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Original Research Article

Endoscopic Total Extra Peritoneal (ETEP) Vs Open Retro-Rectus Hernia Repair in the Management of Ventral Hernia: A Comparative Study and Analysis of Operative Outcomes

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Abstract

Background: Ventral and incisional hernias are common causes of postoperative morbidity and impaired quality of life. Open retro-rectus mesh repair is an established and durable technique; however, endoscopic total extraperitoneal (eTEP) repair allows placement of mesh in the retromuscular plane while potentially reducing abdominal wall trauma, postoperative pain, wound complications, and hospital stay. This study compared the operative, postoperative, and patient-centered outcomes of eTEP and open retro-rectus repair for ventral hernias.

Aim: To compare the operative outcomes, efficacy, safety, postoperative recovery, complications, recurrence, and patient-centered outcomes of eTEP with open retro-rectus mesh repair in the management of ventral hernias.

Materials and Methods: A prospective cohort study was conducted from July 2024 to June 2025 in the Department of General Surgery, Narayana Medical College and Hospital, Nellore. Fifty adult patients with clinically or radiologically confirmed ventral hernias were included and divided into eTEP (n=25) and open retro-rectus (n=25) groups. Operative duration, blood loss, drain requirement, postoperative pain, analgesic requirements, surgical-site complications, hospital stay, functional recovery, late complications, and hernia recurrence were assessed. Patients were followed up at 1 week, 1, 3, 6, and 12 months. Statistical significance was considered at $p<0.05$.

Results: The mean operative time was significantly longer with eTEP than with open retro-rectus repair (118.6 ± 14.8 vs. 92.4 ± 12.6 minutes; $p<0.001$). However, eTEP was associated with significantly lower intraoperative blood loss (72.8 ± 18.4 vs. 148.6 ± 26.3 mL; $p<0.001$) and reduced drain requirement (24% vs. 68%; $p=0.002$). Postoperative pain was significantly lower in the eTEP group at 6, 24, 48, and 72 hours (all $p<0.001$). The duration of parenteral analgesia, total analgesic doses, and rescue analgesic requirement were also significantly lower with eTEP. Surgical-site infection occurred in 4% of eTEP patients compared with 24% following open repair ($p=0.04$). Hospital stay was significantly shorter with eTEP (3.2 ± 0.8 vs. 5.6 ± 1.1 days; $p<0.001$), with earlier ambulation, oral intake, and return to normal activities. Hernia recurrence was 4% with eTEP versus 16% with open repair ($p=0.16$). Overall surgical success was significantly higher in the eTEP group (88% vs. 56%; $p=0.01$).

Conclusion: eTEP repair demonstrated favourable short-term outcomes compared with open retro-rectus repair, with significantly reduced blood loss, postoperative pain, analgesic requirements, surgical-site infection, hospital stay, and time to functional recovery, despite a longer operative duration. Although the difference in recurrence was not statistically significant, recurrence showed a favourable trend with eTEP. eTEP appears to be a safe and effective minimally invasive alternative to open retro-rectus repair in appropriately selected patients, particularly when performed by surgeons with adequate expertise in endoscopic retromuscular techniques.

Keywords: Ventral Hernia; eTEP Repair; Retro-Rectus Mesh; Minimally Invasive Surgery.

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Introduction

Ventral and incisional hernias are prevalent complications of abdominal surgery and a significant source of postoperative morbidity and healthcare expenses. Extensive modern datasets and analyses indicate that incisional hernias develop in around 10–30% of midline laparotomy closures over time, with several patients necessitating surgical intervention and resulting in

significant resource expenditure. The European Hernia Society (EHS) midline incisional hernia guideline underscores modifiable risk factors such as obesity, diabetes, smoking, and identifies quality of life, recurrence, surgical-site occurrences (SSOs), mesh infection, chronic pain, and cost-effectiveness as the most significant outcomes for patients and healthcare systems. [1,2]

Nonetheless, while incisional and primary ventral hernias are sometimes grouped together, it is crucial to acknowledge that each has distinct pathophysiology, differing patient risk factors, and thus, occasionally diverse treatment strategies. Hernias can cause significant discomfort and distress that greatly impact patients' quality of life. Moreover, they may lead individuals to cultivate a harmful body image perception, potentially resulting in serious issues such as intestinal obstruction. Consequently, ventral hernias frequently require surgical intervention and demand repair. [3]

