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Patient-Reported Outcomes of Robotic vs Laparoscopic Ventral Hernia Repair With Intraperitoneal Mesh
The PROVE-IT Randomized Clinical Trial

Clayton C. Petro, MD; Sam Zolin, MD; David Krpata, MD; Hemasat Alkhatib, MD; Chao Tu, MS; Michael J. Rosen, MD; Ajita S. Prabhu, MD

IMPORTANCE Despite rapid adoption of the robotic platform for ventral hernia repair with intraperitoneal mesh in the United States, there is no level I evidence comparing it with the traditional laparoscopic approach. This randomized clinical trial sought to demonstrate a clinical benefit to the robotic approach.

OBJECTIVE To determine whether robotic approach to ventral hernia repair with intraperitoneal mesh would result in less postoperative pain.

DESIGN, SETTING, AND PARTICIPANTS A registry-based, single-blinded, prospective randomized clinical trial at the Cleveland Clinic Center for Abdominal Core Health, Cleveland, Ohio, completed between September 2017 and January 2020, with a minimum follow-up duration of 30 days. Two surgeons at 1 academic tertiary care hospital. Patients with primary or incisional midline ventral hernias of an anticipated width of 7 cm or less presenting in the elective setting and able to tolerate a minimally invasive repair.

INTERVENTIONS Patients were randomized to a standardized laparoscopic or robotic ventral hernia repair with fascial closure and intraperitoneal mesh.

MAIN OUTCOMES AND MEASURES The trial was powered to detect a 30% difference in the Numerical Rating Scale (NRS-11) on the first postoperative day. Secondary end points included the Patient-Reported Outcomes Measurement Information System Pain Intensity short form (3a), hernia-specific quality of life, operative time, wound morbidity, recurrence, length of stay, and cost.

RESULTS Seventy-five patients completed their minimally invasive hernia repair: 36 laparoscopic and 39 robotic. Baseline demographics and hernia characteristics were comparable. Robotic operations had a longer median operative time (146 vs 94 minutes; $P < .001$). There were 2 visceral injuries in each cohort but no full-thickness enterotomies or unplanned reoperations. There were no significant differences in NRS-11 scores preoperatively or on postoperative days 0, 1, 7, or 30. Specifically, median NRS-11 scores on the first postoperative day were the same (5 vs 5; $P = .61$). Likewise, postoperative Patient-Reported Outcomes Measurement Information System 3a and hernia-specific quality-of-life scores, as well as length of stay and complication rates, were similar. The robotic platform adds cost (total cost ratio, 1.13 vs 0.97; $P = .03$), driven by the cost of additional operating room time (1.25 vs 0.85; $P < .001$).

CONCLUSIONS AND RELEVANCE Laparoscopic and robotic ventral hernia repair with intraperitoneal mesh have comparable outcomes. The increased operative time and proportional cost of the robotic approach are not offset by a measurable clinical benefit.

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Invited Commentary
Author Audio Interview
Supplemental content

Author Affiliations: Cleveland Clinic Center for Abdominal Core Health, Digestive Diseases and Surgery Institute, The Cleveland Clinic Foundation, Cleveland Clinic, Cleveland, Ohio (Petro, Zolin, Krpata, Alkhatib, Rosen, Prabhu); Lerner Research Institute, Department of Quantitative Health Sciences, The Cleveland Clinic Foundation, Cleveland, Ohio (Tu).

Corresponding Author: Clayton C. Petro, MD, Cleveland Clinic Center for Abdominal Core Health, Digestive Disease and Surgery Institute, The Cleveland Clinic Foundation, 9500 Euclid Ave, A-100, Cleveland, OH 44195 (petroc@ccf.org).

