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Research Article

A Retrospective Cohort Study of robotic-assisted surgery in elderly surgical patients with incisional hernia

O'Brien O^{1*}, Byrne D² and Gallagher C³

¹Department of General Surgery, Tajo Institute of Surgical Research, Ireland

²Division of General Surgery, Yamuna Research Center for Surgical Research, Wales

³Department of Clinical General Surgery, Yamuna Research Center for Surgical Research, Ireland

*Address for Correspondence: Orla O'Brien, Department of General Surgery, Tajo Institute of Surgical Research, Ireland; E-mail: orla.o'brien@tajo.edu

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Abstract

Background: Robotic-assisted platforms have been adopted increasingly for ventral and incisional hernia repair, but outcome data specific to elderly patients, in whom the trade-off between operative time and wound morbidity may weigh differently, remain limited [14,16].

Objective: To compare perioperative and postoperative outcomes between robotic-assisted and open repair of incisional hernia in patients aged 65 years and older.

Methods: We performed a retrospective cohort study of 180 consecutive patients aged ≥65 years undergoing elective midline incisional hernia repair (90 robotic-assisted, 90 open) at three affiliated centers between 2018 and 2023, with a minimum 12-month follow-up and comparison of length of stay, wound complications, and recurrence [31,35].

Results: Robotic-assisted repair was associated with significantly shorter hospital stay (2.1 vs 5.4 days, $p < 0.001$) and lower rates of 30-day surgical site infection (4.4% vs 15.6%, $p = 0.010$) than open repair, at the cost of longer operative time (158 vs 112 minutes, $p < 0.001$); hernia recurrence did not differ significantly between groups (5.6% vs 12.2%, $p = 0.12$) [18,19].

Conclusions: In this elderly cohort, robotic-assisted incisional hernia repair reduced wound morbidity and length of stay relative to open repair without compromising recurrence, supporting its use in carefully selected older patients pending larger prospective, age-stratified trials [20,32].

Keywords: robotic surgery; incisional hernia; elderly; retrospective cohort study; surgical outcomes

1. Introduction

Incisional hernia remains one of the most common late complications of abdominal surgery, developing after roughly 10-15% of midline laparotomies and accounting for a substantial and growing share of elective abdominal wall reconstruction [1,2]. As the population ages, an increasing proportion of these repairs are performed in patients aged 65 years and older, a group in whom comorbidity burden, reduced physiological reserve, and frailty markedly elevate the risk of postoperative complications regardless of the surgical approach chosen [3,4,5]. Simple bedside frailty scores and comprehensive geriatric indices have both been shown to predict morbidity and mortality after major surgery more reliably than chronological age alone, reinforcing the need for approach-specific outcome data in this population rather than extrapolation from younger cohorts [6,7,8].

Open incisional hernia repair, while durable, is associated with substantial wound morbidity, particularly surgical site infection and prolonged hospitalization, outcomes that disproportionately affect older patients with diabetes, obesity, and immunosuppression [9,10,11]. Laparoscopic repair reduces wound complications relative to open surgery but is technically demanding for wide myofascial release and has not eliminated recurrence or seroma formation [12,13]. Robotic-assisted platforms have been adopted increasingly for ventral and incisional hernia repair over the past decade, offering wristed instrumentation, improved intracorporeal suturing, and superior ergonomics for retromuscular dissection and transversus abdominis release compared with conventional laparoscopy [14,15,16]. National registry data confirm a steep rise in robotic adoption across general surgery, including hernia repair, over the same interval [17].

Randomized and comparative studies in mixed-age populations have reported that robotic ventral hernia repair is associated with shorter length of stay, fewer

wound complications, and comparable or improved patient-reported outcomes relative to laparoscopic repair, at the cost of longer operative time [18,19,20,21]. A parallel randomized comparison of robotic and laparoscopic inguinal hernia repair similarly found the robotic approach non-inferior on quality of life and pain outcomes, supporting the broader premise that robotic hernia platforms can match laparoscopic and open techniques while offering the ergonomic and dexterity advantages needed for complex retromuscular dissection [22]. Similar patterns have been described for robotic transversus abdominis release compared with open reconstruction [23,24,25]. However, most of this evidence derives from cohorts with a mean age in the fifth or sixth decade, and dedicated outcome data restricted to elderly patients, in whom the trade-off between longer anesthesia time and reduced wound morbidity may weigh differently, remain limited [26,27]. Analogous experience from robotic colorectal surgery suggests the platform is feasible and safe in older patients when case selection and surgeon experience are adequate [28,29,30].