The management of abdominal wall hernias is a rapidly evolving surgical field, driven by the substantial rise in laparotomies and major surgical interventions, advancements in anaesthesiology, an increasing elderly population with weakened connective tissue, and a greater prevalence of hernia risk factors. [4]

Multiple studies shown that the costs related to laparoscopic ventral hernia repair surgery exceeded those of the open approach, mostly owing to the requirement for more expensive types of mesh. Laparoscopic repair is associated with diminished complications, abbreviated hospital stays, fewer readmissions, reduced outpatient visits, and fewer lost workdays compared to open repair. These findings may reduce post-treatment costs and perhaps make this surgical method more economical than open surgery. [5]

New comparative studies indicate that eTEP may decrease surgical site occurrences (SSOs) and minimise length of hospital stay compared to open sublay; however, these findings are new, predominantly observational, and may not accurately represent results in diverse clinical settings or during initial learning phases.

Furthermore, a significant portion of the minimally invasive research juxtaposes eTEP with IPOM; while informative, these comparisons confound the intraperitoneal plane with the retromuscular plane and fail to address the practical dilemma that surgeons currently encounter: endoscopic retromuscular (eTEP) vs open retro-rectus. The EHS midline incisional hernia guideline emphasises the necessity for standardised, patient-centric objectives (quality of life, recurrence, surgical site occurrences/serious surgical site occurrences, mesh infection, chronic pain, expenses), since present research exhibit intolerable heterogeneity. [6,7]

A meticulously structured comparative study from our institution that assesses operative duration, intraoperative complications, conversion rates, early postoperative pain trajectories, surgical site occurrences (including seroma, surgical site infection, and surgical site postoperative infection), length of hospitalisation, 30-day readmission rates, and early recurrence—while incorporating patient- reported quality of life—will fill a significant evidence gap. This data is immediately applicable to daily decision-making, might enhance patient selection and perioperative processes, and may quantify the learning-curve trade-offs associated with eTEP. This study will delineate the circumstances under which eTEP should replace or augment open retro-rectus repair in the therapy algorithm for ventral hernia, by contextualising outcomes within current guideline frameworks and resource utilisation realities.

Aim: To Compare Operative Outcomes, Efficacy and Safety, Patient-reported Outcomes, Clinical Decision-making, Contribute to Evidence-based Practice Endoscopic Total Extra Peritoneal (eTEP) Vs Open Retro-Rectus Hernia Repair in the management of ventral hernia. Objectives: To Compare Recurrence Rates, Complication Rates, Patient-Reported Outcomes, Compare Healthcare Resource Utilization, Identify Predictive Factors and to Provide Evidence-Based Recommendations.

Materials and Methods: This was a Prospective cohort study done from July 2024 to June 2025 in 50 Patients diagnosed with ventral hernias in Narayana Medical College and Hospital, Nellore.

Inclusion criteria: Confirmed ventral hernia (clinical/imaging) in adults ≥18 years willing for surgery (eTEP/Open). Exclusion criteria: Age <18 years, Emergency hernia cases and having Contraindications to general anesthesia.

Outcomes: Primary outcomes: Operative duration (from skin incision to skin closure, in minutes); Postoperative pain severity evaluated using a 10-cm Visual Analogue Scale (VAS) at predetermined intervals (e.g., 6, 24, and 48 hours); Duration of postoperative hospitalisation (in days). Secondary outcomes: Early postoperative complications occurring within 30 days (surgical-site infection, seroma, haematoma, organ/mesh-related events), documented and classified according to standard clinical definitions; postoperative analgesic requirements during the index admission (total opioid equivalents or number of doses of the standard analgesic protocol); hernia recurrence during follow-up; resumption of routine daily activities/work; and patient-reported

satisfaction/comfort (brief Likert/VAS as applicable).

Data collection procedures: Preoperative data encompassed demographics, body mass index (BMI), comorbidities, hernia features (location, defect size where applicable), and previous abdominal procedures. Intraoperative data recorded operative duration, intraoperative occurrences, mesh implantation level, and necessity for drains.