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The robotic platform has been rapidly adopted in the realm of general surgery, with little high-level evidence to support its use.[1-3] Ventral hernia repair in particular is a popular application for robotic implementation, with several large retrospective series demonstrating appealing clinical benefits.[4-6] While prospective trials are lacking, retrospective data on robotic hernia repair with intraperitoneal mesh have demonstrated a reduction in length of stay (LOS) and postoperative morbidity compared with the traditional laparoscopic approach originally described by LeBlanc and Booth.[7-9] When compared with open mesh repair, randomized controlled data have shown the laparoscopic alternative does provide decreased wound morbidity and shorter hospital LOS.[10-15] However, laparoscopic intraperitoneal mesh placement is notoriously painful in the early postoperative period, and rates of chronic pain, bulging, and patient dissatisfaction as high as 25% are significant.[16-18] Introduction of the robotic platform allows for several potential advantages vs the traditional laparoscopic approach when repairing a ventral hernia with intraperitoneal mesh[19]:

- Intracorporeal suturing allows for closure of the fascial defect with a running self-locking suture, a practice associated with improved quality of life (QoL) and reduced recurrence for laparoscopic closures with the shoelacing technique.[20,21]
- Peritoneal mesh fixation with a running stitch as opposed to tacks and transfascial sutures often implicated as a source of postoperative pain following laparoscopic repairs.[17,22]

Here, we hypothesized that the robotic approach to ventral hernia repair with intraperitoneal mesh would provide a measurable clinical benefit in regards to early postoperative pain compared with the traditional laparoscopic approach. To our knowledge, this is the first prospective randomized clinical trial that sought to answer this question.

Key Points

Question Does robotic ventral hernia repair with intraperitoneal mesh offer a clinical benefit compared with the traditional laparoscopic approach?

Findings In this single-blinded, randomized clinical trial of 75 patients, no significant difference in pain, complications, quality of life, and hospital length of stay was found. The 52-minute increase in median operative time of the robotic approach incurring additional cost is not countered by a measurable benefit.

Meaning There is no apparent clinical benefit to the robotic approach when compared with the traditional laparoscopic ventral hernia repair with intraperitoneal mesh.

Methods

Design, Eligibility, and Randomization

This registry-based, prospective, single-blinded RCT enrolled patients between September 2017 and January 2020 at the Cleveland Clinic Center for Abdominal Core Health in Cleveland, Ohio. The Cleveland Clinic's institutional review board approved the trial protocol, and all participants provided written consent. Eligible participants were aged 18 years or older, presenting in the elective setting with primary or incisional midline ventral hernias of an anticipated width of 7 cm or less who were candidates for minimally invasive hernia repair. The formal trial protocols can be found in Supplement 1.

Recruitment was performed by surgeons (A.P. and C.P.) who screened for eligibility. Both surgeons completed fellowships that included training in advanced laparoscopy and complex abdominal wall reconstruction. Both surgeons also had robotic training and credentialing that was in line with requirements defined by Intuitive Surgical and our department of General Surgery. A concealed randomization scheme was performed by using a random number of blocks with a 1:1 ratio of assigning patients to each arm. Data managers randomized patients to the robotic or laparoscopic approach before scheduling their operation to confirm the availability of the robotic platform if needed. Patients were blinded to the operative approach throughout the study. Patient demographics, hernia characteristics, and operative details were recorded in the Americas Hernia Society Quality Collaborative (AHSQC) Database. Additional patient-reported outcomes were stored in a separate database (Research Electronic Data Capture; Vanderbilt University).