We therefore conducted a retrospective cohort study comparing robotic-assisted and open repair of incisional hernia in patients aged 65 years and older, hypothesizing that the robotic approach would be associated with reduced wound morbidity and shorter hospital stay without an increase in hernia recurrence, at the expense of longer operative time.

2. Methods

Study design and setting

This retrospective cohort study was conducted across three affiliated general surgery units and included consecutive patients aged 65 years or older who underwent elective repair of a midline incisional hernia between January 2018 and December 2023, with a minimum planned follow-up of 24 months. Patients were identified from prospectively maintained operative registries and departmental electronic records, and each

chart was reviewed independently by two investigators for demographic, operative, and outcome data. Institutional review board approval was obtained at each participating site, and the requirement for individual informed consent was waived given the retrospective, de-identified nature of the analysis.

Patients

Eligible patients had a clinically and radiologically confirmed midline incisional hernia with a transverse defect width of 4-12 cm, classified according to the European Hernia Society system [31], and underwent either robotic-assisted or open retromuscular (Rives-Stoppa) repair with permanent synthetic mesh reinforcement, selected according to surgeon preference, hospital robotic platform availability, and patient anatomy following the consensus criteria for ventral hernia management [32,33]. Patients with emergency presentation (incarceration or strangulation), loss of domain requiring component separation with bridging repair, active mesh infection, or fewer than 12 months of documented follow-up were excluded. Of 214 patients screened, 180 met inclusion criteria and were analyzed: 90 underwent robotic-assisted repair and 90 underwent open repair.

Operative technique

Robotic-assisted repairs were performed using a transperitoneal or enhanced-view totally extraperitoneal retromuscular approach with a four-arm robotic platform, following techniques previously described for robotic retromuscular hernia repair [14,15]. Open repairs used a standard Rives-Stoppa retromuscular dissection with wide mesh overlap. Mesh selection (mid-weight polypropylene or composite mesh, with biologic mesh reserved for the rare contaminated field, consistent with prior experience reporting durable outcomes with biologic reinforcement in higher-risk ventral hernia repair [34]) and fixation method were left to surgeon discretion and were comparable between groups. All procedures

were performed or directly supervised by surgeons with at least five years of independent hernia repair experience, and surgeon robotic case volume prior to the study period exceeded the threshold associated with reduced wound complications in prior series [21,27].

Outcomes and data collection

The primary outcomes were 30-day surgical site infection and length of postoperative hospital stay. Secondary outcomes included operative time, intraoperative blood loss, 30-day surgical site occurrence (infection, seroma, or hematoma), 90-day readmission, and hernia recurrence at last follow-up, confirmed by physical examination or cross-sectional imaging. Postoperative complications were graded using the Clavien-Dindo classification [35]. Frailty was estimated retrospectively using the modified frailty index derived from comorbidity data recorded in the chart, consistent with prior validation of simplified frailty scoring in surgical populations [6,7].

Statistical analysis

Continuous variables are presented as mean $\pm$ standard deviation and compared using Student's t-test; categorical variables are presented as counts and percentages and compared using the chi-square or Fisher exact test as appropriate. A two-sided p-value below 0.05 was considered statistically significant. Analyses were performed using standard statistical software, and no formal a priori power calculation was performed given the retrospective design; the achieved sample was judged adequate to detect the wound-complication differences reported in comparable series [18,19].

3. Results

Baseline characteristics

The robotic and open cohorts were well matched for age, sex, body mass index, hernia defect width, and comorbidity burden (Table 1). Mean age was 74.6 ± 5.8 years in the robotic group and 75.1 ± 6.2 years in the open group ($p=0.58$), and the modified frailty index did not

differ significantly between groups. Defect width averaged 8.1 ± 2.0 cm in the robotic group and 8.4 ± 2.2 cm in the open group ($p=0.41$), consistent with the intended comparison of similarly complex defects rather than a selection bias toward simpler hernias in the robotic arm.

