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eTEP-PP for repair of primary midline ventral hernias

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Abstract

BACKGROUND: Minimally invasive surgery for hernia repair has advanced significantly, with techniques such as transabdominal preperitoneal repair (TAPP) and totally extraperitoneal repair for inguinal hernias inspiring similar approaches for ventral and incisional hernias. The enhanced-view totally extraperitoneal repair (eTEP) technique, introduced in the twenty-first century, demonstrated advantages in inguinal hernia repair. Leveraging the benefits of eTEP and TAPP while addressing their limitations, we developed the extended totally extraperitoneal preperitoneal repair (eTEP-PP) technique for primary midline ventral hernias. This technique combines the benefits of eTEP and TAPP, avoids specific drawbacks such as the need to divide the posterior rectus sheath or close the peritoneum, and ensures safer and more effective repair. The eTEP-PP method shows promise as a future standard for small-to-medium primary ventral hernia repairs. Further studies are needed to confirm its long-term efficacy and application.

MATERIALS AND METHODS: This retrospective study included 15 patients who underwent eTEP-PP surgery between February 2024 and June 2024 at the Department of Surgical Gastroenterology, Regency Hospital, Kanpur, Uttar Pradesh, India. Patients with primary midline ventral abdominal wall hernias were studied, noting intraoperative and postoperative outcomes.

RESULTS: All 15 patients experienced no intraoperative complications or conversions to open surgery. Two patients required conversion from eTEP-PP to eTEP due to challenges in creating the preperitoneal flap. Postoperative outcomes were excellent, with no surgical site occurrences or complications requiring intervention. There were no readmissions, mortalities, or recurrences 1 month post-surgery.

CONCLUSION: The eTEP-PP technique for primary ventral hernia repair is reproducible and has shown excellent initial outcomes. While the study's sample size is a limitation, the technique's potential as a future standard for small-to-medium primary ventral hernia repairs is evident. Further studies are needed to establish its long-term efficacy and broaden its application.

Keywords:

eTEP-PP, eTEP-RS, laparoscopic, PeTEP, ventral hernia, ventral TAPP

Introduction

Minimal access surgery for hernia repair is evolving at a fast pace. In the early 1990s, Ger *et al.* described the laparoscopic closure of patent processus vaginalis.[1] Toy and Smoot described IPOM repair of inguinal hernia.[2] Arregui and Dion, Phillips, and Mackernan described the laparoscopic technique TAPP and TEP for inguinal hernia.[3,4]

Spurred by positive outcomes and faster recovery witnessed by laparoscopic surgery, efforts to address ventral and incisional hernias in a minimally invasive fashion were initiated.[5] LeBlanc and Booth[6] pioneered the initial laparoscopic procedures for ventral and incisional hernia repairs in 1993 by utilizing an expanded polytetrafluoroethylene mesh, a process which later became known as intraperitoneal onlay mesh placement (IPOM) repair.

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Twenty-first century: Introduction of eTEP hernia repair. The enhanced-view totally extraperitoneal technique for repair of inguinal hernia was described by Jorge Daes in 2012.[7] Advantages of eTEP in inguinal hernia are as follows: quick and straightforward establishment of an extraperitoneal area, ample operating space, flexible port configuration, and improved tolerance to inadvertent pneumoperitoneum.[8] Based on this, eTEP for ventral hernia was first adapted by Belyansky *et al.* and published in 2017.

eTEP and TAPP repair for ventral abdominal wall hernia: the eTEP technique for ventral hernia provides large operative retrorectus space but comes with few prerequisites and some peculiar complications. Prerequisites: eTEP requires division of the insertion of the posterior rectus sheath (PRS) into the linea alba, cross-over across the midline, and then division of contralateral posterior rectus sheath. The procedure-specific complications include injury to the linea alba, posterior rectus sheath repair dehiscence, injury to the neurovascular bundles, and sometimes even complete injury to the entire linea alba.[9] The need to divide PRS especially while repairing small, primary ventral abdominal hernias was seen as an over-kill by numerous surgeons. This led to an increased interest in TAPP repair for small primary ventral abdominal hernias. In TAPP repair of ventral hernias, a mesh is placed in the preperitoneal plane, but it needs entry into the peritoneal cavity. TAPP repair for ventral hernias has specific challenges of its own, such as the problem of peritoneal button holes, because the peritoneum may be very thin, making the procedure very challenging. In addition, there is a need to close the peritoneal flap after deployment of the mesh and unsuitability of the procedure when there is a lack of preperitoneal fat.[10]