Operative Details

All operations began by achieving laparoscopic access using a technique according to each surgeon's discretion. If used, a cutdown incision onto the hernia could not be greater than what would be necessary for a traditional Hassan technique. After achieving safe intraperitoneal access, additional 5-mm/12-mm laparoscopic or 8-mm robotic ports would be placed to sufficiently allow for safe reduction of the hernia contents, 5 cm of circumferential adhesiolysis around the defect, and mesh placement. At the discretion of the surgeon, those randomized to the robotic technique could have their adhesiolysis performed with the robot or laparoscopically. After intracorporeal measurement of the defect, patients undergoing the robotic technique (DaVinci Si or Xi; Intuitive Inc) underwent defect closure with a running 0 permanent monofilament self-locking suture (V-loc; Medtronic). Barrier-coated monofilament polypropylene (Parietene DS; Medtronic or Ventralight ST; Bard) was then secured circumferentially with 3-0 monofilament absorbable self-locking suture (V-loc; Medtronic or Stratafix; Ethicon), with 5 cm of overlap from the initial measurement prior to defect closure. For those randomized to the laparoscopic approach, the fascial defects were closed with serial figure of 8's using 0 monofilament permanent suture (Prolene; Ethicon) passed by a Carter-Thomason (ie, shoelacing technique) in 1-cm increments.[23] The mesh was secured circumferentially with 4 permanent transfascial sutures at each apex followed by fixation with a permanent tacking device (ProTack; Medtronic) using the double crown technique.[24] Port sites were injected with bupivacaine, 0.25%, for both approaches.

Outcome Measurements

The primary outcome was pain on the first postoperative day as measured by the 0 to 10 Numerical Rating Scale (NRS-11),

which was collected preoperatively and in the postanesthesia care unit (PACU) as well as 1, 7, 30, and 365 days after surgery.[25] Secondary outcomes measured preoperatively, at a mean (SD) of 30 (15) days and a mean (SD) of 12 (3) months, included pain as measured by the Patient-Reported Outcomes Measurement Information System (PROMIS) Pain Intensity short form 3a and abdominal-wall-specific QoL using the hernia-specific quality of life (HerQLes) survey.[26-28] Additional secondary outcomes included operating room time, PACU opioid consumption measured in morphine equivalents, rates of same-day discharge, hospital LOS, as well as surgical site infection, surgical site occurrence, surgical site occurrence requiring a procedural intervention, ventral hernia recurrence, and cost.[29]

Because our institution does not permit reporting of cost in dollars, values for cost are reported as ratios. Total cost includes operating room cost (as calculated by cost per minute of operating room time required for the case) and disposable/reusable cost, which was calculated to include disposable materials as well as reusable materials including the robotic instruments. Robotic and laparoscopic capital equipment costs were not amortized for the purpose of this analysis.

Statistical Analysis

In the absence of data regarding postoperative pain, QoL, wound morbidity, and recurrence for robotic IPOM available at the time of the trial design, the investigators determined that a 30% reduction in NRS-11 on the first postoperative day would be a minimal clinically important difference.[30] A mean (SD) reported postoperative day 1 NRS-11 data for laparoscopic ventral hernia repair of 4.76 (1.98) is fortunately available.[31] Assuming a 2-sided α of .05 and β of 0.20, a total sample size of 62 patients (31 per arm) was initially calculated. Considering a 20% dropout rate to occur in each arm, 74 patients (37 patients per arm) were defined as the sample size necessary to detect a difference in the primary end point. Patients converted to an open procedure would be removed from analysis. As surgeons were permitted to change minimally invasive platforms if necessary, patients would be analyzed in intent to treat fashion based on their initial randomization.

