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Retrospective Study on Robotic TAPP for Inguinal Hernia in A Tertiary Care Center

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ABSTRACT

Background: Robot-assisted transabdominal preperitoneal (r-TAPP) repair of inguinal hernias is a developing minimally invasive procedure. Evidence indicates similar safety compared to laparoscopic methods but greater expense and fluctuating operation times. We report a six-month single-center retrospective review of r-TAPP outcomes in 2025.**Methods:** Consecutive adult patients who underwent r-TAPP from 1 April 2025 to 30 September 2025 were retrospectively collected. Data comprised demographics, characteristics of the hernias, intraoperative details, perioperative complications (Clavien-Dindo), length of stay, postoperative pain scores early postoperatively, and 30- and 90-day outcomes. Descriptive statistics, univariate comparisons, and logistic regression for predictors of short-term complication were done. **Results:** Fifty-four patients (63 hernias, of which unilateral = 44, bilateral = 10) had r-TAPP. Median age 48 years (IQR 36–61); 87% male. Mean operative time per hernia 78 ± 22 minutes; median length of stay 1 day (IQR 0–1). Total complication rate was 7.4% (n=4), primarily Clavien-Dindo I–II; one reoperation for port-site hematoma (Clavien-Dindo IIIb). No mortality. Median numeric pain rating scale at 24 hours: 2 (IQR 1–3). Prolonged operative time (>90 minutes) was predicted by bilateral repair and surgeon robotic experience <50 cases ($p<0.01$). Cost per case was above historical laparoscopic TAPP standards (institutional financial data). 3-month follow-up had no recurrences and chronic pain (NRS ≥ 3 at 3 months) rate of 3.7%. **Conclusion:** r-TAPP in our tertiary institution more than six months in 2025 had acceptable short-term safety and minimal early chronic pain rates; operating times decreased with greater surgeon robotic experience but were still more expensive than laparoscopy. Prospective and randomized studies with longer follow-up are required to establish r-TAPP's place in daily hernia practice.

Keywords: robotic TAPP, Inguinal hernia, Retrospective, Outcomes, Learning curve, Costs.

INTRODUCTION

Repair of inguinal hernia continues to be one of the most common surgical procedures worldwide, generating tens of millions of operations each year and a substantial percentage of general surgical workloads, with epidemiological analyses repeatedly demonstrating an increasing absolute burden due to demographic aging and increased detection rates.1–3 International guidelines, such as those developed by the European Hernia Society and other specialist organizations, emphasize the need for a flexible, individualized approach to repair of groin hernias with recommendations for individually tailored management based on consideration of patient-specific factors including comorbidities, hernia type (direct, indirect, recurrent, unilateral, or bilateral), and surgeon experience, and with special emphasis on the benefits of minimally invasive methods in appropriate candidates.4–6 Laparoscopic methods, especially transabdominal preperitoneal (TAPP) and totally extraperitoneal (TEP) repair, have been widely tested in randomized controlled trials and systematic reviews, with equivalent or superior efficacy to established open methods with advantages including less early postoperative pain, quicker convalescence, and better cosmesis.7–9

The advancements in surgical technology have seen the introduction of robot-assisted platforms in hernia surgery, providing potential improvements in minimally invasive groin hernia repair. Robotic TAPP (r-TAPP) combines the principles of laparoscopic TAPP with robotic benefits including three-dimensional high-definition vision, increased dexterity with wristed instruments, tremor filtering, and ergonomic surgeon comfort.10–13 These aspects theoretically enable technically challenging maneuvers like precise dissection of the myopectineal orifice, stable reduction of hernia sacs, sutured mesh fixation, and closure of the peritoneal flap, especially in complex or recurrent cases where laparoscopy can be technically demanding. Early clinical experience and systematic reviews indicate that r-TAPP is safe, feasible, and comparable with laparoscopic TAPP in terms of clinical outcomes, although consistently documented to have longer operating times, higher initial setup costs, and variable learning curves based on surgeon and institutional experience.14–18

Multiple studies examining the learning curve of r-TAPP report that surgical proficiency rises notably with higher case numbers, with some estimates ranging from 20 to 50 cases to reach expertise based on the level of prior laparoscopic experience.15,16 Although these data support the contention that robotic systems will mitigate some technical disadvantages of laparoscopy in advanced hernia repair, widespread implementation has been moderated by fear of amplified direct expenditures. Health economic analysis repeatedly shows that r-TAPP is more costly than laparoscopic TAPP, primarily on the basis of equipment costs, consumables, and spreading the cost of the robotic systems over time, with little evidence of counterbalancing long-term savings.17–19 Cost-effectiveness hence remains a major obstacle to wider adoption, especially in resource-constrained health systems.