Postoperative evaluations documented pain ratings at predetermined intervals, complications up to day 30, analgesic usage, and duration of hospitalisation. Follow-up appointments were arranged at roughly 1 week (for wound assessment), 1 month, 3 months, 6 months, and 12 months. Recurrence was evaluated clinically at each appointment; supplementary ultrasonography was employed where the clinical assessment was ambiguous.

Statistical Analysis: Analyses were conducted on an intention-to-treat basis, supplemented by per-protocol sensitivity analyses when applicable. Continuous variables were summarised as mean ± SD or median (IQR) according to their distribution (Shapiro–Wilk test). Comparisons across groups employed Student's t-test or Mann–Whitney U test for continuous variables, and χ^2 test or Fisher's exact test for categorical variables. Time-to-event outcomes (e.g., time to recurrence, if relevant) were analysed using Kaplan–Meier estimates accompanied by log-rank testing. Multivariable logistic regression (for binary outcomes like any complication or 30-day surgical site infection) and linear regression (for continuous outcomes such as operational duration and length of hospitalisation) were intended to control for predetermined confounders. A two-sided p-value of less than 0.05 indicates statistical significance. Missing data were addressed mostly using complete-case analysis, with multiple imputation used if the missingness above around 5–10% for critical variables. Statistical analyses were conducted utilising SPSS (version 26.0 or later) or R (version 4.0 or above).

Results

Table 1: Baseline Demographic Characteristics of Study Participants

Variable	eTEP Group	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Age (years)	53.24 ± 7.12	54.36 ± 6.85	0.56	Independent t-test
Male	14 (56.0%)	13 (52.0%)	1.00	Chi-square test
Female	11 (44.0%)	12 (48.0%)		
Body Mass Index(kg/m²)	27.12 ± 3.21	27.46 ± 3.08	27.46 ± 3.08	Independent t-test
ASA I	8 (32.0%)	5 (20.0%)	0.61	Chi-square test
ASA II	10 (40.0%)	11 (44.0%)		
ASA III	7 (28.0%)	9 (36.0%)		

Table 2: Comparison of Clinical and Anthropometric Parameters

Variable	eTEP Group	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Duration of symptoms (months)	14.8 ± 6.3	15.6 ± 7.1	0.67	Independent t-test
Body Mass Index Category				
Normal (18.5–24.9 kg/m²)	6 (24.0%)	5 (20.0%)	0.74	Chi-square test
Overweight (25.0–29.9 kg/m²)	12 (48.0%)	13 (52.0%)		
Obese (≥30 kg/m²)	7 (28.0%)	7 (28.0%)		
H/of Previous Surgery	9 (36.0%)	5 (20.0%)	0.56	Chi-square test
Smoking History	6 (24.0%)	11 (44.0%)	0.75	Chi-square test
Alcohol Consumption	7 (28.0%)	9 (36.0%)	0.77	Chi-square test

Table 3: Distribution of Ventral Hernia Characteristics

Hernia Characteristic	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Type of Ventral Hernia				
Primary Ventral Hernia	15 (60.0%)	14 (56.0%)	0.83	Chi-square test
Incisional Hernia	10 (40.0%)	11 (44.0%)		
Hernia Defect Size Category				
< 4 cm	7 (28.0%)	6 (24.0%)	0.69	Chi-square test
4–8 cm	11 (44.0%)	12 (48.0%)		
> 8 cm	7 (28.0%)	7 (28.0%)		
Location of Hernia Defect				
Midline	18 (72.0%)	19 (76.0%)	0.76	Chi-square test
Paramedian	7 (28.0%)	6 (24.0%)		

Table 4: Comparison of Pre-Operative Risk Factors and Comorbid Conditions

Comorbid Condition	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Diabetes Mellitus	9 (36.0%)	10 (40.0%)	0.77	Chi-square test
Hypertension	11 (44.0%)	12 (48.0%)	0.78	Chi-square test
COPD	3 (12.0%)	4 (16.0%)	0.68	Fisher's Exact test
Ischemic Heart Disease	2 (8.0%)	3 (12.0%)	0.64	Fisher's Exact test
Chronic Kidney Disease	1 (4.0%)	2 (8.0%)	0.55	Fisher's Exact test
Multiple Comorbidities (≥2)	8 (32.0%)	9 (36.0%)	0.77	Chi-square test