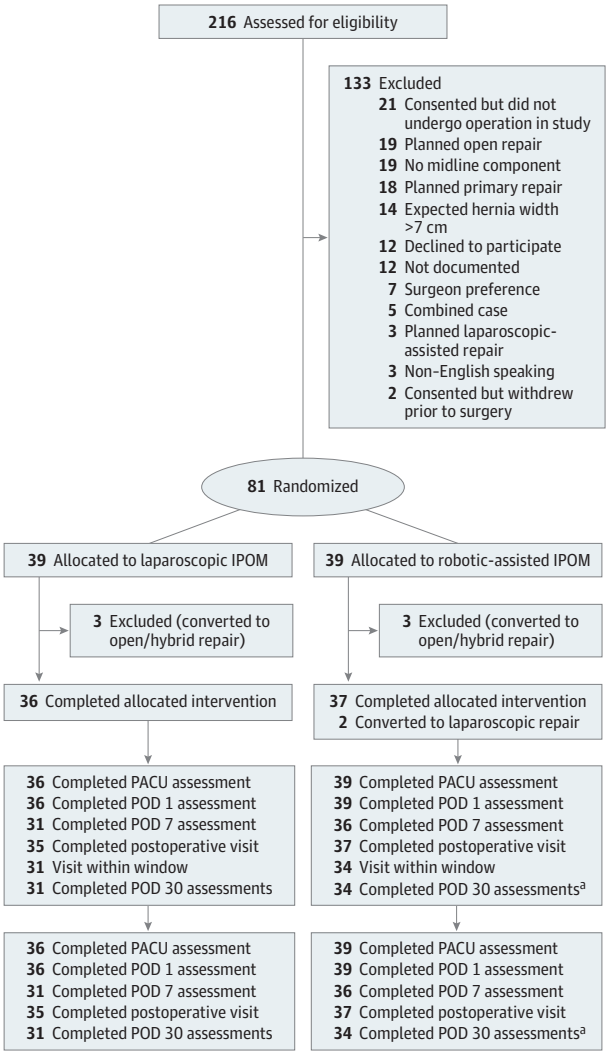
Bivariate analysis was first conducted to compare all characteristics and short-term end points among groups. Unpaired, 2-tailed *t* test; Mann-Whitney test; χ^2 test; and Fisher exact test were used when appropriate.

Results

During the enrollment period, 105 of 216 eligible patients were consented for the trial (**Figure 1**). Of those enrolled, 2 subsequently withdrew, and 21 were awaiting their operation when the study closed. Ultimately, 81 patients were operated on, and 6 of these cases were converted to an open approach, 3 from the laparoscopic group and 3 from the robotic group, owing to the surgeon's judgment of an inability to perform safe adhesiolysis or failure to progress. Of the 75 patients completing their minimally invasive operative intervention, baseline patient demographics, medical comorbidities, and hernia characteristics summarized in **Table 1** were similar, with the exception that laparoscopic patients had a lower median body mass index (BMI; calculated as weight in kilograms divided by height in meters squared; 31 vs 35; $P = .02$) (Table 1). All patients achieved fascial closure and mesh placement with adequate overlap adhering to the study protocol. Two patients randomized to the robotic platform were converted to a laparoscopic technique, one owing to an operating room bed malfunction that made docking the robot unsafe and one owing to a lack of intraperitoneal space to allow for intracorporeal suturing. These patients were analyzed in intention-to-treat fashion (**Table 2**).

There were 4 intraoperative complications that did not warrant conversion to an open procedure. Two serosal

Figure 1. CONSORT Flow Diagram



[a] Thirty-five patients had hernia-specific quality of life (HerQLes) and Patient-Reported Outcomes Measurement Information System (PROMIS) scores within window. However, only 34 patients had Numerical Rating Scale (NRS) scores. IPOM indicates intraperitoneal onlay mesh; PACU, postanesthesia care unit; POD, postoperative day.

Table 1. Patient Demographics and Hernia Characteristics

Patient demographic	No. (%) Laparoscopic (n = 36)	Robotic (n = 39)	*P* value
Age at the assessment date, median (IQR), y	55 (49-60)	56 (50-70)	.18
Female, %	58	41	.21
Race/ethnicity, %			
Black	17	19	.87
White	83	81	
BMI, median (IQR)	31 (27-36)	35 (31-39)	.02
Hypertension requiring medication	17 (47)	17 (44)	.93
COPD	1 (3)	4 (10)	.36
Diabetes mellitus	3 (8)	9 (23)	.15
Current smoker (active within 1 mo of surgery)	4 (11)	2 (5)	.42
Chronic immunosuppression	3 (8)	2 (5)	.66
History of abdominal wall SSI	0	2 (5)	.49
ASA			
1	1 (3)	1 (3)	>.99
2	2 (19)	7 (18)	
3	27 (75)	29 (74)	
4	1 (3)	2 (6)	
Hernia characteristics			
Primary	9 (25)	8 (20.5)	.85
Incisional	27 (75)	31 (79.5)	
Recurrent incisional hernia	8 (22)	5 (13)	.44
Modified ventral hernia working group stage			
1	10 (28)	5 (13)	.18
2	26 (72)	34 (87)	
Hernia, median (IQR)			
Width, cm	4 (2-5)	3(2.5-5)	.88
Length	5 (2-8)	5(3-8)	.36

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); COPD, chronic obstructive pulmonary disease; IQR, interquartile range; SSI, surgical site infection.

