

Safety, mid-term outcomes and quality of life after eTEP repair for ventral hernia: A prospective study of 100 consecutive patients

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ABSTRACT

Background: The extended-view totally extraperitoneal (eTEP) technique is a minimally invasive approach for ventral hernia repair that allows retromuscular mesh placement without entering the peritoneal cavity. However, prospective data on its safety and mid-term outcomes remain limited. This study aimed to evaluate the safety and mid-term outcomes of eTEP repair.

Methods: This prospective study included 100 consecutive patients undergoing eTEP repair. Demographic, clinical, operative, and follow-up data were analyzed. Quality of life was assessed using the EuraHS-QoL questionnaire, with changes over time evaluated by the Friedman test and Wilcoxon signed-rank test.

Results: The mean patient age was 57.4 ± 12.9 years (range 31–88) and 65% were female. Primary hernias accounted for 54% of cases and incisional hernias for 46%. Standard eTEP repair was performed in 88% of patients, while 12% required transversus abdominis release (TAR). The mean operative time was 132 ± 47 minutes and hybrid conversion occurred in 9% of cases. The median hospital stay was 4 days (range 2–8). Early complications included seroma (7%), surgical-site infection (2%), hematoma (2%), ileus (1%), cellulitis (1%), and paresthesia (1%). Two bowel injuries (2%) occurred, including one intraoperative enterotomy and one unrecognized injury requiring reoperation. After a median follow-up of 21.9 months (range 6–39), hernia recurrence occurred in two patients (2%). Chronic postoperative pain occurred in 4% of patients and was mild. Late mesh infection occurred in two patients (2%). Quality of life improved significantly over time



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(Friedman test, $p < 0.001$), with significant improvements observed at all postoperative time points compared with preoperative values (all $p < 0.001$).

Conclusions: eTEP repair is a safe and feasible minimally invasive technique for ventral hernia repair, associated with low complication and recurrence rates and significant improvement in patient-reported quality of life.

Key words: ventral hernia; laparoscopic hernia repair; eTEP; minimally invasive surgery; quality of life.

Introduction

Ventral hernias, including primary and incisional defects, are common surgical conditions that may lead to chronic pain, functional limitation, and impaired quality of life. Despite advances in surgical techniques, recurrence and postoperative morbidity remain important concerns after ventral hernia repair, highlighting the need for effective and durable treatment strategies (1, 2). Mesh-based repair has become the standard approach, with retromuscular (sublay) mesh placement demonstrating favorable biomechanical properties and lower recurrence rates compared with other mesh positions (3, 4). Although minimally invasive approaches may reduce wound-related complications compared with open repair, intraperitoneal mesh placement in conventional intraperitoneal onlay mesh (IPOM) repair introduces potential mesh–viscera interactions. Conventional open retromuscular repair is associated with wound complications, whereas laparoscopic IPOM repair may lead to intraperitoneal adhesions, bowel injury, and mesh-related complications (1, 2, 5). Minimally invasive retromuscular techniques have therefore been developed to combine the advantages of retromuscular mesh placement with the benefits of laparoscopic surgery. The extended-view totally extraperitoneal (eTEP) approach allows wide dissection of the retromuscular plane without entering the peritoneal cavity, enabling placement of a large mesh with adequate overlap while minimizing visceral contact and surgical trauma (6, 7). Early studies have reported favorable perioperative outcomes and encouraging patient-reported results after minimally invasive ventral hernia repair (2, 7). In addition, improvement

in postoperative quality of life has increasingly become an important outcome measure in modern abdominal wall surgery (4, 6). Nevertheless, prospective data evaluating the safety and mid-term outcomes of eTEP repair remain limited, particularly in Vietnam and Southeast Asian countries, where clinical data on minimally invasive retromuscular ventral hernia repair are still relatively scarce (8, 9). This evidence gap is clinically relevant, as patient characteristics (including body habitus and comorbidity profiles), healthcare resource availability, and surgical practice patterns in Southeast Asia may differ from those reported in studies conducted predominantly in Western populations. Furthermore, real-world prospective data from this region are essential to validate the feasibility and generalizability of the eTEP technique in diverse clinical settings. Therefore, this study aimed to evaluate the safety, mid-term outcomes, and postoperative quality of life following eTEP repair for ventral hernias in a prospective cohort of patients treated at a tertiary center in Vietnam, thereby providing region-specific evidence to complement the existing international literature.