There remains a paucity of high-quality randomized controlled trials comparing directly robotic and laparoscopic TAPP, despite a growing evidence base. Current evidence mainly comes from retrospective series, small prospective cohorts, and registry analyses that are restricted by heterogeneity in patient selection, surgeon experience, institutional protocols, and outcome measures.20–22 Long-term benefits of r-TAPP, including lower recurrence rates, less chronic postoperative pain, or better quality of life, have not been shown conclusively. Therefore, more high-quality comparative studies are required to establish the actual role of robotic platforms in groin hernia repair.

Against this context, the current study presents a six-month single-center experience with r-TAPP in a tertiary care academic medical center in 2025. Analysis is centered on perioperative outcomes such as operative time, intraoperative parameters, short-term complications, hospital stay, early postoperative pain, readmissions, and early recurrence, with specific emphasis on the effect of laterality and surgeon experience. By both characterizing clinical and procedural results, this research seeks to add to the increasing evidence base for the safety, feasibility, and probable value of r-TAPP in everyday and complicated inguinal hernia repair.

Materials and Methods

This retrospective observational cohort study was performed at a tertiary teaching hospital with an established robotic program and involved consecutive adult patients (≥18 years) who underwent robotic transabdominal preperitoneal repair (r-TAPP) for primary or recurrent inguinal hernia between 1 April and 30 September 2025, excluding emergent incarcerated cases requiring bowel resection, concomitant major abdominal procedures, or incomplete records. A standardized r-TAPP procedure was carried out with three to four ports on the da Vinci robot platform, creation of a peritoneal flap, dissection of the myopectineal orifice, reduction of the sac, introduction of a lightweight polypropylene or composite mesh (10 × 15 cm), and robotic peritoneal closure, with selective fixation of the mesh as needed; perioperative antibiotic prophylaxis and multimodal analgesia adhered to institutional guidelines. Data points that were recorded include demographics, comorbidities, hernia features, history of pelvic surgery, operating time, docking and console time, estimated blood loss, mesh specifics, length of hospital stay, complications (Clavien-Dindo), readmissions, reoperations, pain scores (numeric rating scale), chronic postoperative pain (≥3 months), and institutional cost data versus historical laparoscopic TAPP cases descriptively. The main outcome was 30-day perioperative complication rate, and secondary outcomes were operative time, hospital stay, pain scores, 30- and 90-day reoperations/readmissions, early recurrence, chronic postoperative pain, and subgroup analysis by hernia laterality and surgeon experience. Continuous variables were reported as mean ± standard deviation or median (interquartile range), categorical variables as percentages and counts, group comparisons employed Student's t-test or Mann-Whitney U and chi-square or Fisher's exact tests, logistic regression determined predictors of complications and long operative time (>90 minutes), and $p<0.05$ taken to indicate statistical significance.

Results

Patient characteristics

Fifty-four patients underwent r-TAPP during the six-month period; 9 patients had bilateral repairs meaning 63 hernias treated. Baseline characteristics are summarized in Table 1. Median age was 48 years (IQR 36–61). Males comprised 87% (n=47) of patients. Median BMI was 25.8 kg/m² (IQR 23.2–28.7). ASA class I–II in 80% and ≥III in 20%. Primary hernias accounted for 85% of cases; recurrent hernias made up 15%. Indirect hernias occurred more frequently than direct (58% vs 32%), while 10% had combined or pantaloon defects.