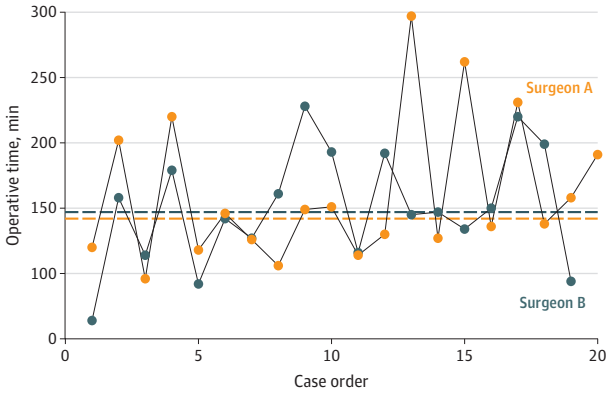
Table 2. Operative Details

Variable	No. (%) Laparoscopic (n = 36)	Robotic (n = 39)	*P* value
Antibiotics given according to SCIP protocol	36 (100)	39 (100)	>.99
Type of robot used			
Si	NA	14 (36)	NA
Xi	NA	25 (64)	NA
Fascial closure	36 (100)	39 (100)	>.99
Sublay intraperitoneal permanent mesh fixation			
Transfascial suture and permanent tack fixation	36 (100)	2 (6)	<.001
Peritoneal suture fixation	0	37 (94)	
Conversion to laparoscopy	NA	2 (6)	NA
Conversion to robotic repair	0	NA	NA
Intraoperative complications	2 (6)	2 (6)	
Bowel serosal injury	2 (6)	1 (3)	>.99
Liver injury	0	1 (3)	
Operative time, median (IQR), min	94 (69-116)	146 (123-192)	
Surgeon A	94 (57-128)	142 (124.5-194)	<.001
Surgeon B	89 (61.5-123)	147 (121.5-185.5)	

Abbreviations: IQR, interquartile range; NA, not applicable; SCIP, Surgical Care Improvement Project.

injures in the laparoscopic group were repaired laparoscopically with Lembert sutures. In the robotic group, 1 serosal injury was repaired robotically with Lembert sutures, and a liver injury that occurred during optical entry was cauterized for hemostasis. Laparoscopic operations had a significantly shorter median operative time than robotic counter-

Figure 2. Sequential Operative Times for Robotic Cases



Median operative time in minutes (surgeon A, 142; surgeon B, 147; $P = .51$).

parts (94 vs 146 minutes; $P < .001$). Both enrolling surgeons had comparable median operative times for laparoscopic (89 and 94 minutes; $P = .98$) and robotic procedures (142 and 147 minutes; $P = .51$) (**Figure 2**).

