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RESEARCH ARTICLE

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Falciform Ligament Laparoscopic Approach for Preperitoneal Ventral Hernia Repair

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ABSTRACT

Background and Objectives: To overcome the limitations of intraperitoneal mesh and technically demanding extraperitoneal techniques, the "Falciform Ligament Laparoscopic Approach for Preperitoneal Ventral Hernia Repair" method, enables direct optical entry into the preperitoneal space using the falciform fat as a safety buffer. This approach avoids fascial division to maintain structural integrity.

Methods: Between December 2018 and December 2024, 50 patients with primary, midline, medium-sized ventral hernias underwent repair using the technique. Primary outcomes included operative duration, complication rate and recurrence. Preperitoneal entry was achieved by a 5-mm optical trocar in the epigastrium. Upon space creation and hernia reduction, mesh was placed without fixation.

Results: Fifty patients (mean age 41.2 ±7.6 years; body mass index [BMI] 29.4 ±4.7 kg/m^2) with umbilical/paraumbilical hernia (M3-European Hernia Society classification) and mean defect size 2.9 ±0.6 cm underwent repair using the technique. All surgeries were completed laparoscopically without intraoperative complications. Median operative time was 85 minutes; median hospital stay was 1 day. Pain scores (visual analogue scale) were low: 1.7 (evening), 1.3 (day 1), 0.8 (day 7). No complications occurred, except one hematoma-resolved after aspiration; two seromas—no intervention needed; no recurrences observed over a 41-month median follow-up.

Conclusion: It is a feasible, safe, structurally preserving technique with favorable outcomes. By eliminating mesh fixation and enabling early discharge with minimal postoperative pain, it offers a potential cost advantage. Further multicenter validation is warranted.

Key Words: Abdominal wall reconstruction, eTEP technique, Extraperitoneal mesh placement, Minimally invasive surgery, Rives-Stoppa, Umbilical..

INTRODUCTION

Recent ventral hernia guidelines[1] emphasize the importance of placing mesh outside the peritoneal cavity, favoring preperitoneal or retrorectus position to reduce complications of intraperitoneal mesh.

The retrorectus space offers a well-vascularized environment, ideal for mesh incorporation[2,3]; however, access necessitates division of the posterior rectus sheath, a vital fascial structure contributing to abdominal wall integrity. In contrast, the preperitoneal space, is a naturally occurring, expansive anatomical plane which allows mesh placement without disrupting any natural abdominal wall support, providing a structurally

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Acknowledgments: Prof. Shaji Thomas, MS, DNB, Director-Professor of Surgery at Lady Hardinge Medical College, New Delhi, for his invaluable scientific support and assistance in organizing the manuscript. Dr. Farhat Arsalan, MBBS, FCPS, MRCS, Arab Board, Consultant General and Laparoscopic Surgeon at Zulekha Hospital, Sharjah, for her essential role as part of the operative team. Dr. Nafad Elhadidi, MBBch, MSc, Consultant and Head, General, Laparoscopic, and Vascular Surgeon at Zulekha Hospital, Sharjah, for his significant contributions as part of the operative team.

Conflict of interests: none.

Disclosure: none.

Funding sources: none.

Compliance with Ethical Standards: The study was approved by the institutional ethical review committee, and all treatments followed the principles of the 1964 Helsinki Declaration and its later amendments.

Consent: All patients signed informed consent which included consent to participate and for publishing their data and operative photographs.

The original technique and initial results were presented at following international conferences and online platforms: (1) American College of Surgeons Annual Clinical Congress 2024, held at San Francisco, CA, October 19–22, 2024, as a part of video-based education; (2) Hernia Surgery Webinar for Video-based Education, American College of Surgeons on February 25, 2025, for discussion about the technique; (3) AWR Deep Impact-Surge, held at Chennai, India, March 6–9, 2025 as a part of main hall video presentation; (4) the procedural video supplied with this article is also uploaded to social media platforms like: Facebook "International Hernia Collaboration" group, LinkedIn, and YouTube.

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DOI: 10.4293/JSLS.2025.00085

conserved and anatomically favorable alternative for ventral hernia repair.[4,5]

A pivotal observation, that the peritoneal compartment could remain intact during the superior crossover in the extended totally extraperitoneal (eTEP) sparked the concept of utilizing falciform ligament fat as a protective cushion for direct entry.[2,6] This foundational idea, coupled with visually guided access by optical-view trocar, paved the way for a prospective study evaluating the feasibility, safety, and efficacy of the falciform ligament laparoscopic approach for preperitoneal ventral hernia repair (FLAP-VH).