Table 5: Comparison of Operative Parameters

Operative Parameter	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Operative time minutes	118.6 ± 14.8	92.4 ± 12.6	< 0.001	Independent t-test
Intra-operative blood loss (mL)	72.8 ± 18.4	148.6 ± 26.3	< 0.001	Independent t-test
Mesh size used (cm^2)	186.4 ± 32.1	162.8 ± 28.6	0.01	Independent t-test
Drain placement required	6 (24.0%)	17 (68.0%)	0.002	Chi-square test
Conversion to open procedure	1 (4.0%)	-	-	-

Table 6: Comparison of Intra-Operative Complications

Intra-operative Complication	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Peritoneal breach	4 (16.0%)	-	-	-
Bleeding requiring additional hemostasis	2 (8.0%)	6 (24.0%)	0.12	Fisher's Exact test
Bowel injury	0 (0%)	1 (4.0%)	0.31	Fisher's Exact test
Anesthetic-related complications	1 (4.0%)	1 (4.0%)	1.00	Fisher's Exact test
Others	6 (24.0%)	8 (32.0%)	0.53	Chi-square test

Table 7: Comparison of Post-Operative Pain Scores (Vas)

Time Interval (Post-operative)	eTEP Group (Mean ± SD)	Open Retro-Rectus Group (Mean ± SD)	p-value
6 hours	4.12 ± 0.83	6.18 ± 0.92	< 0.001
24 hours	3.04 ± 0.76	4.86 ± 0.88	< 0.001
48 hours	1.96 ± 0.68	3.24 ± 0.81	< 0.001
72 hours	1.12 ± 0.52	2.04 ± 0.69	< 0.001

Table 8: Comparison of Post-Operative Analgesic Requirement

Analgesic Parameter	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Duration of parenteral analgesia (days)	1.8 ± 0.6	3.2 ± 0.8	< 0.001	Independent t-test
Total number of analgesic doses required	4.6 ± 1.2	7.8 ± 1.6	< 0.001	Independent t-test
Requirement of rescue analgesia	3 (12.0%)	11 (44.0%)	0.01	Chi-square test

Table 9: Comparison of Early Post-Operative Complications

Post-operative Complication	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Seroma formation	3 (12.0%)	8 (32.0%)	0.09	Chi-square test
Surgical site infection	1 (4.0%)	6 (24.0%)	0.04	Fisher's Exact test
Wound dehiscence	0 (0%)	2 (8.0%)	0.15	Fisher's Exact test
Hematoma	1 (4.0%)	3 (12.0%)	0.30	Fisher's Exact test
Post-operative ileus	1 (4.0%)	2 (8.0%)	0.55	Fisher's Exact test
Other early postoperative complication	5 (20.0%)	13 (52.0%)	0.02	Chi-square test

Table 10: Comparison of Length of Hospital Stay and Early Recovery Parameters

Recovery Parameter	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value
Length of hospital stay (days)	3.2 ± 0.8	5.6 ± 1.1	< 0.001
Time to ambulation (hours)	9.4 ± 2.1	16.8 ± 3.4	< 0.001
Time to oral intake (hours)	11.2 ± 2.6	19.6 ± 3.8	< 0.001

Table 11: Comparison of Time to Return to Normal Daily Activities

Recovery Outcome	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value
Time to return to normal daily activities (days)	7.6 ± 1.8	14.2 ± 2.6	< 0.001

Table 12: Comparison of Late Post-Operative Complications

Late Post-operative Complication	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Chronic postoperative pain (>3 months	1 (4.0%)	5 (20.0%)	0.08	Fisher's Exact test
Mesh infection	0 (0%)	2 (8.0%)	0.15	Fisher's Exact test
Port-site / Incisional hernia	1 (4.0%)	3 (12.0%)	0.30	Fisher's Exact test
Other late complications	2 (8.0%)	8 (32.0%)	0.04	Chi-square test

Table 13: Comparison of Hernia Recurrence Rates

Outcome	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Hernia recurrence	1 (4.0%)	4 (16.0%)	0.16	Fisher's Exact test
No recurrence	24 (96.0%)	21 (84.0%)		

Table 14: Association of Hernia Size and Patient-Related Factors with Operative Outcomes