Median NRS-11 scores on the first postoperative day, the primary end point of the study, were the same (5 vs 5; $P = .61$) (**Table 3**). There was no significant difference in hospital LOS (10 vs 25 hours; $P = .17$), same-day discharge (56% vs 44%; $P = .42$), opioid consumption in PACU morphine equivalents (45 vs 46; $P = .88$), or overall complication rates (8% vs 6%; $P > .99$) for laparoscopic patients and patients undergoing the robotic procedure, respectively. Laparoscopic patients developed 1 seroma that did not require intervention, 1 readmission for an ileus, and 1 reoperation for a thin patient who could feel a transfascial suture at her waistline and requested its excision 3 months later. One patient undergoing the robotic procedure developed deep vein thrombosis and had a readmission for pain control. There were no other unplanned reoperations or procedural interventions. Additional NRS-11 scores at baseline, in PACU, and on postoperative days 7 and 30 were similar. Likewise, PROMIS 3a scores preoperatively and at 30 days were similar, although patients in the laparoscopic group demonstrated statistically significant improvement (−3 vs 0; $P = .03$). Baseline and postoperative HerQLes scores demonstrated no difference in baseline or postoperative hernia-specific QoL. Finally, to address the statistically significant difference in baseline BMI, we performed a covariate-adjusted analysis accounting for BMI and randomization. The effect of robotic/laparoscopic randomization remained insignificant (effect of difference, −0.46; 95% CI −1.59 to 0.67; $P = .42$) in regards to the primary outcome (NRS-11 on the first postoperative day) after adjusting for BMI.

Cost ratios are summarized in Table 3 as well. Total cost was significantly less for the laparoscopic cohort (0.97 vs 1.13; $P = .03$). The discrepancy between total cost was driven by a difference in operating room time cost (0.85 vs 1.25; $P < .001$), while the cost of disposables/reusables was comparable (1.00 vs 0.97; $P = .60$).

Discussion

To our knowledge, this is the first prospective, randomized, single-blinded trial comparing laparoscopic and robotic ventral hernia repair with intraperitoneal mesh that reveals no difference in postoperative pain. Complication rates, QoL, and hospital LOS likewise demonstrated no discernable difference. Both techniques appear to have similar rates of maintaining and completing the intended minimally invasive approach. However, the 52-minute increase in median operative time incurring additional cost does not appear to be offset by a measurable clinical benefit.

First, the decision to pursue a reduction in early postoperative pain as the primary end point should be addressed. A previous analysis of data from the AHSQC database compared propensity-matched groups of laparoscopic (n = 454) and robotic (n = 177) hernia repairs with intraperitoneal mesh and fascial closure. There, the longer operative time for robotic repairs (46% vs 30% > 2 hours; $P < .001$) was countered by a shorter median LOS (0 vs 1 day; interquartile range, 3.00; $P < .001$), lower rate of seroma (4% vs 9%; $P = .02$), and fewer overall complications (8% vs 19%; $P < .001$).[7] Several analyses acknowledge the confounded nature of LOS, often affected by a multitude of social factors and the distance a patient has traveled for care, and therefore, we decided this was not a reliable primary end point.[32,33] Presumably, the touted benefit of reduced LOS by the robotic approach was the consequence of less early postoperative pain. Therefore, this was chosen as the more salient variable off of which to power the analysis, and a 30% reduction has been consistently defined elsewhere as a minimal clinically important difference.[34,35] The resultant homogeneity of outcomes among our cohorts in regards to pain, complications, QoL, and hospital LOS are likely a consequence of the randomized design, neutralizing the selection bias inherent to any retrospective analysis. Because the higher BMI in the robotic group was potentially clinically significant (35 vs 31; $P = .02$) in regards to increased pain on the first postoperative day, we did feel it was important to confirm that after adjusting for BMI, randomization did not have an independent effect on the primary outcome.

Next, some of the secondary outcomes and exclusions should be contextualized. The difference in the change (Δ) of the PROMIS pain intensity 3a scores suggesting more pain improvement for laparoscopic repairs (−3 vs 0; $P = .03$), while statistically significant, may not be clinically relevant. While there is no validation of the PROMIS 3a for patients with a hernia, data from orthopedic literature would suggest that an SD of 5 is the minimal clinically important difference for that specific tool.[36] A separate issue concerns our 6 conversions to an open procedure. The summative experience of randomized clinical trials comparing laparoscopic and open ventral hernia repair have shown less wound morbidity and shorter hospital stays for laparoscopic repairs, often at the expense of an increased rate of bowel injury, demonstrated in several meta-analyses and systematic reviews.[37-39] While our 7% conversion rate could be considered high, the absence of any missed enterotomies or unplanned reoperations could be framed as