MATERIAL AND METHODS

Study Design and Patient Selection

A prospective study was conducted at author's institution, over a 6-year period (December 2018 to December 2024), following approval from the institutional ethics committee. All consecutive patients undergoing elective surgery for primary midline ventral hernia (M2, M3, M4 according to the European Hernia Society classification) were enrolled. Clinical examination supplemented by ultrasound were used to identify and characterize the hernia, diagnose associated intrabdominal pathologies, note rectal diastasis if any. Computed tomography (CT) scans were selectively performed in cases of complexity or suspicion of intra-abdominal pathology.

Patients with recurrent hernias, prior laparotomy, rectal diastasis >3 cm, severe comorbidities (e.g., uncontrolled diabetes, cardiopulmonary disease) and those unfit for general anesthesia or for laparoscopy were excluded from study. Similarly, those for emergency surgery or with intestinal obstruction were also excluded.

The patient demographics, hernia characteristics, and operative information (type of mesh, operative time, peritoneal holes—none/repaired/unrepaired, small), hospital stay, complications and recurrence were recorded. The primary outcome of the study included operative time, postoperative complication rates, and hernia recurrence. Pain score was noted on evening of surgery, 1st postoperative day and after a week during follow-up. The first follow-up at 1 week included clinical examination for any complications or recurrence. Subsequently telephonic interview assessment (validated questionnaire[7]) was done at 1, 3, 12 months after surgery and annually after that. Patients were instructed to visit if they experience any symptoms (bulge, pain, tender area, redness over belly, fever) or if any detected during telephonic interview. Patients not reachable by telephone were interviewed by email. Clinical examination and or imaging (ultrasound/CT) was conducted in case of any suspected recurrence or complication

Statistical analysis.
Qualitative data were expressed as percentages and quantitative data as the mean ± standard deviation (SD) or median (minimum to maximum; interquartile range [IQR]) according to their distribution. Statistical assessments were conducted using Excel program.

Surgical Technique

Patient preparation, OT setup, and marking.
General anesthesia was administered

With patient in supine position, the flex point of table was placed just above thoracolumbar junction, to produce reasonable extension (10–15°F) at thoracolumbar junction and thoracic spine. This provided space for

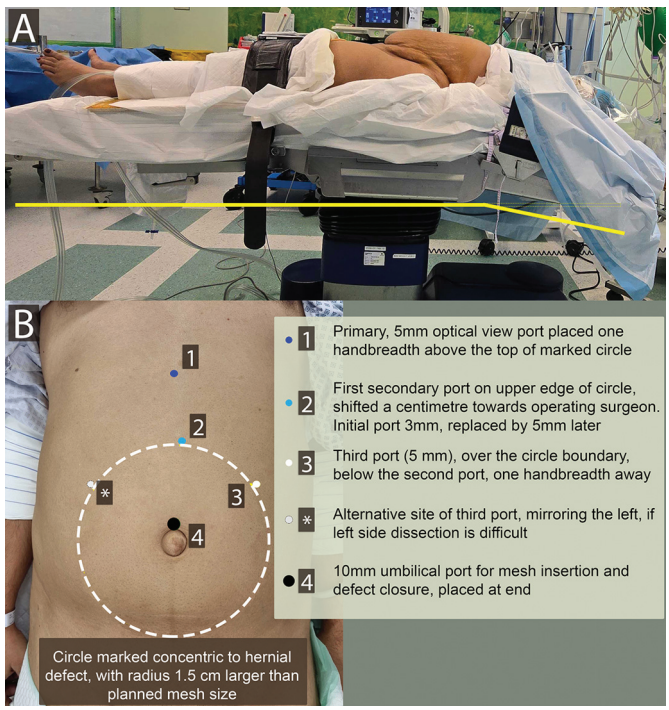

Figure 1. (**A**) Patient position with table flexion (10–15 degrees) at thoracolumbar junction, to provide space for scope handling without colliding with endotracheal tube. (**B**) Abdominal marking and port positions.

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scope handling without colliding with endotracheal tube (**Figure 1A**).