While retaining the benefits of eTEP and TAPP and at the same time avoiding their specific drawbacks, we describe this innovative modified approach to the preperitoneal space, called the extended totally extraperitoneal preperitoneal repair (eTEP-PP). It is noteworthy that this innovative approach has been described in two papers: Li Binggen *et al.*, 2020; Alpuche *et al.*, 2024. Li Binggen *et al.* had described the extraperitoneal approach to the preperitoneal space as an open technique access to the preperitoneal space.[11] Alpuche *et al.*[12] described the left retrorectus space approach to the preperitoneal space for repair of primary midline ventral hernias and diastasis recti, achieving good initial outcomes. In this study, we described the left retrorectus space approach to the preperitoneal space – eTEP-PP surgical technique and their results in 15 patients.

Table 1: Patient demographics

Patient demographics	
Number of patients (n)	*N* = 15
Gender (male/female)	10/5
Median age (IQR)	44 years (21 years)
Mean body mass index (kg/m^2) ± SD	24.26 ± 1.72

Materials and Methods

This study includes 15 patients who underwent eTEP-PP surgery from February 2024 to June 2024, in the Department of Surgical Gastroenterology, Regency Hospital, Kanpur, Uttar Pradesh, India. Patients of either sex with primary midline ventral abdominal wall hernias who underwent eTEP-PP were retrospectively studied [Table 1]. Intraoperative and postoperative outcomes were noted [Table 2]. Conversion from eTEP-PP to eTEP was needed in two patients.

Table 2: List of patients who underwent eTEP-PP, included in the study

No.	Cases	Location	Size	Reducibility	Operative time (in min)
1	45 years, M	E	E – 8 cm^2	Partially reducible	110
		U	U – 4 cm^2		
2	30 years, F	E	E – 9 cm^2	Reducible	80
3	35 years, M	U	U – 9 cm^2	Reducible	78
4	52 years, M	U	U – 6 cm^2	Reducible	85
5	29 years, F	U	U – 10 cm^2	Reducible	99
6	38 years, M	U	U – 10 cm^2	Reducible	105
7	31 years, M	E	E – 7.5 cm^2	Partially reducible	100
8	48 years, F	U	U – 7 cm^2	Reducible	86
9	31 years, M	U	U – 8 cm^2	Reducible	104
10	60 years, M	U	U – 4 cm^2	Reducible	77
11	56 years, M	U	U – 6 cm^2	Reducible	92
12	28 years, F	U	U – 8 cm^2	Reducible	81
13	44 years, M	E	E – 9 cm^2	Reducible	103
14	47 years, F	U	U – 6 cm^2	Reducible	104
15	52 years, M	U	U – 6 cm^2	Reducible	97

E: epigastric; U: umbilical; EHS classification was used to classify the hernia[13]

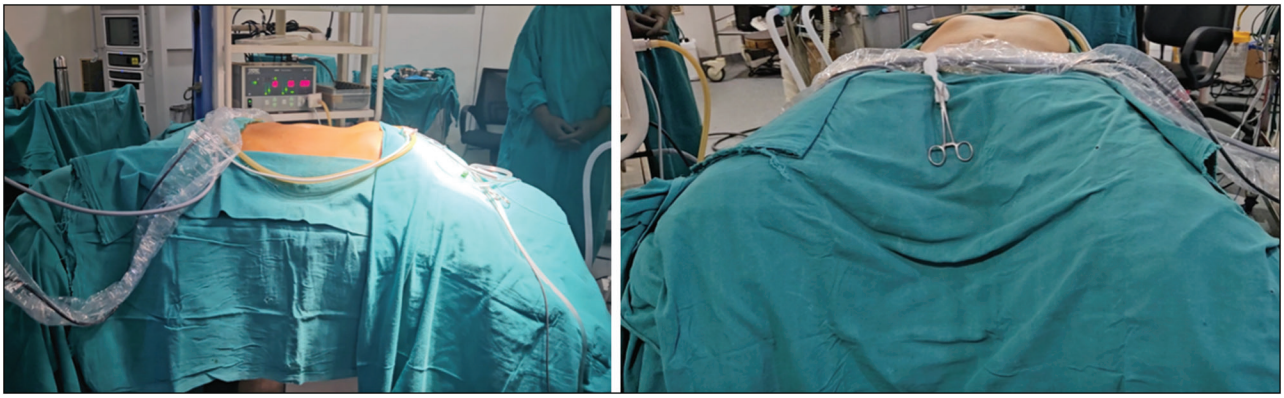

Figure 1: Patient positioning

Figure 2: 5-mm optical port in the left hypochondrium medial to the left semilunaris