Table 3. Outcomes

Outcome	Data captured, No.	Median (IQR)		P value
		Laparoscopic (n = 36)	Robotic (n = 39)	
Length of hospital stay, h	75	10 (8 to 31)	25 (10 to 30)	.17
Discharged home, No. (%)	75	20 (56)	17 (44)	.42
PACU, morphine equivalents	75	45 (29 to 71)	46 (28 to 68)	.88
Postoperative complications, No. (%)	75	3 (8)	2 (6)	>.99
Pulmonary embolism	NA	0	1 (3)	>.99
SSO	NA	1 (3)	0	>.99
Readmission	NA	1 (3)	1 (3)	>.99
Reoperation	NA	1 (3)	0	>.99
NRS-11				
Preoperative	75	1.5 (0 to 4)	1 (0 to 3)	.86
PACU	75	6 (4 to 8)	6 (5 to 8)	.97
Postoperative day				
1st	73	5 (3 to 7)	5 (3 to 6)	.61
7th	68	3 (2 to 5)	4 (2 to 5)	.58
30th	65	2 (0 to 2)	1 (0 to 2)	.71
PROMIS 3a				
Preoperative	75	49 (40 to 49)	44 (31 to 51)	.29
Postoperative day 30	65	44 (38 to 48)	46 (42 to 51)	.28
Delta	66	−3 (−9.4 to .41)	0 (−2.9 to 9.5)	.01
HerQLes				
Preoperative	75	51 (37 to 73)	55 (35 to 73)	.91
Postoperative day 30	66	75 (41 to 81)	67 (45 to 79)	.66
Cost				
Disposable/reusable median cost ratio	NA	1.00 (0.87 to 1.19)	0.97 (0.85 to 1.51)	.60
Operating room time-cost ratio	NA	0.85 (0.67 to 1.00)	1.25 (0.98.1.49)	<.001
Total cost ratio	NA	0.97 (0.85 to 1.16)	1.13 (0.90 to 1.52)	.03

Abbreviations: HerQLes, hernia-specific quality of life; IQR, interquartile range; NRS-11, Numerical Rating Scale; PACU, postanesthesia care unit; PROMIS, Patient-Reported Outcomes Measurement Information System; SSO, surgical site occurrence.

prudent surgical judgment in a context where bowel injury is somewhat notorious. Importantly, the platform also did not appear to affect the conversion rate. A more legitimate criticism is our exclusion of these 6 patients from analysis. While they could have been included in intent to treat fashion, we ultimately excluded them to isolate the comparison of the minimally invasive techniques alone.

The discrepancy in operative times warrants a thorough discussion. The median operative time for the robotic repairs (146 minutes) is significantly longer than the laparoscopic arm (94 minutes). Retrospective data by which to compare our robotic OR time are widely variable. Indeed, the aforementioned retrospective analysis[7] from the AHSQC found that robotic repairs took more than 2 hours in 46% of cases but offers no additional granularity.[7] Alternatively, several large series of robotic ventral hernias repairs, including Gonzalez et al (n = 368)[40] and Kudsi et al (n = 68),[41] have reported median operative times of 89 and 80 minutes, respectively. To account for some of the time discrepancy, it is worth noting that in the series by Gonzalez et al,[41] more than 30% of patients did not have their fascial defect closed, and 40% of patients had their mesh tacked in place despite use of the robotic platform. In the 2020 series by Kudsi et al,[40] 20% of patients did not have their fascial defect closed and more than 40% were primary defects. Our robotic cohort included 80% incisional and 13% recurrent incisional defects, likely requiring a more time-consuming adhesiolysis. Furthermore, all of the patients undergoing robotic surgery achieved fascial closure and a near-complete rate of intraperitoneal mesh suture fixation. In full transparency, because one of the enrolling surgeons had several years of robotic experience while the other was in their first year of clinical practice after completing an abdominal wall reconstruction fellowship, we thought it was important to demonstrate the similarity in operative times of robotic cases (Figure 2). This is critically important because our data would suggest that the cost discrepancy would be neutralized if surgeons were able to overcome the difference in operative time.