Materials and Methods

Study subjects

This was a prospective, single-center observational cohort study including all consecutive adult patients with primary or incisional ventral hernias who underwent extended-view totally extraperitoneal (eTEP) repair at the Department of General Surgery, Can Tho

General Hospital, Vietnam, between August 2022 and August 2025. The study was designed and reported in accordance with the STROBE guidelines for observational studies. The study did not include a comparator group, as its primary objective was to evaluate the safety and clinical outcomes of the eTEP technique in a real-world setting. No formal sample size calculation was performed, as the study included all consecutive eligible patients during the study period. Ethical approval was obtained from the Institutional Review Board of Can Tho General Hospital, and written informed consent was obtained from all patients prior to inclusion in the study.

Inclusion and exclusion criteria

Patients were included if they were ≥ 18 years old, were diagnosed with primary or incisional ventral hernia, underwent elective surgical repair, and were suitable for laparoscopic retromuscular repair. Patients were excluded if they had emergency surgery (eg, strangulated or contaminated hernias), loss-of-domain hernias, contaminated or dirty surgical fields (Centers for Disease Control and Prevention (CDC) class III–IV), previous mesh infection, or contraindications to general anesthesia.

All patients underwent standardized preoperative assessment, including clinical examination and abdominal computed tomography to evaluate defect

size and location according to the European Hernia Society (EHS) classification (10) (Figure 1).

Surgical approach

All procedures were performed using a standardized eTEP technique according to institutional practice. In selected cases where additional medialization or adequate retromuscular space was required, transversus abdominis release (TAR) was performed. Detailed operative steps are not described, as the primary focus of this study was clinical outcomes rather than surgical technique.

Data collection and outcome measures

Data were prospectively recorded using a standardized case report form and included baseline characteristics (age, sex, body mass index, comorbidities, and American Society of Anesthesiologists (ASA) classification), hernia characteristics, and perioperative variables. Study outcomes included: operative time and length of postoperative hospital stay; early postoperative complications (≤ 30 days), classified according to the Clavien–Dindo system; hernia recurrence; chronic postoperative pain, defined as pain persisting for ≥ 3 months with a visual analog scale (VAS) score ≥ 1 , consistent with standard definitions of chronic pain; and health-related quality of life, assessed using the

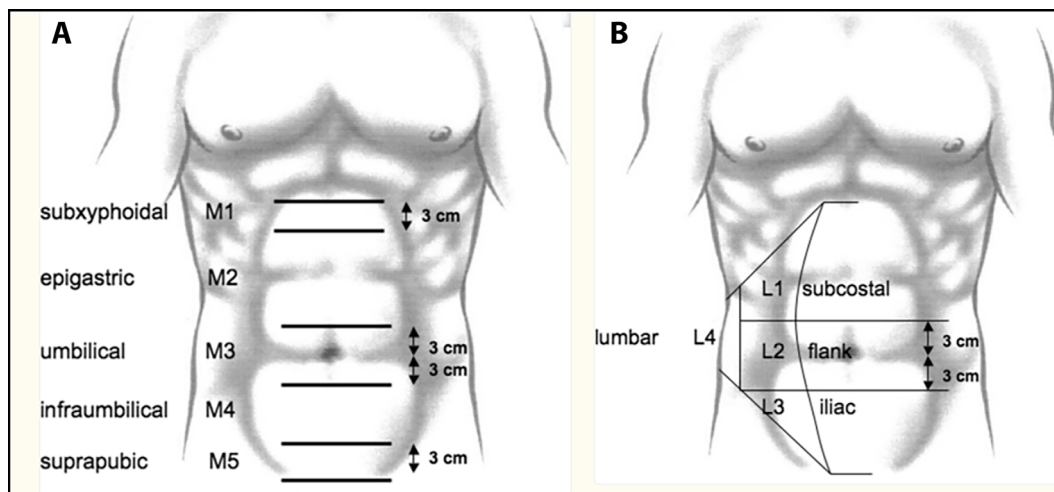


Figure 1. European Hernia Society (EHS) classification of ventral hernias. (A) Midline ventral hernia classification; (B) Lateral ventral hernia classification (10).