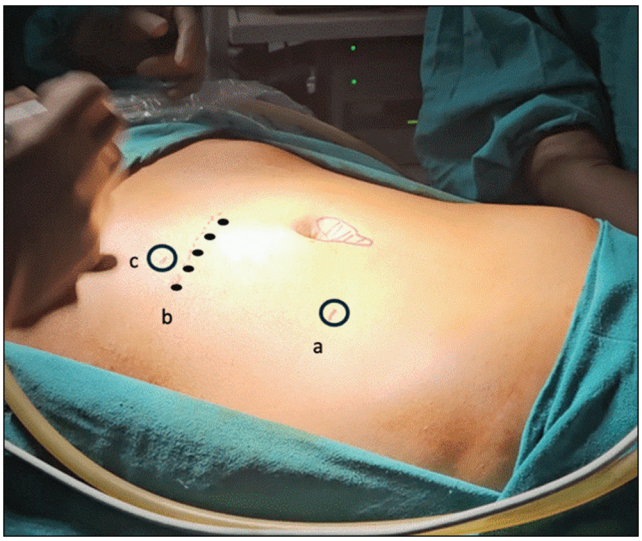

Figure 3: A – 5-mm optical port in the left hypochondrium medial to the left semilunaris, B – imaginary left arcuate line and C – likely location of first working ports below the left arcuate line; this port is created after entering into the preperitoneal space below the left arcuate line

Inclusion/Exclusion criteria

Inclusion criteria: Primary midline ventral hernia patients;

Exclusion criteria: Incisional hernias, Recurrent hernia, Lateral ventral hernia, Patient not consenting for minimally invasive surgery.

Surgical technique

After preoperative evaluation, laparoscopic eTEP-PP surgery was performed electively under general anesthesia. The patient was placed in supine decubitus with leg split and extension 15° on the operation table splitting to improve the widening of the anterior abdominal wall [Figure 1].

The surgeon will work initially from the left side of the patient for left eTEP access and in between the patient's legs while working in the TAPP plane cranially, while the camera assistant and scrub nurse may be positioned on either side of the patient.

Step 1 and 2: Left eTEP retrorectus space creation and entry into the preperitoneal plane below the left arcuate

Left extraperitoneal retrorectus space access is created by inserting a 5-mm optical port in the left hypochondrium 3 cm below the costal margin, medial to left linea semilunaris [Figures 2 and 3]. With blunt telescopic dissection and CO_2 insufflation, the left retrorectus space is created and extended caudally till the left arcuate line is visualized [Figure 4]. Further caudal dissection is carried out, at least 4 cm caudal to the arcuate line [Figure 5].

The preperitoneal space below the arcuate line is further established in the hypogastric region. Once adequate space is available, this allows insertion of three more ports, as shown in Figure 6. One 5-mm suprapubic midline camera port and two 5-mm working ports are placed on either side.

Step 3: Extension of the PP plane above the arcuates

The preperitoneal space (pre-transversalis space) formed in the hypogastric region, with working ports in place, facilitates the dissection of the preperitoneal area above

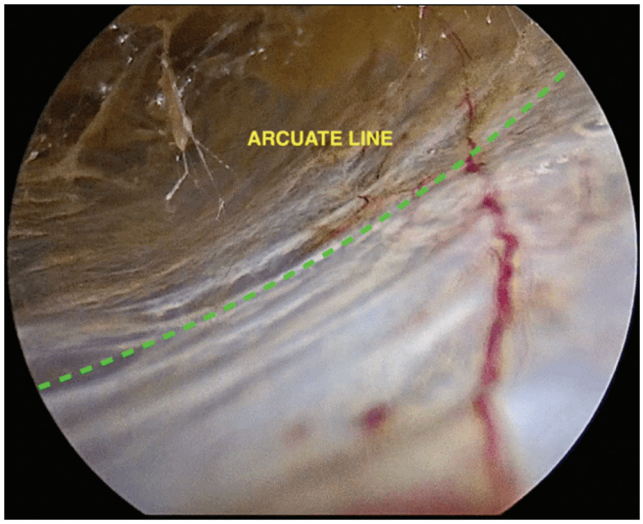

Figure 4: Left arcuate visualized after creation of the left retrorectus space

Figure 5: Transition from the left retrorectus space into the pre-transversalis space (peritoneal space)

the level of arcuate line, which can be extended cranially [Figure 7]. Preperitoneal space dissection is performed using a hook (monopolar cautery) progressing cranially from the hypogastric region toward the umbilicus and then toward the xiphoid process. The peritoneum is separated from the right and left posterior rectus sheath and linea alba [Figure 8]. Once the hernia sac is encountered while dissecting cranially, contents are reduced and care is taken to preserve the sac [Figure 9]. Laterally, the extent of dissection is usually up to the linea semilunaris [Figure 10].