Factor	Category	Favorable Outcome	Unfavorable Outcome	p-value	Statistical Test
Hernia Defect Size	< 4 cm	12 (92.3%)	1 (7.7%)	0.01	Chi-square test
	4–8 cm	17 (73.9%)	6 (26.1%)		
	> 8 cm	9 (56.3%)	7 (43.7%)		
Body Mass Index	< 25 kg/m²	9 (90.0%)	1 (10.0%)	0.03	Chi-square test
	25–29.9kg/m²	18 (72.0%)	7 (28.0%)		
	≥ 30 kg/m²	11 (61.1%)	7 (38.9%)		
Presence of ≥2 Comorbidities	≥ 30 kg/m²	11 (61.1%)	7 (38.9%)	0.04	Chi-square test
	Yes	10 (58.8%)	7 (41.2%)		
	No	28 (84.8%)	5 (15.2%)		

Table 15: Overall Outcome Assessment and Success Rates

Outcome Measure	eTEP Group (n = 25)	Open Retro-Rectus Group (n = 25)	p-value	Statistical Test
Overall surgical success	22 (88.0%)	14 (56.0%)	0.01	Chi-square test
Overall failure	3 (12.0%)	11 (44.0%)		
Early/Late complications	7 (28.0%)	17 (68.0%)	0.004	Chi-square test
No complication	18 (72.0%)	8 (32.0%)		

Discussion:

Background and rationale: The repair of ventral hernias has progressively transitioned from conventional open surgeries to minimally invasive methods that maintain the essential biomechanical principle of retromuscular (retro-rectus) mesh placement, a concept popularised by the Rives–Stoppa repair, which has long been considered a reliable open solution for midline ventral/incisional hernias.

Simultaneously, advancements in endoscopic and robotic techniques have allowed surgeons to replicate the retromuscular "sublay" plane without accessing the peritoneal cavity, with the objective of minimising wound morbidity, postoperative discomfort, and duration of hospitalisation while ensuring a low recurrence rate. Initial method publications and series, including the original implementation of eTEP principles for ventral hernia, highlighted this benefit: expansive extraperitoneal working area, sublay mesh positioning, and the circumvention of intraperitoneal mesh-related complications. [8]

In this context, our study comparing endoscopic total extraperitoneal (eTEP) repair with open retro-rectus (open Rives–Stoppa/retro-rectus) repair examines the pertinent question: can a minimally invasive retromuscular technique maintain the durability of open retro-rectus repair while enhancing short-term recovery and wound outcomes?

The trend of our findings—prolonged operational duration yet less blood loss, diminished discomfort, fewer wound infections, shorter hospital stays, and expedited functional recovery with eTEP—aligns with the overall pattern observed in published

eTEP outcomes and comparative literature on minimally invasive sublay techniques. [9]

Baseline comparability of groups and implications for internal validity: A significant advantage of our dataset is the precise baseline equivalence between the two groups. The age, sex distribution, BMI, and ASA physical state exhibited no significant differences, and the groups were likewise analogous in terms of symptom duration, BMI categories, previous abdominal surgeries, smoking habits, and alcohol consumption history. The distribution of hernia types (primary vs incisional), defect size categories, and defect locations (midline versus paramedian) was comparable, as was the burden of comorbidities (diabetes, hypertension, COPD, IHD, CKD, and two or more comorbidities). This level of equilibrium mitigates confounding factors and enhances the attribution of observed disparities in perioperative outcomes to the surgical method rather than patient selection. This reflects the design rationale in extensive comparative studies where researchers endeavoured to manage baseline disparities when contrasting eTEP with open sublay repairs. In the comparison cohort of eTEP versus open sublay described by Looft et al., the demographic and clinical variables were mostly comparable between the groups, allowing for the interpretation of outcome differences as technique-related rather than influenced by case-mix. Consequently, our baseline similarity offers a reliable foundation for analysing the ensuing disparities in operational and recovery results. [9]

Operative time: why eTEP takes longer in our hands and how this compares with literature: In our study, the operational duration for eTEP was substantially greater (118.6 ± 14.8 min) compared to open retro-rectus repair (92.4 ± 12.6 min), $p < 0.001$. This discovery aligns with a significant portion of the minimally invasive retromuscular literature, particularly during the initial phases of institutional learning curves. The endoscopic retromuscular dissection, formation of a substantial extraperitoneal space, midline closure, and meticulous mesh placement necessitate more stages than an open retro-rectus procedure, where exposure is direct and instrument triangulation is more straightforward.