European Hernia Society Quality of Life (EuraHS-QoL) questionnaire, a validated hernia-specific instrument evaluating pain, restriction of activities, and cosmetic discomfort (11). The questionnaire was administered in Vietnamese. The original English version was translated by the research team and reviewed by experienced hernia surgeons to ensure conceptual equivalence. The translated version was pilot-tested in a small group of patients before application in the present study.

Patients were followed at 1, 3, and 6 months postoperatively and every 6 months thereafter. Follow-up duration ranged from 6 to 39 months, with a median of 21.9 months. Hernia recurrence was assessed clinically and confirmed by imaging when indicated.

Statistical analyses

Statistical analysis was performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were expressed as mean \pm standard deviation, and categorical variables as frequencies and percentages. Changes in quality-of-life (QoL) scores over time were analyzed using the Friedman test. Pairwise comparisons between preoperative and postoperative QoL scores were performed using the Wilcoxon signed-rank test. All statistical tests were two-tailed, and a p -value < 0.05 was considered statistically significant.

Results

A total of 100 consecutive patients underwent extended-view totally extraperitoneal (eTEP) repair during the study period. The mean age was 57.4 ± 12.9 years (range 31–88), with a median age of 58 years. The mean body mass index (BMI) was 24.4 ± 3.4 kg/m², and women accounted for 65% of the cohort. Most patients were classified as ASA II (63%), followed by ASA I (31%) and ASA III (6%). Hypertension was the most common comorbidity (63%), followed by chronic cardiopulmonary disease (45%) and diabetes mellitus (32%) (Table 1).

Table 1. Baseline characteristics of the study population (n = 100)

Characteristics	Results, n (%)
Mean age, years (range)	57.4 \pm 12.9 (31–88); median 58
Female sex	65 (65%)
BMI, kg/m ²	24.4 \pm 3.4
ASA I	31 (31%)
ASA II	63 (63%)
ASA III	6 (6%)
Hypertension	63 (63%)
Chronic cardiopulmonary disease	45 (45%)
Diabetes mellitus	32 (32%)
Heavy labor	26 (26%)
Smoking	18 (18%)

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists.

Primary ventral hernias accounted for 54% of cases (45% umbilical and 9% epigastric), while incisional hernias represented 46%, including 2% recurrent defects. According to the European Hernia Society classification, most defects were located in the M3 region (63%), whereas lateral defects were less frequent (Table 2).

Standard eTEP repair was performed in 88% of patients, while 12% required additional transversus abdominis release (TAR). The mean operative time was 132 ± 47 minutes. Hybrid conversion was required in 9% of cases. The median postoperative hospital stay was 4 days (IQR 3; range 2–8). Postoperative pain scores decreased progressively from a mean VAS of 4.2 ± 1.47 at 24 hours to 3.2 ± 1.56 at 48 hours and 1.2 ± 1.28 at discharge (Table 3).

Perioperative complications were infrequent. Two bowel injuries (2%) occurred, including one intraoperative enterotomy repaired laparoscopically and one unrecognized injury requiring reoperation with mesh removal. Other early complications included seroma in 7%, surgical-site infection in 2%, subcutaneous hematoma in 2%, ileus in 1%, cellulitis in 1%, and paresthesia in 1%. Most were managed conservatively (Table 4).