Both arms were tucked in, and the equipment around operating table allowed unhindered movement of operating surgeon from one side to another, if required.

The surgeon stood to the patient's left, with the camera assistant positioned cranially on the same side.

A circle was drawn over the abdominal wall, centered on the hernia defect, with a radius 1.5 cm larger than the planned mesh size (**Figure 1B**). The mesh size was calculated to maintain a defect-to-mesh area ratio exceeding 1:16.

Equipment.

A 5-mm, 0-degree scope with 5-mm optical view trocar was deployed for initial access, replaced by 30-degree scope for working (**Figure 2A**). The first secondary port was 3mm pediatric port, through which 3mm scissors with diathermy were used to create space for subsequent port (**Figure 2B**). Vessel sealing- division device was advantageous for quick dissection, without exchange of instruments; in its absence, conventional electrocautery was acceptable. Both coated and polypropylene meshes were kept ready.

Optical trocar-assisted entry.

Primary trocar entry was achieved using a 5-mm optical-view trocar placed in the epigastric quadrant, a handbreadth above the marked circle. It was advanced vertically down under vision through all layers, stopping just beyond the posterior sheath within the falciform ligament fat. The trocar was then angled caudally targeting the plane between posterior sheath and preperitoneal fat, using the glistening posterior sheath as a key landmark for correct plane identification (**Figure 2A**).

Port placement.

A 3-mm pediatric trocar served as the first secondary port, minimizing insertion force in the limited space. It was placed at the upper edge of the marked circle following scope-guided caudal dissection and confirmation by a percutaneous needle. The third port (5 mm) was placed over the circle boundary, below the second one, hand's breadth away from it—typically on the left, or mirrored on the right, if left dissection was difficult.

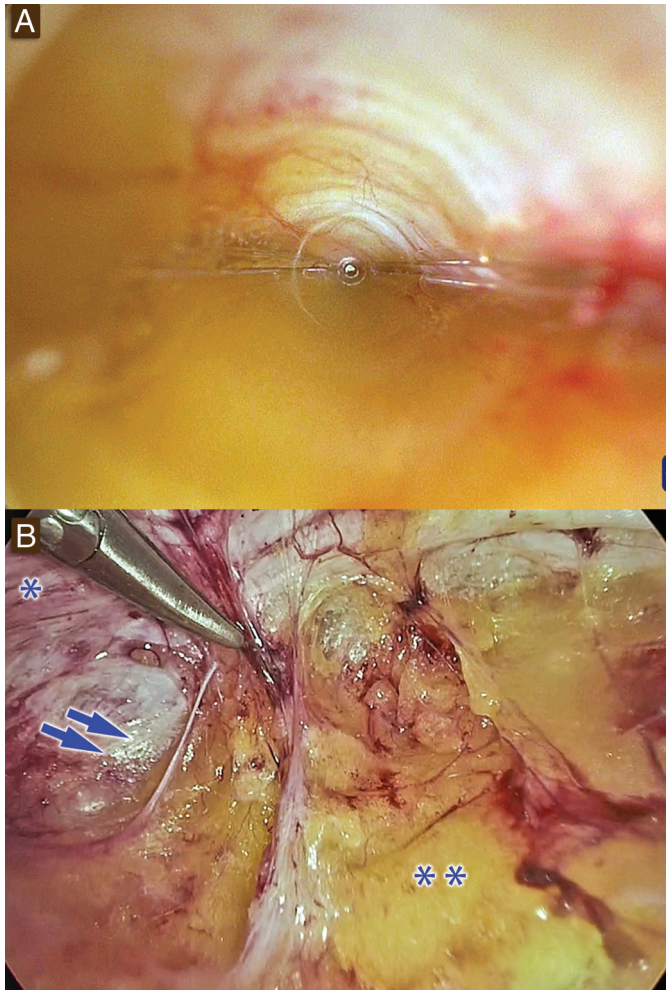

Figure 2. (**A**) View from optical view trocar showing glistening fibers of posterior rectus sheath (over upper half) indicating correct entry plane. (**B**) Initial space creation using 3-mm scissors. The fine network of fibers (arrows) between posterior rectus sheath (*) above and peritoneum (**) below.

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A 10-mm umbilical trocar was added later to introduce the mesh and close the hernial defect (**Figure 1A**).

Preperitoneal space creation.