Published eTEP series often indicate operating durations within a similar broad spectrum as ours, frequently around 120 to 140 minutes, contingent upon complexity. Montechiari et al. documented an average operating duration of around 137 minutes in a substantial eTEP experience, while also acknowledging a discernible learning curve. Meta-analytic data indicates that eTEP is possible, exhibiting low complication and conversion rates; nevertheless, operational time fluctuates significantly depending on defect size, the inclusion of TAR, and the surgeon's skill. The practical interpretation of our extended eTEP duration suggests that it likely reflects (i) the inherent complexity of endoscopic retromuscular reconstruction and (ii) the anticipated time investment during the adoption of the technique—counterbalanced by significant enhancements in blood loss and recovery outcomes, which are frequently prioritised in minimally invasive decision-making. [10,11]

Intraoperative blood loss and drain usage: our results align strongly with minimally invasive physiology: Notwithstanding the extended operational duration, we noted a markedly reduced blood loss with eTEP (72.8 ± 18.4 mL) compared to open retro-rectus repair (148.6 ± 26.3 mL), $p < 0.001$. This approach is physiologically credible: endoscopic magnification enhances the visualisation of perforators and dissection planes, pneumodissection may control mild haemorrhage, and the diminished open soft tissue trauma reduces raw surface exudation. The necessity for drainage was markedly reduced with eTEP (24%) compared to open retro-rectus repair (68%), $p = 0.002$ (Table 5). with comparative analyses, diminished drain use and abbreviated hospital stays often correlate with minimally invasive sublay techniques—indicative of decreased dead space, smaller incisions, and reduced wound exudate. Looft et al.'s comparative study of eTEP versus open sublay shown that overall postoperative complication rates and hospital stays were more favourable for eTEP, aligning with a subsequent decrease in wound morbidity that frequently diminishes the perceived necessity for extended drainage.

Intraoperative complications and conversion: interpreting safety signals: Our intraoperative complication profile underscores two significant factors: Peritoneal breach transpired alone in the eTEP group (16%), an anticipated outcome peculiar to the method during extraperitoneal dissection. Numerous studies characterise peritoneal opening as a prevalent technical challenge rather than a disastrous complication, often addressed with suturing, clips, or, if necessary, a change in approach. This corresponds with the comprehensive eTEP safety profile, wherein surgical complication and conversion rates are often minimal. A systematic review/meta-analysis of eTEP results indicated pooled intraoperative complication rates of around 2% and a conversion rate of about 1%, varying per research, so affirming that eTEP is generally safe when conducted in suitable environments. [11]

Clinically relevant events—bleeding necessitating further haemostatic intervention and bowel injury—were more prevalent in the open group (bleeding haemostasis: 24% open vs 8% eTEP; bowel injury: 4% open vs 0% eTEP), however

these differences did not reach statistical significance in our sample. Considering our restricted sample size (n=25 each group), these discrepancies may indicate insufficient power rather than actual comparability. Nonetheless, the approach is credible: open dissection along fibrotic planes (particularly in incisional hernia) might elevate the risk of visceral damage, and open exposure may result in more widespread haemorrhage. The 4% conversion rate in eTEP aligns with real-world observations, where conversions are rare yet occur, frequently due to challenging planes, peritoneal rips resulting in less working space, haemorrhage, or unforeseen anatomical variations.

Extensive eTEP series indicate low conversion rates (about 2–3% in certain cohorts). [51] In summary, our intraoperative data indicates that eTEP is both safe and practical, exhibiting approach-specific occurrences (peritoneal breach) without evidence of increase severe iatrogenic harm.

Postoperative pain trajectory: consistent, clinically meaningful benefit with eTEP: Our analysis reveals a notable disparity: eTEP consistently demonstrates a pain benefit over open retro-rectus repair at all assessed early time intervals. VAS ratings were markedly reduced at 6, 24, 48, and 72 hours (all $p < 0.001$). The analgesic consumption statistics corroborate this: a reduced duration of parenteral analgesia (1.8 vs 3.2 days), fewer total doses (4.6 vs 7.8), and less need for rescue analgesia (12% vs 44%), all statistically significant.