Follow-up ranged from 6 to 39 months (median 21.9 months), and 67 patients completed at least

Table 2. Hernia characteristics

Characteristics	Results, n (%)
Hernia type	
Primary	54 (54%)
Incisional	46 (46%)
Primary hernias	
Umbilical	45 (45%)
Epigastric	9 (9%)
Incisional hernias	
First-time	44 (44%)
Recurrent	2 (2%)
EHS midline classification	
M2	12 (12%)
M3	63 (63%)
M4	9 (9%)
M5	3 (3%)
EHS lateral classification	
L1	1 (1%)
L2	5 (5%)
L3	7 (7%)

Abbreviations: EHS, European Hernia Society.

Table 3. Operative outcomes

Outcomes	Results, n (%)
Procedure performed	
Standard Etep	88 (88%)
eTEP + TAR	12 (12%)
Operative time, minutes	132 ± 47
Mesh area, cm ² , mean ± SD	229.8 ± 45.6
Mesh overlap, cm (range)	6.09 (5–7.5)
Hybrid conversion	9 (9%)
Length of hospital stay, days (IQR; range)	Median 4 (3; 2–8)
VAS pain score at 24 h, mean ± SD (range)	4.2 ± 1.47 (3–6)
VAS pain score at 48 h, mean ± SD (range)	3.2 ± 1.56 (2–5)
VAS pain score at discharge, mean ± SD (range)	1.2 ± 1.28 (1–3)

Abbreviations: eTEP, extended-view totally extraperitoneal; TAR, transversus abdominis release; VAS, visual analog scale. *Nine cases required a hybrid approach because of dense adhesions or unfavorable scarring; a small auxiliary incision was used to facilitate adhesiolysis, fascial closure, or cosmetic skin revision.*

12 months of follow-up. Mid-term outcomes, including hernia recurrence, chronic postoperative pain, and late complications, are summarized in Table 5.

Hernia recurrence occurred in two patients (2%). Chronic postoperative pain was reported in 4% of patients and was mild in intensity. Late mesh infection occurred in two patients (2%), both requiring mesh explantation. No other significant late complications were observed.

Health-related quality of life assessed using the EuraHS-QoL questionnaire is presented in Table 6 and Figure 2, with statistically significant changes over time (Friedman test, $p < 0.001$).

As shown in Table 6, the mean QoL score increased slightly at 1–2 weeks postoperatively compared with preoperative values, reflecting early postoperative discomfort, and then decreased progressively from 1 month onward, indicating sustained improvement during follow-up. Pairwise comparisons using the Wilcoxon signed-rank test demonstrated significant differences between preoperative and all postoperative time points (all $p < 0.001$).

The longitudinal trend of QoL changes is illustrated in Figure 2.

Discussion

This prospective cohort study evaluated the safety, mid-term outcomes, and patient-reported quality of life following extended-view totally extraperitoneal (eTEP) repair in 100 consecutive patients with primary and incisional ventral hernias. The principal findings include a low perioperative complication rate, a recurrence rate of 2% during a median follow-up of 21.9 months, a low incidence of mild chronic postoperative pain, and significant improvement in health-related quality of life. These findings suggest that minimally invasive retromuscular repair using the eTEP approach is feasible and associated with favorable clinical outcomes in a tertiary surgical center in Vietnam. Previous reports have similarly demonstrated that minimally invasive retromuscular techniques can achieve favorable clinical outcomes while preserving

Table 4. Perioperative and late complications

Complications	n (%)	Management	Clavien–Dindo Classification
Intraoperative bowel injury	1 (1%)	Repaired laparoscopically during surgery	Not classified
Unrecognized bowel injury diagnosed postoperatively	1 (1%)	Reoperation on postoperative day 3 with bowel repair and mesh removal	Grade IIIB
Clinical seroma	7 (7%)	One case required aspiration; others managed conservatively	Grade II–IIIA
Surgical site infection	2 (2%)	Conservative treatment	Grade II
Subcutaneous hematoma	2 (2%)	Conservative treatment	Grade I
Ileus	1 (1%)	Conservative treatment	Grade II
Cellulitis	1 (1%)	Conservative treatment	Grade II
Paresthesia	1 (1%)	Conservative treatment	Grade I
Late mesh infection	2 (2%)	Mesh explantation performed at 3 and 20 months	Grade IIIB