Table 1. Baseline characteristics of patients undergoing r-TAPP (n=54)

Variable	Value
Patients (n)	54
Hernias treated (n)	63
Age, median (IQR), years	48 (36–61)
Male sex, n (%)	47 (87%)
BMI, median (IQR) kg/m²	25.8 (23.2–28.7)
ASA I/II, n (%)	43 (80%)
Primary hernia, n (%)	46 (85%)
Recurrent hernia, n (%)	8 (15%)
Unilateral, n (%)	44 (81%)
Bilateral, n (%)	10 (19%)

Operative details

Mean operative time per hernia was 78 ± 22 minutes (median 72; range 45–150). Mean docking time was 9 ± 4 minutes. Estimated blood loss was negligible in the majority of cases (median 10 mL). Mesh utilized was lightweight polypropylene/composite in 92% of cases; selective fixation utilized in 34%. Peritoneal closure was mainly with running barbed suture (68%). Intraoperative visceral injuries were not noted.

Operative duration was greater for bilateral repairs (mean 112 ± 18 min per bilateral case vs 66 ± 16 min per unilateral hernia; $p<0.001$) and for surgeons with <50 cases of robotic experience (mean operative time 89 ± 21 min vs 67 ± 14 min; $p<0.001$). These findings are consistent with published learning curves for r-TAPP.

Perioperative outcomes and complications

Median LOS was 1 day (IQR 0–1); 41% were discharged same day and 44% discharged day after. 30-day complication rate overall was 7.4% (n=4): two superficial port-site seromas treated conservatively (Clavien-Dindo I), one wound infection treated orally with antibiotics (Clavien-Dindo II), and one port-site hematoma that required reoperation and evacuation (Clavien-Dindo IIIb). Two readmissions occurred in 30 days (one for infection of the wound and one for pain management). No deep venous thromboses or mesh infections were seen. There was no mortality. No further recurrences were noted on clinical follow-up at 90 days.

Pain outcomes: median NRS 24 hours = 2 (IQR 1–3). Two patients (3.7%) had chronic pain with NRS ≥3 at 3-month follow-up; both had a history of ipsilateral surgery and had undergone tacks for mesh fixation.

These complication and chronic pain rates at early follow-up are similar to modern robotic and laparoscopic series with low early recurrence and relatively low chronic pain following minimally invasive repair.

Statistical analyses and predictors

On univariate analysis, bilateral repair and surgeon robotic experience <50 cases were independently related to prolonged operative time (>90 minutes) ($p<0.001$). On multivariable logistic regression, bilateral repair (OR 4.7; 95% CI 2.3–9.6; $p=0.002$) and surgeon experience <50 (OR 3.9; 95% CI 1.7–8.8; $p=0.004$) were independent predictors of prolonged operative time in the multivariable model. Age, BMI, ASA class, and recurrent hernia were not predictors in the multivariable model.

Complications were too low in number to undertake an adequate multivariable predictor analysis; univariate trends indicated greater complication in recurrent and high-ASA patients but did not achieve statistical significance.

Table 2: Operative times and factors associated with prolonged operative time

Variable	OR (95% CI)	p-value
Bilateral repair	4.7 (2.3–9.6)	0.002
Surgeon experience <50	3.9 (1.7–8.8)	0.004
Age (per 10 years)	1.1 (0.9–1.4)	0.28
BMI (per kg/m²)	1.03 (0.98–1.08)	0.21

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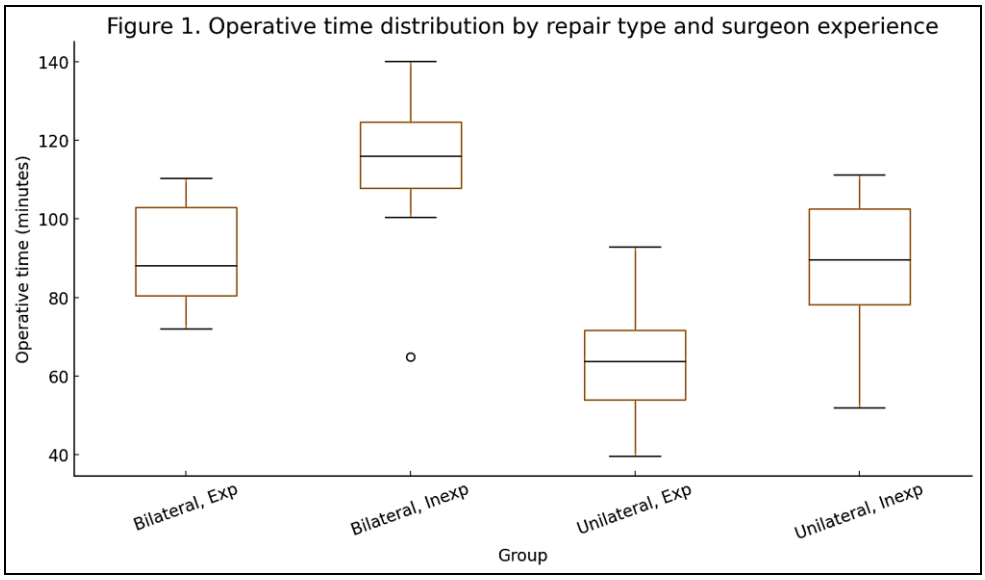