Dissection was done over the posterior sheath, rather than towards the peritoneum or the cleavage between peritoneum and posterior sheath (**Figure 3**).

Adherent areas were addressed with sharp division of clinging fibers, while gentle blunt sweeping, helped peel off the peritoneum. Traction-countertraction was particularly effective for peripheral dissection.

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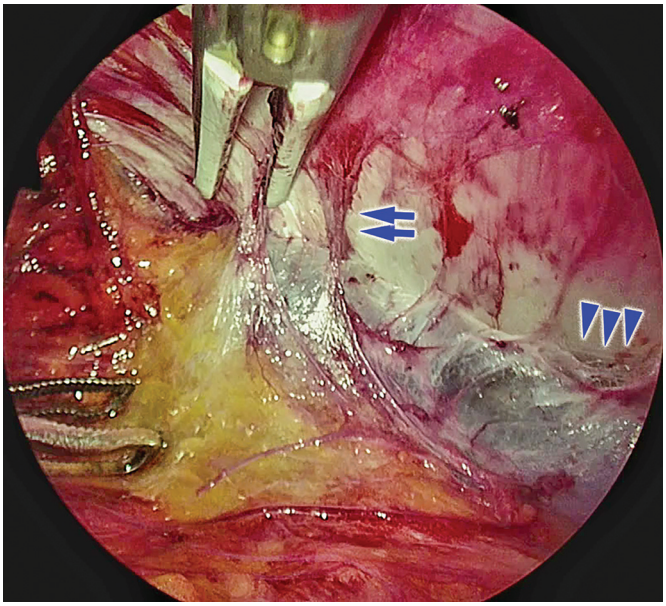

Figure 3. Correct plane of dissection (two arrows) lies superiorly above the natural cleavage between peritoneum and posterior rectus sheath (three arrow heads). Translucent fat deficient peritoneum visible at 4 o clock corresponding to linea semilunaris (right upper abdomen).

Dissection was done in the upper hemisphere followed caudally on either side of hernia. Lateral extension beyond the linea semilunaris required delicate handling, due to the thin, fat-deficient, and adherent peritoneum in that zone. Separation of fibers on the undersurface of the posterior sheath allowed the peritoneum to drop down safely; the optimal plane lay on the roof, above the natural peritoneum-sheath cleavage (**Figure 3**).

The final segment of caudal dissection below the arcuate line was convenient due to loose peritoneal attachments and abundant areolar tissue, similar to TEP inguinal hernia repair.

Hernial sac management.

The hernia sac was addressed last to preserve the preperitoneal space, which could be compromised by inadvertent peritoneal entry. The preferred approach was complete sac separation while preserving umbilical skin integrity and avoiding thermal injury—achieved with traction-countertraction and minimal energy use (**Figure 4A**). F4

If the sac was densely adherent or contained bowel, contents were first reduced via entry near the sac neck, followed by safe dissection of the remaining sac.

Managing structures around umbilicus.

Anatomical knowledge and coagulation-division of periumbilical helped in progressing safely:

Superior to umbilicus: Paraumbilical veins in falciform ligament.

Inferior to umbilicus: Obliterated umbilical arteries in medial umbilical fold; Urachus in median umbilical fold (**Figure 4B**).

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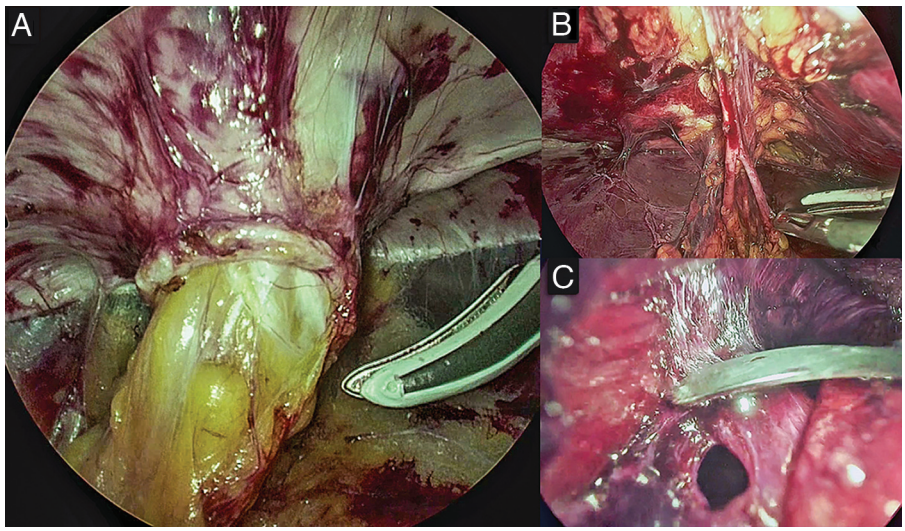