Table 5. Mid-term follow-up outcomes

Outcome	Results
Follow-up duration, months	Median 21.9 (range 6–39)
Patients with ≥12-month follow-up	67 (67%)
Hernia recurrence	2 (2%)
Chronic postoperative pain (mild)	4 (4%)
Late mesh infection	2 (2%)
Other late complications	0
EuraHS-QoL	QoL data are presented separately in Table 6

Abbreviations: EuraHS-QoL, European Hernia Society Quality of Life questionnaire.

Two recurrences occurred during follow-up: one overweight patient with an epigastric incisional hernia at 3 months and one patient with primary epigastric hernia associated with heavy labor and smoking at 20 months. Four patients reported mild chronic pain only during strenuous activity.

Table 6. Changes in EuraHS-QoL scores over time

Time point	Mean ± SD	p-value vs pre-op
Pre-op	29.0 ± 1.4	–
1–2 weeks	32.5 ± 1.7	<0.001
1 month	13.4 ± 1.2	<0.001
3 months	8.3 ± 1.3	<0.001
6 months	4.0 ± 1.2	<0.001
12 months	2.6 ± 1.1	<0.001

the biomechanical advantages of sublay mesh placement (1, 2, 6, 7, 12).

Perioperative safety and feasibility

Overall perioperative outcomes in the present study were acceptable and consistent with previously reported experiences of minimally invasive retromuscular ventral hernia repair. Seroma occurred in 7% of patients, which is comparable to rates reported in contemporary series of eTEP and other minimally invasive retromuscular approaches (8, 12, 13). Seroma formation remains one of the most common postoperative events after ventral hernia repair and is influenced by dead space formation and tissue dissection (14, 15). Other early complications, including hematoma and superficial surgical-site infection, were uncommon and were successfully managed with conservative treatment. Similar perioperative safety profiles have been reported in recent prospective and retrospective studies evaluating minimally invasive retromuscular techniques (16, 17). Two bowel injuries (2%) were observed in our cohort. Enterotomy remains a recognized risk during ventral hernia repair, particularly in patients with previous abdominal surgery and dense adhesions (18). The observed bowel injury rate of 2% remains within the range reported in the literature. Large analyses have also demonstrated that adhesiolysis during minimally invasive ventral hernia repair

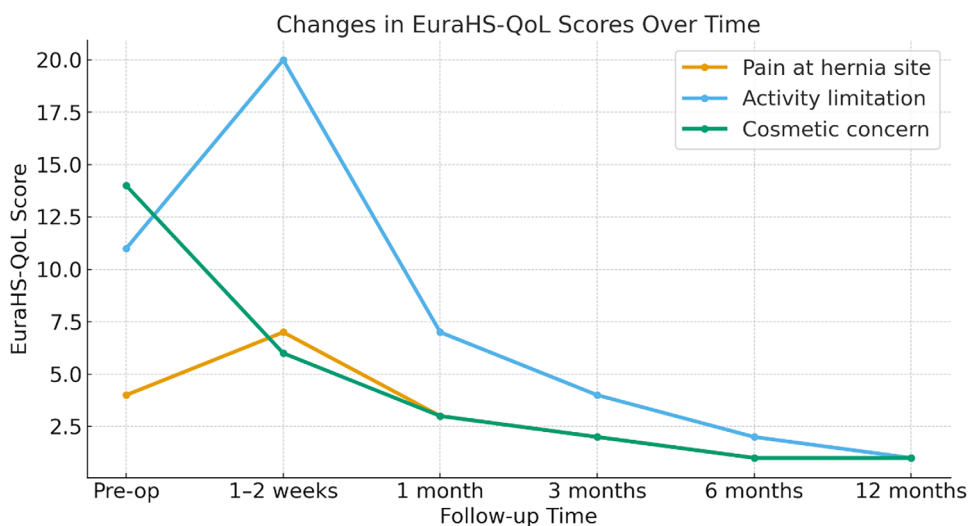


Figure 2. Longitudinal changes in EuraHS-QoL scores following eTEP repair. QoL scores were slightly worse at 1–2 weeks after surgery and then improved progressively from 1 month onward.