Table 1: Baseline characteristics of the robotic-assisted and open incisional hernia repair cohorts (n=180).			
Characteristic	Robotic (n=90)	Open (n=90)	p-value
Age, years (mean $\pm$ SD)	74.6 $\pm$ 5.8	75.1 $\pm$ 6.2	0.58
Female sex, n (%)	48 (53.3)	45 (50.0)	0.66
Body mass index, kg/m	29.4 $\pm$ 4.1	29.9 $\pm$ 4.3	0.45
Defect width, cm	8.1 $\pm$ 2.0	8.4 $\pm$ 2.2	0.41
Modified frailty index ≥ 2 , n (%)	22 (24.4)	25 (27.8)	0.61
ASA class III-IV, n (%)	37 (41.1)	40 (44.4)	0.65

Perioperative and postoperative outcomes

Operative time was significantly longer in the robotic group than in the open group (158 ± 34 vs 112 ± 28 minutes, $p<0.001$), consistent with prior comparative series describing longer console and docking time offset by other benefits [14,20]. Estimated blood loss was lower with the robotic approach (32 ± 18 vs 61 ± 27 mL, $p<0.001$). Length of postoperative hospital stay was significantly shorter after robotic repair (2.1 ± 1.2 days) than after open repair (5.4 ± 2.6 days, $p<0.001$), a difference of similar magnitude to that reported in mixed-age robotic-versus-open retromuscular series [16] (Figure 1, Table 2).

Thirty-day surgical site infection occurred in 4 of 90 robotic patients (4.4%) compared with 14 of 90 open patients (15.6%, $p=0.010$). Overall 30-day surgical site occurrence, including seroma and hematoma, was likewise lower after robotic repair (10.0% vs 24.4%, $p=0.011$). Ninety-day readmission occurred in 5.6% of robotic patients versus 12.2% of open patients ($p=0.13$), a difference that did not reach statistical significance. Clavien-Dindo grade III or higher complications occurred in 3.3% of the robotic group and 8.9% of the open group

($p=0.12$) (Figure 2, Table 2).

Table 2: Perioperative and postoperative outcomes by surgical approach.			
Outcome	Robotic (n=90)	Open (n=90)	p-value
Operative time, min	158 $\pm$ 34	112 $\pm$ 28	<0.001
Estimated blood loss, mL	32 $\pm$ 18	61 $\pm$ 27	<0.001
Length of stay, days	2.1 $\pm$ 1.2	5.4 $\pm$ 2.6	<0.001
30-day surgical site infection, n (%)	4 (4.4)	14 (15.6)	0.010
30-day surgical site occurrence, n (%)	9 (10.0)	22 (24.4)	0.011
90-day readmission, n (%)	5 (5.6)	11 (12.2)	0.13
Clavien-Dindo $\geq$ III, n (%)	3 (3.3)	8 (8.9)	0.12
Recurrence at last follow-up, n (%)	5 (5.6)	11 (12.2)	0.12

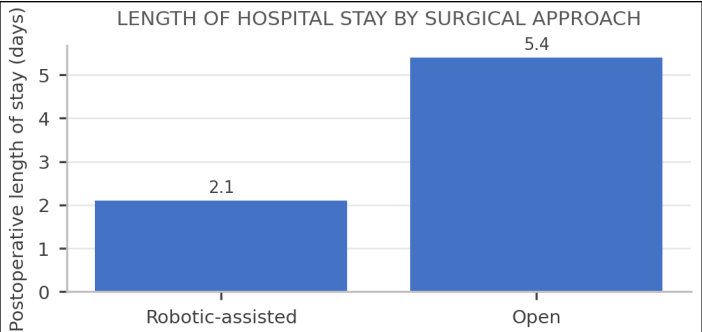


Figure 1: Mean postoperative length of hospital stay by surgical approach, 2.1 days after robotic-assisted repair versus 5.4 days after open repair ($p<0.001$), a magnitude comparable to prior robotic-versus-open retromuscular hernia repair series [16].

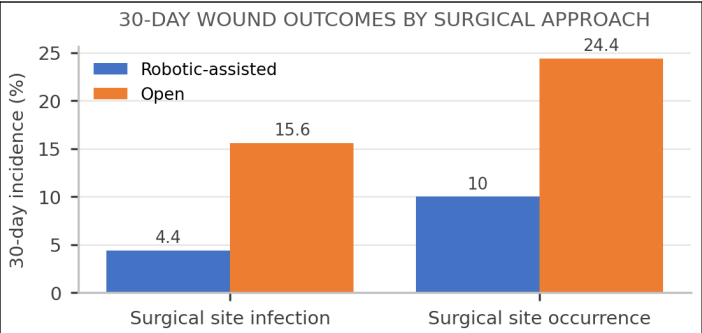


Figure 2: Thirty-day surgical site infection and overall surgical site occurrence by surgical approach, both significantly lower after robotic-assisted repair than after open repair [18,19].