The cost analysis for this operation is unique. Previously, our trial of laparoscopic vs robotic transabdominal preperitoneal inguinal hernia repair found that the robotic platform not only added cost in regards to operative time but also added to the disposable/reusable costs (median $1784 vs $623; $P < .001$).[42] In this study, disposable/reusable costs were similar, likely because several tacking devices were required for laparoscopic repairs, offsetting the cost of self-fixating suture and robotic disposables. Therefore, if comparable operative times were achieved, the value discrepancy could theoretically be mitigated, and other authors have reported advancements in robotic efficiency in a short time.[43] That said, our operative times between an experienced and less experienced robotic surgeon were comparable, suggesting that we were not necessarily en route to overcoming the 52-minute dis-

crepancy. While some may contend the robot offers benefits to the surgeon that are not conventionally measured, the aforementioned randomized trial on inguinal hernia repair also found no measurable clinical benefit to the robot while causing more surgeon frustration and no difference in ergonomics.[42] To date, as long as the time and associated cost discrepancy exists, the onus remains on the robotic platform and its users to either become very efficient or provide evidence of an objective benefit to justify its use.

Currently, adoption of the robotic platform without high-level evidence, particularly in the realm of general surgery, has become commonplace. From 2012 to 2018, use of the robot for general surgery procedures increased from 1.8% to 15.1%.[1] Commonly, robotic inguinal repair and intraperitoneal mesh placement for ventral hernias are regarded as basic procedures that the surgeons should be comfortable with before pursuing advanced techniques.[44-46] Having completed 2 randomized clinical trials that failed to show a measurable benefit of these procedures, an alternative argument could be made that the robotic outcomes are comparable, safe, and allow surgeons to gain comfort with the robotic platform while working toward more complex approaches. Namely, these advanced operations are ventral hernia repair techniques with extraperitoneal mesh placement, including the robotic transabdominal preperitoneal repair, robotic endoscopic totally extraperitoneal approach, and robotic transversus abdominis release (TAR). In retrospective series, both Martin-Del-Campo et al[5] and Bittner et al[6] described a reduction in complications and LOS for robotic TAR compared with open TAR historical controls. A separate AHSQC analysis comparing all robotic retromuscular approaches with open repairs in a matched group of patients with hernia likewise found a similar benefit in LOS for robot repairs.[4] Most recently, in 2020 Kudsi et al[40] demonstrated fewer complications and wound morbidity favoring robotic totally extraperitoneal when compared with robotic placement of intraperitoneal mesh, suggesting that the more complex robotic approach adds even greater value. The need for randomized trials evaluating these robotic techniques now grows more important than ever. If advanced techniques can likewise not elucidate a clinical benefit, then use of basic techniques as a training platform becomes a bridge to nowhere.

Limitations

Remaining limitations include a lack of long-term follow-up to elucidate the durability of each repair technique, as well as implications regarding prolonged pain. Long-term follow-up will further establish the safety, efficacy, and unanticipated benefits of the robotic technique. While 3% to 10% of the short-term data points for pain and QoL assessments were not collected, the analysis was powered for 20% attrition, and therefore, that missing data should not affect the validity of our primary end point. Finally, granular data regarding postdischarge opioid consumption would have been a timely addition to this assessment but was not built into the initial protocol.

Conclusions

Laparoscopic and robotic ventral hernia repair with intraperitoneal mesh offer similar early postoperative outcomes in regards to pain, QoL, and complication rates. Owing to the increased operative time and associated cost, there is currently no measurable benefit to justify the robotic approach.

ARTICLE INFORMATION

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Concept and design: Krpata, Tu, Rosen, Prabhu.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Petro, Rosen.
Critical revision of the manuscript for important intellectual content: All authors.
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