is a major risk factor for intraoperative complications, including bowel injury (19). Importantly, despite these risks, the overall complication profile in our study remained within the ranges reported in contemporary ventral hernia series, although direct comparison should be interpreted with caution given differences in study design and patient populations. The mean operative time of 132 ± 47 minutes was comparable to that reported in early clinical experiences with the eTEP approach (12, 13). Previous reports indicate that operative time generally decreases with increasing surgical experience, reflecting the learning curve associated with retromuscular dissection and posterior component separation techniques (18, 19). This learning curve may have influenced operative efficiency in the present study, particularly during the early phase of implementation. The hybrid conversion rate of 9% observed in this study likely reflects careful intraoperative decision-making in technically demanding cases rather than procedural failure. Conversion strategies have been described as part of safe adoption of the eTEP technique, particularly during the early learning phase of minimally invasive retromuscular surgery (16). Therefore, the observed conversion rate may also be partly attributable to the institutional learning curve. Selective use of transversus abdominis release (12%) in this series is also consistent with modern

abdominal wall reconstruction principles. Posterior component separation is typically reserved for larger defects requiring medialization of the rectus muscles and tension-free fascial closure (20, 21).

Mid-term recurrence and durability

Hernia recurrence occurred in two patients (2%) during follow-up. This recurrence rate compares favorably with previously published minimally invasive retromuscular series, where recurrence rates generally range between 2% and 6% at comparable follow-up intervals (8, 12, 13). Our findings are consistent with previous clinical experience from our institution, where the eTEP approach demonstrated favorable early outcomes in patients with midline ventral hernias (8). Retromuscular mesh placement has consistently been associated with improved durability compared with other mesh positions, including onlay and intraperitoneal mesh placement (3, 22). By restoring the posterior layer and enabling wide mesh overlap, the eTEP approach preserves the biomechanical advantages of the traditional open sublay repair while reducing wound morbidity and avoiding intraperitoneal mesh contact (6). Comparative studies have increasingly demonstrated favorable outcomes for minimally invasive retromuscular techniques compared with intraperitoneal

onlay mesh (IPOM) repair. Several randomized and observational studies have reported lower complication rates, reduced postoperative pain, and comparable recurrence rates following eTEP repair (23-25). More recent comparative analyses have further supported the clinical advantages of the eTEP approach. Studies comparing eTEP with IPOM have reported favorable early outcomes and comparable long-term durability (26-29). In addition, economic analyses suggest that extraperitoneal mesh placement may reduce long-term healthcare costs associated with mesh-related complications (30). Our findings are consistent with these observations and provide additional prospective data supporting the feasibility of the eTEP approach as a minimally invasive option for ventral hernia repair in a Southeast Asian population.

Chronic pain and mesh-related complications

Chronic postoperative pain was reported in 4% of patients in the present study and was mild in all cases. Chronic pain is increasingly recognized as an important outcome after ventral hernia repair and may significantly affect long-term patient satisfaction and functional recovery (31). Previous studies have suggested that retromuscular mesh placement may reduce nerve irritation and visceral contact compared with intraperitoneal mesh placement, potentially explaining the lower incidence of persistent pain observed with minimally invasive retromuscular techniques (17, 23). Late mesh infection occurred in two patients (2%), both requiring mesh removal. Although uncommon, late mesh infection remains one of the most challenging complications in abdominal wall surgery and may occur months or even years after the initial procedure (23). Fortunately, the incidence observed in our cohort remains within the lower range reported in contemporary ventral hernia literature.