This pattern aligns with the reasoning and documented advantages of minimally invasive retromuscular repair: smaller incisions diminish somatic pain; decreased tissue trauma mitigates inflammatory pain; and retromuscular placement without aggressive fixation may alleviate nerve irritation, a concern often highlighted when comparing extraperitoneal sublay with intraperitoneal repairs necessitating tacks or transfascial sutures. The systematic synthesis of eTEP results indicates minimal morbidity and a brief duration of stay, with downstream effects frequently facilitated by less pain and expedited mobilisation. Moreover, comparative analyses of minimally invasive sublay techniques against open repairs frequently highlight diminished discomfort and lower analgesic needs as significant benefits of minimally invasive treatments, despite longer operational durations. [11]

Surgical site infection and early wound morbidity: eTEP advantage is concordant with published evidence: Our first postoperative consequences reveal a substantial distinction between techniques: the incidence of surgical site infection (SSI) was markedly reduced with eTEP (4%) compared to open retro-rectus repair (24%), p = 0. with general, early problems were considerably reduced with eTEP (20% vs to 52%, p = 0.02). This approach is in strong accordance with the recognised premise that smaller incisions and minimised wound dissection decrease the incidence of surgical site infections, particularly in patients with obesity, diabetes, smoking history, and previous surgeries—risk factors present in both groups of our sample. Evaluations of surgical site infections (SSI) in hernia procedures highlight the complex factors contributing to infection and the necessity of reducing wound burden and dead space. Furthermore, the eTEP systematic review/meta-analysis conducted by Aliseda et al. revealed remarkably low pooled SSI rates (about 0% in the aggregated estimate), underscoring the consistently advantageous wound profile associated with minimally invasive retromuscular repairs. The elevated SSI rate in eTEP compared to the pooled estimate is justifiable due to sample size, local perioperative variables, patient risk factors, and the effect of selective reporting and inconsistent follow-up on pooled estimates. [12]

In our investigation, seroma development was lower in eTEP (12%) compared to open repair (32%), however the difference was not statistically significant ($p = 0.09$). Seroma frequently occurs during ventral hernia repair, irrespective of the surgical method, because to the presence of dead space and lymphatic disruption, and typically need bigger samples to identify significant changes. Extensive data indicate seroma rates in the mid-single digits for eTEP in some instances (about 6–7% in particular cohorts), suggesting that with method improvement (such as precise closure, prudent drainage, compression, and minimised dissection), seroma occurrence may decrease. [10]

Collectively, our first morbidity outcomes indicate that eTEP offers a superior wound morbidity benefit compared to open retro-rectus repair—especially regarding surgical site infections—without adding additional categories of severe early postoperative problems.

Length of stay and early functional recovery: our findings match comparative evidence Our recovery endpoints favored eTEP across all measured parameters: Length of stay: 3.2 ± 0.8 days (eTEP) vs 5.6 ± 1.1 days (open), $p < 0.001$ Time to ambulation: 9.4 ± 2.1 hours vs 16.8 ± 3.4 hours, $p < 0.001$. Time to oral intake: 11.2 ± 2.6 hours vs 19.6 ± 3.8 hours, $p < 0.001$, Return to normal daily activities: 7.6 ± 1.8 days vs 14.2 ± 2.6 days, $p < 0.001$

These results are consistent with our pain and complication outcomes and reflect published comparison data. In the eTEP versus open sublay cohort by Looft et al., the duration of hospital stay

was considerably reduced in the eTEP group (median 3 days compared to 5 days), closely aligning with our mean results. Similarly, the extensive research on minimally invasive retromuscular procedures consistently highlights reduced hospitalisation duration as one of the most reliable advantages, frequently observed even with prolonged operational times. [9]