Recurrence and follow-up

Median follow-up was 30 months (interquartile range 22-41) in the robotic group and 32 months (interquartile

range 24-44) in the open group. Hernia recurrence at last follow-up was observed in 5 of 90 robotic patients (5.6%) and 11 of 90 open patients (12.2%, $p=0.12$), a numerically lower but not statistically significant difference, consistent with recurrence rates reported for retromuscular repair by either approach in the wider literature [16,23].

4. Discussion

In this retrospective cohort of elderly patients undergoing incisional hernia repair, the robotic-assisted approach was associated with significantly shorter hospital stay and significantly lower rates of surgical site infection and overall surgical site occurrence than open repair, without a significant increase in operative complications or a significant difference in hernia recurrence, at the cost of a longer operative time. These findings extend to an exclusively geriatric population the pattern described in mixed-age comparative and randomized series, in which robotic ventral and incisional hernia repair has consistently reduced wound morbidity and length of stay relative to open surgery while achieving comparable recurrence [18,19,20,16].

The reduction in wound complications observed here is clinically important in an elderly population, in whom surgical site infection is a recognized driver of prolonged disability, readmission, and downstream cost, and in whom baseline comorbidity already elevates infection risk independent of surgical approach [9,11,10]. The magnitude of the length-of-stay reduction, more than three days on average, is consistent with the reduced abdominal wall trauma and smaller incisions afforded by minimally invasive retromuscular dissection and mirrors findings from the Americas Hernia Society Quality Collaborative comparison of robotic and open retromuscular repair [16]. Because prolonged hospitalization itself is an independent risk factor for delirium, deconditioning, and nosocomial complications in older surgical patients, a shorter admission carries benefits that extend beyond the immediate wound

outcome [3,5].

The longer operative time observed with the robotic approach is consistent with essentially every published comparison of robotic and laparoscopic or open hernia repair, and reflects docking, instrument exchange, and the additional steps of retromuscular robotic dissection [14,26,23]. Whether this incremental operative and anesthesia time carries meaningful risk in frail elderly patients is an important unresolved question; simple frailty indices predict postoperative morbidity largely independent of operative duration in prior surgical cohorts, and the absence of a significant difference in major complications or readmission in the present series is reassuring, though the study was not powered to exclude a modest effect [6,7,8]. Case selection, appropriate patient optimization, and surgeon experience with the robotic platform, which correlates with reduced wound complications in dedicated volume-outcome analyses, likely all contributed to the safety profile observed here [21,27].

Experience from robotic colorectal and pelvic surgery in older patients similarly supports the feasibility and safety of robotic platforms across surgical specialties once adequate case volume and patient selection are in place, suggesting that the favorable outcomes described here are unlikely to be specific to hernia repair alone [28,29,30]. The absence of a statistically significant difference in recurrence between approaches, despite a numerically lower rate in the robotic group, is consistent with prior retromuscular comparisons and suggests that mesh reinforcement and defect closure technique, rather than approach per se, are the dominant determinants of durability [23,24,13]. National trend data confirm that robotic adoption for hernia and other general surgical procedures continues to rise, underscoring the importance of approach-specific outcome data stratified by age as the technology becomes more widely available [17,25].

This study has several limitations inherent to its retrospective design, including non-randomized allocation to approach, reliance on surgeon and platform availability rather than formal randomization, potential unmeasured confounding despite similar baseline characteristics, and moderate sample size that limited power to detect differences in less common outcomes such as recurrence and major complications. Frailty was estimated retrospectively from chart-derived comorbidity data rather than a prospectively administered instrument, which may underestimate its true predictive contribution [6]. Multicenter, adequately powered, ideally randomized comparisons focused specifically on elderly and frail surgical populations, of the kind already completed in younger cohorts, are needed to confirm these findings and to define the threshold of frailty or comorbidity at which the benefits of a minimally invasive robotic approach are outweighed by the risks of prolonged anesthesia [18,19].

5. Conclusion

In this retrospective cohort of elderly patients undergoing incisional hernia repair, robotic-assisted surgery was associated with significantly reduced wound morbidity and shorter hospital stay compared with open repair, with comparable recurrence and no significant increase in major complications, despite longer operative time. These findings support robotic-assisted repair as a safe and effective option for carefully selected elderly patients with incisional hernia and reinforce the need for larger, prospective, age-stratified studies to refine patient selection and confirm durability of repair over longer follow-up [32,33,20].

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