Figure 4. (**A**) Hernia defect with sac containing omentum, being manipulated out. (**B**) Urachus and medial umbilical ligaments in common fascial covering. (**C**) Peritoneal breach managed by cold scissors, away from the site of peritoneal injury.

The inferior epigastric vessels in the lateral umbilical fold could be reliably preserved.

Managing peritoneal holes.
Occurring early, they can jeopardize the decision to continue the procedure, while after substantial space creation they have negligible effect on progress.

Strategies to manage:

Veress needle at Palmer's point to desufflate peritoneal cavity and restore preperitoneal space.

Manual pressure over abdominal wall, combined with one-handed dissection, helped lower the wall back into the operative field when it ballooned upward under effect of pneumoperitoneum.

Continuing dissection near a defect often enlarged the hole; instead, working around it and gently releasing adjacent tissue allowed the peritoneum to drop naturally. Cold scissors were optimal for precise release (**Figure 4C**).

Flap mobilization reduced hole size; Small, pinpoint holes with no risk of bowel herniation were left unrepaired, while larger ones were closed with 3-0 absorbable suture after complete release.

Holes beneath the hernial defect were closed later, via the 10-mm umbilical port; peripheral defects were repaired laparoscopically.

Type of mesh and placement.
Preoperative skin markings confirmed adequate dissection before mesh deployment (**Figure 5A**).

F5

A polypropylene mesh was used when the peritoneum was intact or repaired (**Figure 5B**); coated mesh was reserved for unrepaired breaches.

A 10-mm umbilical port was introduced at this stage for mesh insertion. The mesh was evenly spread and centered beneath the defect using an absorbable (PDS) suture, without formal fixation.

Desufflation, following Jackson-Pratt drain placement, allowed peritoneal recoil to sandwich the mesh securely against the abdominal wall.

Closure and conclusion of procedure.
The hernial defect was conveniently closed using absorbable (PDS No. 1) suture through 10-mm umbilical port opening, which avoided complex laparoscopic endosuturing on the roof. Any peritoneal holes beneath the defect were repaired beforehand. Both aforementioned steps were performed during umbilical port placement, though hernial defect sutures were tightened at the end.