Late complications, chronic pain, and durability: interpreting recurrence signals in a small cohort: Late problems in our sample were either numerically or considerably elevated following open repair. Chronic postoperative pain beyond 3 months was observed in 4% of the eTEP group compared to 20% in the open repair group ($p = 0.08$). Mesh infection was exclusive to the open repair group (8%), and "other late complications" were considerably more prevalent in the open repair group (32% vs 8%, $p = 0.04$). While not all individual endpoints achieved statistical significance, the overall trend in late morbidity is advantageous for eTEP. In the eTEP literature, chronic pain and enduring functional problems are often minimal, although high-quality comparison evidence over the long term is still few. Nevertheless, extensive studies indicate minimal recurrence and tolerable late morbidity, reinforcing the idea that minimally invasive retromuscular repair can be enduring. [10]

Our investigation noted 1 recurrence (4%) in eTEP compared to 4 recurrences (16%) in open repair, $p = 0.16$. The lack of statistical significance probably indicates a restricted sample size and follow-up limitations rather than established equivalency. The impact direction supports eTEP and aligns with the idea that retromuscular mesh implantation, with sufficient overlap and midline closure, should provide lasting reinforcement. Systematic data for eTEP indicates a pooled short-term recurrence rate of around 1%, with many studies exhibiting a relatively brief median follow-up, suggesting a low incidence of early recurrence but highlighting the necessity for extended surveillance. Extensive single-center studies indicate a remarkably low recurrence rate (e.g., <1% in some cohorts) across moderate follow-up periods. [10,11]

In contrast, open retro-rectus repair has demonstrated historical durability; nonetheless, recurrence remains significant, particularly in cases of wound infection. Classic observational studies on open Rives–Stoppa repair emphasised the significant correlation between wound infection/abscess and recurrence risk, highlighting the therapeutic relevance of our substantially elevated SSI rate in the open arm for long¬term durability. Current data consistently indicate favourable long-term outcomes for open retrorectus repairs in appropriately chosen patients; nonetheless, this approach frequently entails increased wound morbidity. [13,14]

Predictors of unfavorable outcomes: hernia size, BMI, and comorbidity burden: Our study of risk factors indicates that: A defect size greater than 8 cm correlated with increased adverse outcomes ($p= 0.01$). A higher BMI (≥ 30 kg/m^2) was associated with worse results ($p = 0.03$). The presence of two or more comorbidities was linked to worse outcomes ($p = 0.04$).

Simultaneously, substantial defects and intricate reconstructions may necessitate advanced methodologies (e.g., eTEP-TAR), with outcomes in these instances being significantly influenced by expertise, surgical planning, and patient optimization—factors highlighted by various eTEP series through discussions on the learning curve and technique evolution. [15]

Overall success rates: integrated interpretation: The composite result indicates a superior overall surgical success rate for eTEP (88%) compared to open retro-rectus repair (56%), $p = 0.01$, and a significantly reduced rate of "any complication" in eTEP (28% vs 68%), $p = 0.004$. These composite findings correspond with comparative studies indicating that less invasive retromuscular procedures can diminish postoperative complications and duration of stay compared to open sublay repairs. The mechanistic basis for the success advantage in our investigation seems to be influenced by: Considerably reduced SSI and overall wound morbidity, markedly diminished pain and analgesic consumption, accelerated mobility and healing milestones, and a favourable (although not statistically significant) trend towards decreased recurrence.

Clinical implications and positioning of eTEP vs open retro-rectus in ventral hernia care: Our findings, in alignment with current research, suggest that eTEP is a procedure that maintains the advantageous retromuscular mesh plane while mitigating the expenses associated with open surgery, including discomfort, wound problems, and extended recovery times. The open retro-rectus repair is a reliable and adaptable procedure, especially in situations where minimally invasive skills or tools are lacking, or when extensive adhesiolysis, previous mesh, loss of domain, or intricate abdominal wall reconstruction are better managed through an open technique. [9]

Conclusion: Endoscopic total extraperitoneal (eTEP) ventral hernia repair exhibited superior short-term outcomes relative to open retro-rectus repair, characterised by reduced blood loss, significantly diminished postoperative pain, fewer wound complications, shorter hospital stays, and expedited functional recovery, notwithstanding an

extended operative duration. The recurrence rates were similar, with a positive inclination towards eTEP.

eTEP is a safe and effective minimally invasive alternative to open retro¬rectus repair, providing superior patient-centered outcomes and reduced morbidity, especially in suitably selected patients, while acknowledging the impact of hernia size, BMI, and comorbidity on surgical outcomes.

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