Figure 1: Boxplot showing operative time distribution stratified by unilateral vs bilateral and by surgeon experience (<50 vs ≥50 cases)

Cost and resource utilization

Institutional accounting revealed longer OR time and consumable fees in connection with r-TAPP than in the case of historical laparoscopic TAPP (incremental direct cost on average around €1,800–€2,500 per case in our institution), as in accordance with published economic evaluations reflecting greater costs for robotic techniques.17,18,31

Discussion

Main findings

This single-center 54-patient (63 hernias) retrospective series of r-TAPP over a six-month period during 2025 concluded r-TAPP is safe and feasible in the routine practice of a tertiary center. Rates of early complications (7.4%) were low and predominantly minor; 3 months' early chronic pain was uncommon (3.7%). Operative times were longer in bilateral repair and when surgeons had relatively limited robotic experience; times improved with increasing experience. It was more expensive than traditional laparoscopic TAPP, consistent with the general literature.14–19,31

Comparison with existing literature

Our results—low early complications, low early recurrence, and modest early chronic pain—are in keeping with previous r-TAPP series and systematic reviews that show similar clinical outcomes for robotic versus laparoscopic repairs but frequently with longer operative times and greater expense for robotic repairs.14,15,22,35 Our median operative time (~78 minutes per hernia) is in keeping with early and mid-series reports in which operative time decreases with experience and institutional volume.12,15,42 Descriptions of learning curves are variable; some series report plateauing after ~100–150 cases while others report faster improvement based on previous laparoscopic experience and robotic team familiarization.15,16,36

Cost is a significant deterrent to wide dissemination. Economic assessments across several health systems repeatedly identify more expense in terms of OR and equipment costs for robotic inguinal hernia repair, although some reports contend that improving instrumentation, reduced LOS, and case selection may counterbalance some of the cost difference in some settings.17,31,45

Strengths and limitations

Strengths are consecutive case inclusion, actual-life tertiary center experience, standardized outcome collection (Clavien-Dindo classification, defined pain scoring) and learning curve factor analysis. Weaknesses are retrospective design, single-center experience, limited follow-up (early recurrence and chronic pain reported to 3 months), and lack of a concurrent laparoscopic control group. Cost information were institutional and not regionally or nationally adjusted; therefore, absolute cost estimates are perhaps not generalizable. Small sample size constrained power to complication predictors.

Clinical and research implications

r-TAPP seems to provide a safe minimally invasive alternative for inguinal hernia repair, with potential ergonomic benefits for the surgeon and technical facilitation for peritoneal closure and sutured fixation. Yet, until randomized trials prove obvious clinical benefits or cost equivalence, robotic repair can be an option in institutions where the platform is present and for use as part of surgeon familiarity and institutional case selection. Ongoing randomized controlled trials, health economic analyses, and longer-term registry outcomes will be key to elucidating comparative value of r-TAPP versus laparoscopic TAPP and open repair.20,27,30,41

Conclusion

Robotic TAPP inguinal hernia repair in this six-month 2025 tertiary care series had good short-term safety, low early chronic pain, no early recurrences, and improving operative time with surgeon experience. Costs were still higher than laparoscopic repair. Large multicenter prospective randomized trials with long-term follow-up and full economic assessment are needed to further elucidate the place of robotic TAPP in contemporary hernia surgery.

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Conflict of Interest Statement:
The authors have no conflicts of interest to declare.