Quality of life outcomes

A major strength of the present study is the prospective assessment of health-related quality of life using the validated EuraHS-QoL questionnaire. The use of a validated, disease-specific instrument and prospective follow-up strengthens the reliability of

patient-reported outcomes. Significant improvements were observed across all domains during follow-up, including pain, activity limitation, and cosmetic satisfaction. In recent years, patient-reported outcomes have become increasingly important in abdominal wall surgery, complementing traditional clinical endpoints such as recurrence and complications (21). Several studies have demonstrated that successful ventral hernia repair can significantly improve functional status and overall quality of life. Furthermore, avoidance of intraperitoneal mesh contact and restoration of abdominal wall anatomy may contribute to improved postoperative comfort and physical function (24). These findings are consistent with the significant improvements observed in our patient cohort.

Learning curve and institutional experience

The eTEP technique is technically demanding and requires detailed knowledge of retromuscular anatomy and advanced laparoscopic dissection skills. Previous studies have suggested that the learning curve for eTEP repair may plateau after approximately 20–30 cases (13, 20).

The acceptable perioperative outcomes observed in the present study likely reflect increasing institutional experience and standardization of operative technique within our center. Adoption of structured training and progressive case selection may further facilitate safe implementation of minimally invasive retromuscular repair in other institutions.

Regional relevance

Most published studies on eTEP repair originate from Western centers, whereas prospective data from Southeast Asia remain limited. In the present cohort, patient characteristics, including lower body mass index and differences in occupational activity, may differ from those reported in Western populations. Despite these differences, perioperative outcomes, recurrence rates, and quality-of-life improvements in our study were comparable to those reported in international series (8, 12). These findings suggest that the eTEP technique is feasible and reproducible in diverse clinical settings, including resource-variable environments in Southeast Asia.

Limitations

Several limitations should be acknowledged. First, this was a single-center observational study without a comparator group, which limits causal inference. Second, no formal sample size calculation was performed, which may affect the statistical power of the study. Although follow-up extended to 39 months in some patients, longer-term durability beyond three years remains to be established. In addition, only 67% of patients had follow-up beyond 12 months, which may limit the accuracy of long-term outcome assessment. Finally, the results may be influenced by the learning curve associated with the eTEP technique, particularly during the early phase of implementation. Despite these limitations, the present study demonstrates that eTEP repair provides a favorable balance between perioperative safety, mid-term durability, and improvement in patient-reported quality of life. In centers with appropriate expertise, the eTEP approach may represent a feasible minimally invasive alternative to both open retromuscular repair and intraperitoneal mesh techniques. Future multicenter prospective studies and long-term registry analyses will be important to further define the role of eTEP repair in contemporary ventral hernia management.

Conclusions

eTEP repair is a safe and feasible minimally invasive technique for ventral hernia repair, with low rates of perioperative complications and recurrence. In this prospective cohort study, the procedure was associated with a low incidence of mild chronic postoperative pain and significant improvement in patient-reported quality of life. These findings support the feasibility and clinical benefits of eTEP repair in a tertiary center setting. Further multicenter studies with longer follow-up are needed to confirm long-term durability.

Abbreviations: ASA, American Society of Anesthesiologists; eTEP, extended-view totally extraperitoneal; IPOM, intraperitoneal onlay mesh; QoL, Quality of Life; TAR, transversus abdominis release; VAS, visual analog scale; EuraHS-QoL, European Hernia Society Quality of Life questionnaire.

Data Sharing Statement: Raw data were generated at Can Tho General Hospital. Derived data supporting the findings of this study are available from the corresponding author on request.

Ethical Approval: The study protocol was approved by the Ethics Committee of Can Tho General Hospital (Approval No. 01/CN-HĐĐĐ, April 6, 2022). All procedures were conducted in accordance with the Declaration of Helsinki.

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Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Authors Contribution: V.P.L: Conceptualization, Design, Methodology, Formal analysis, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing; A.V.D: Data curation, Investigation, Writing – review and editing; V.Ph.L: Data curation, Investigation, Writing – review and editing. All authors made substantial contributions to the work, approved the final version of the manuscript, and agree to be accountable for all aspects of the study.

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