective study showed a nonsignificant improvement at 1 year and equal outcomes at 3 years with nonabsorbable mesh compared to suture repair (47). Watson *et al.* reported no difference between suture, permanent mesh, or absorbable mesh in a randomized controlled trial for very large hiatal hernia repairs at 1 year (48). Similarly, Koetje *et al.* reported comparable outcomes between suture repair and permanent mesh repairs (45). The lack of consistent evidence supporting mesh use suggests that factors beyond reinforcement material may play a larger role in repair durability.

In our practice, mesh is not used for crural reinforcement due to the absence of compelling data supporting its benefits and concerns regarding mesh-related complications (37,38,44,49). Nonabsorbable mesh placement is associated with an increase rate of dysphagia in initial repairs (44,47). In our study, prior mesh placement had a nonsignificant association with an increased complaint of dysphagia at reoperation [relative risk (RR) =1.343; 95% confidence interval (CI): 0.614–2.94; P=0.05].

In our cohort, 88% of patients experienced initial symptomatic improvement after surgery, with a mean follow-up of 29.3±20.8 months. The majority (83%) underwent postoperative imaging for various indications, including persistent reflex symptoms, monitoring progression of esophagitis, or unrelated medical reasons. Among these patients, radiographic recurrence was observed in 38%, consistent with findings by Jog *et al.*, who reported a 54.9% radiographic recurrence rate in patients undergoing primary repair with variable use of mesh at mean follow-up of 10.4±13.6 months (50). We observed a shorter interval period between primary repair and redo operation in patients who developed symptomatic recurrence than patients who did not have any recurrence. The symptomatic recurrence rate in our cohort was 27%, with an average time of detection of 17.3±12.3 months. Only 2 patients (4%) required further anti-reflux surgery, comparable to reported outcomes following primary repair (50,51). One patient experienced transdiaphragmatic herniation of the fundoplication wrap identified on endoscopy 14 months postoperatively, and one patient developed acute re-herniation found on postoperative esophagram, due to suture failure. Medium term data from Siemssen *et al.* reported a 23% failure rate and 9% reoperation rate following laparoscopic redo hiatal hernia repair at 4.7 years of follow-up (52).

Our study has several limitations. It is retrospective in design and contained a relatively small sample size, limiting causality and generalizability. A lack of direct comparison to standard laparoscopy or mesh usage makes robot superiority speculative. Additionally, our study did not define a minimum size threshold for radiographic recurrence, relying instead on radiologist interpretation. This may have led to an overestimation of recurrence rates, as some authors define recurrent hernias as >2 cm of intrathoracic stomach (53). Finally, our surgical technique during the study period changed to an increasing preference for Toupet over Nissen fundoplication. However, we believe that our data supports the safety profile of robot-assisted laparoscopic surgery and the meshless technique in redo crural repairs. Future studies should further investigate not only the safety but also the potential superiority of robotic surgery in improving patient outcomes.

Conclusions

Robot-assisted laparoscopic redo hiatal hernia repair without mesh is safe and yields favorable short-term outcomes. Our results support the growing body of evidence endorsing robotic technology as a valuable tool in complex abdominal surgery.

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None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-2025-1206/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The study was approved by the Institutional Review Board of Northwell Health (No. 22-0911). The Northwell Health system oversees all the participating medical centers. Individual consent for this retrospective analysis was waived.

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