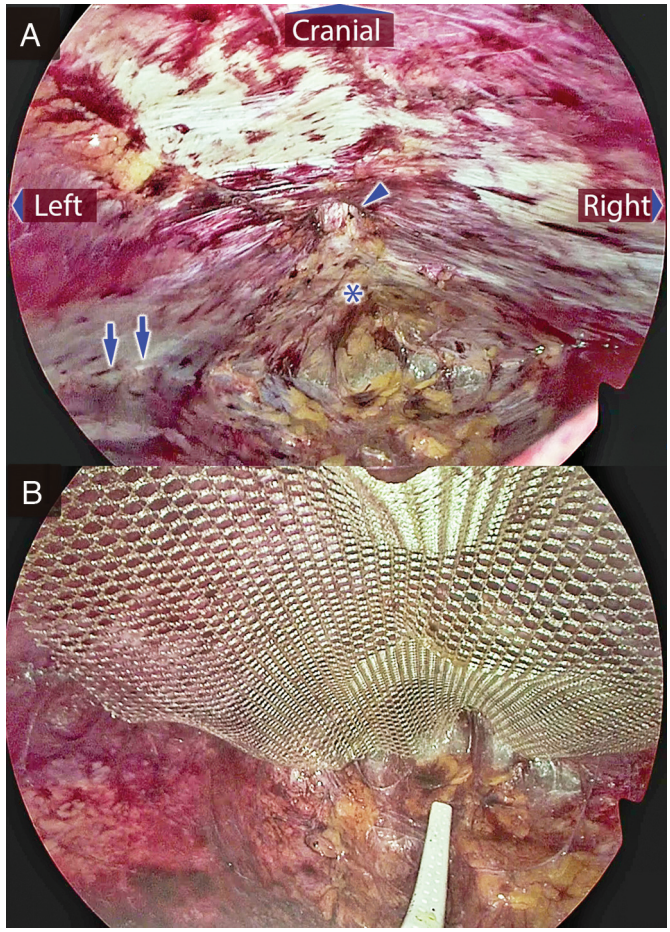

Figure 5. (**A**) Panoramic view of completed dissection showing hernial defect (arrowhead); junction (arrows) of peritoneum below and posterior rectus sheath above. Asterisk marks fatty peritoneum over caudal aspect. (**B**) Polypropylene mesh spread evenly without fixation and drain placed underneath.

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A transversus abdominis plane (TAP) block under ultrasound guidance was applied, upon conclusion of procedure.

Discharge and drain removal.
Patients were discharged once ambulant, tolerating oral intake, and experiencing tolerable pain—typically on the first postoperative day.

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Drain was usually removed on day one if output was <30 ml/24 hours; otherwise, patients were advised to return for removal later.

RESULTS

A total of 50 patients (62% male, 38% female) with primary midline ventral hernias underwent repair using the FLAP-VH technique. The mean age was 41.2 ±7.57 years (range: 28–53), and the mean body mass index (BMI) was 29.42 ±4.68 kg/m^2 (range: 20.2–41.62). All patients were classified as ASA grade I or II and had umbilical/paraumbilical hernia (M3, European Hernia Society classification (EHS)) without significant rectus diastasis (<3 cm). The mean defect size was 2.92 ±0.64 cm (range: 2–4 cm), corresponding to medium (defect size 2–4 cm) of the EHS classification.

All procedures were successfully completed without intraoperative complications or conversion to intraperitoneal or open approaches. Intraoperatively, no peritoneal breach happened in 58% of cases (n = 29) while 32% (n = 16) had small peritoneal holes which did not require any repair. Larger tears requiring peritoneal repair were encountered in 10% (n = 5). Those with no holes or repaired holes received polypropylene mesh—68% (n = 34), while those with unrepaired tiny holes received coated mesh—32% (n = 16).

The median operative time was 85 minutes (IQR: 71.25–118.5), and the median hospital stay was 1 day (IQR: 1–1). Postoperative pain scores, assessed using the visual analogue scale (VAS), were as follows:

- Evening of surgery: 1.70 ± 0.67
- Day 1: 1.26 ± 0.56
- Day 7: 0.82 ± 0.52

Postoperative complications were minimal. Based on standardized definitions by Haskins et al[8,9] for wound events following ventral hernia repair, one patient (2%) developed a hematoma managed by percutaneous aspiration following liquefaction, thus categorized as a surgical site occurrence (SSO) requiring procedural intervention (SSOPI). Two patients (4%) developed seromas that resolved spontaneously and hence classified as a SSO.

Recurrence Analysis

Patients with ≥12 months of follow-up.
Only patients with a minimum follow-up duration of 12 months were included in recurrence analysis. Forty-four out of total 50 patients who met this criterion, had a median follow-up duration of 41 months (IQR: 24.5–59 months). No hernia recurrences were observed during this period.

DISCUSSION

Laparoscopic ventral hernia repair has undergone significant evolution since the introduction of the intraperitoneal onlay mesh (IPOM) technique (LeBlanc and Booth, 1993),[10] driven by concerns regarding adhesion formation, chronic pain, and mesh-related complications, leading to a paradigm shift toward extraperitoneal mesh placement.

Retrorectus Approach (eTEP): The enhanced view TEP (eTEP) technique (Belyansky, Daes) joins both retrorectus spaces by dividing the posterior sheaths, creating a vascularized plane ideal for mesh integration.[3] Despite durable outcomes[11] and permitting advanced procedures like transversus abdominis release (TAR),[12] eTEP has a steep learning curve, prolonged operative times[13] and risk of injury to linea alba, dehiscence of posterior rectus sheath and neurovascular damage,[14] which highlight the need for alternative techniques in less complex cases, such as the preperitoneal approach

Preperitoneal Approach: The peritoneal layer (originating from the embryonic endoderm) can be separated from the parietal layer (originating from the mesoderm)[15] with minimal tissue trauma and be used for placing an inexpensive noncoated mesh for ventral hernia repair, with several advantages:

- Plane of safety: Maintains fascial integrity without division of posterior rectus sheath[4]; no neurovascular injury; no exposure of mesh to abdominal viscera[16,17] and to rectus (rectus muscle can glide freely in its sheath); non-restrictive dissection plane devoid of complex anatomical landmarks or bowel injury.
- Plane of versatility: Extendable caudally for inguinal hernia and laterally (lumbar hernia); concurrent diastasis repair feasible; capacity to house large prostheses, accommodating sizable defects[4,16]; together with reduced postoperative pain.

The preperitoneal space can be accessed through various anatomical routes:

Lateral approach (vTAPP-ventral transabdominal preperitoneal): This transperitoneal technique uses lateral peritoneal flap creation to deploy mesh in the preperitoneal plane. It offers familiar anatomical orientation and procedural similarity to standard laparoscopy.[18] However, flap dissection can be technically demanding in adherent or thin peritoneum. Ergonomic challenges make endosuturing inefficient especially during flap closure risking incomplete mesh coverage. To overcome these limitations, robotic-assisted vTAPP has been increasingly adopted,[19] although with added cost.

From suprapubic region (bottom-up approach): The loose areolar tissue and loosely attached peritoneum below the arcuate line offer a favorable site for preperitoneal space creation and have long supported TEP inguinal hernia repairs. Extending this plane cranially provides the basis for several bottom-up techniques. Binggen Li in 2020[15] and Héctor Valenzuela in 2024 (preperitoneal eTEP [PeTEP])[4] described semiopen access to the preperitoneal space through a suprapubic incision, while Kapoor[20] utilized a left rectus eTEP approach for access, followed by cephalad dissection beneath the posterior sheath, allowing mesh placement without dividing it. Although promising, these techniques are limited by dense peritoneal adherence over the arcuate line risking inadvertent peritoneal entry during cephalad expansion[15] and multiplicity of structures namely the urachus and obliterated umbilical arteries, adding anatomical complexity. Ergonomic limitations, such as instrument crowding and thigh collision,[21] have led surgeons to switch to the subxiphoid top-down variation (Binggen)[22] or robotic approach (Héctor,[21] Radu[23]) albeit at higher expense.

From epigastrium (top-down approach): In 2021, Binggen Li[22] reported 20 patients with open access to the preperitoneal space at the epigastrium, while Rui Tang described a smaller series.[24] After caudal dissection and hernia management, both demonstrated successful preperitoneal mesh placement with minimal complications and no short-term recurrence (3–12 months).

FLAP-VH technique: Adopted in December 2018, our completely laparoscopic approach precedes many published efforts, enabling over five years follow-up data. Besides visually guided precise preperitoneal access, key innovations include: 5 mm trocar use, lowering trocar-site hernia risk; table flexion to reduce instrument-endotracheal tube collision; 3 mm trocar facilitating entry in limited initial space; premarked mesh size guiding accurate flap creation, eliminating fixation; and defect closure via 10-mm umbilical port, avoiding complex intracorporeal suturing. The vacuum created by suction drain aided mesh stabilization and hemostasis by compressing minute bleeders.

Despite these advantages, certain aspects need further evaluation. As our cohort consisted of patients with primary, uncomplicated ventral hernias and medium-sized defects (2–4 cm), the favorable outcomes observed cannot be generalized. Confirmation in larger, more complex hernia categories with broader, multicenter validation is necessary. As our median follow-up was 41 months, longer surveillance is essential to establish the durability and long-term effectiveness. All patients had umbilical/paraumbilical hernias, reflecting their high prevalence (10–12% of primary ventral hernias[16,25]) its application to epigastric, subxiphoid, and incisional hernias is yet to be assessed. Although we observed low pain scores, aided by TAP block, the presence of a drain may aggravate pain and complicate self-care, deserving closer investigation.

CONCLUSION

FLAP-VH is a feasible, minimally invasive technique enabling safe, visually guided preperitoneal access utilizing falciform ligament. It allows fixation-free mesh placement without disrupting core musculoaponeurotic structures, preserving physiologic abdominal wall functionality. Minimal pain, low complications, and no recurrences underscore its clinical potential. While it shows promising results in medium-sized primary hernias, its validation in larger, more complex hernias, with longer follow-up and multicenter studies, is essential to fully establish its role in modern hernia surgery.

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