Step 4: Hernia defect repair and mesh placement

Defects in the linea alba are closed using V-Lock No 1-0. Inadvertent peritoneal tears are closed. The vertical and horizontal dimensions of the created space are measured with a silk thread, and then placement of the uncoated macroporous light-weight polypropylene mesh is performed [Figure 11]. The mesh is not fixed with tackers.

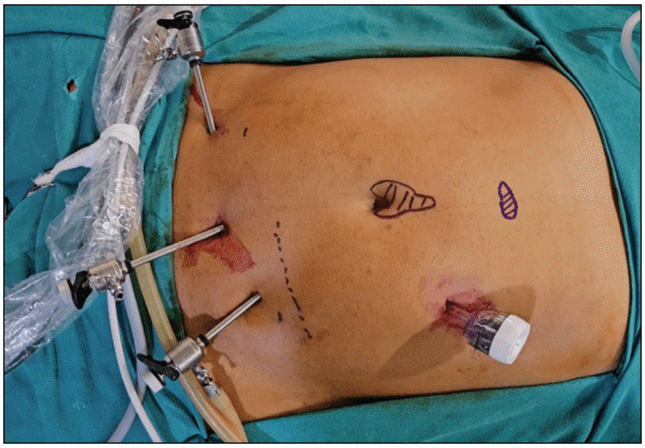

Figure 6: Remaining port position

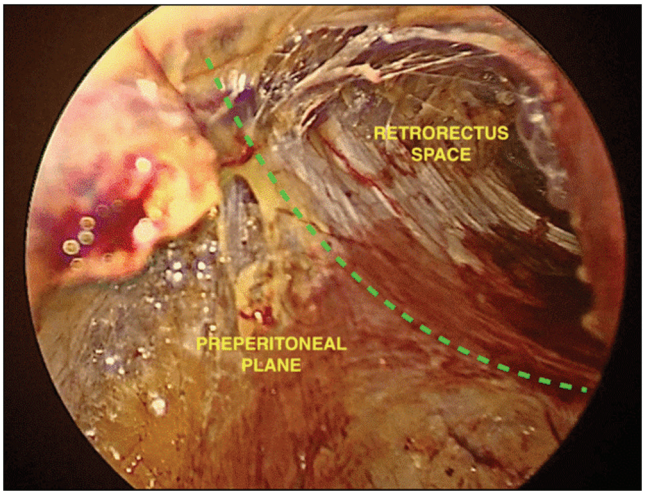

Figure 7: Left eTEP retrorectus space as visualized from the lower camera port, with preperitoneal space (pre-transversalis space) formed in the hypogastric region

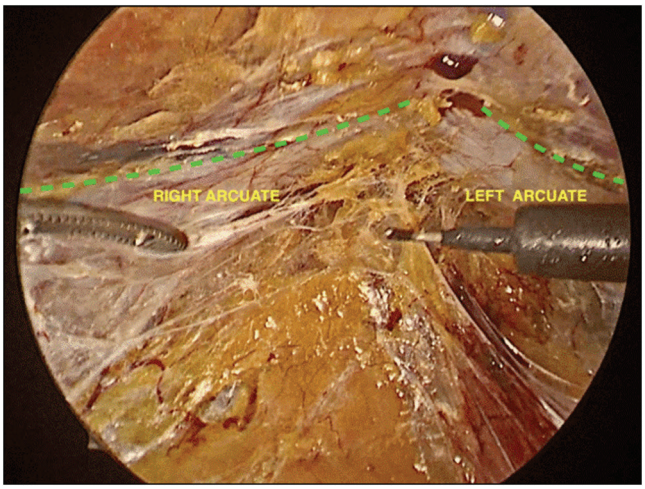

Figure 8: Preperitoneal space dissection separating the peritoneal flap from the right and left posterior rectus sheath and linea alba

It is held in place with help of tissue glue. Folding of the mesh is avoided. Hemostasis is ensured. The space is deflated and obliterated under vision. No drains are used.

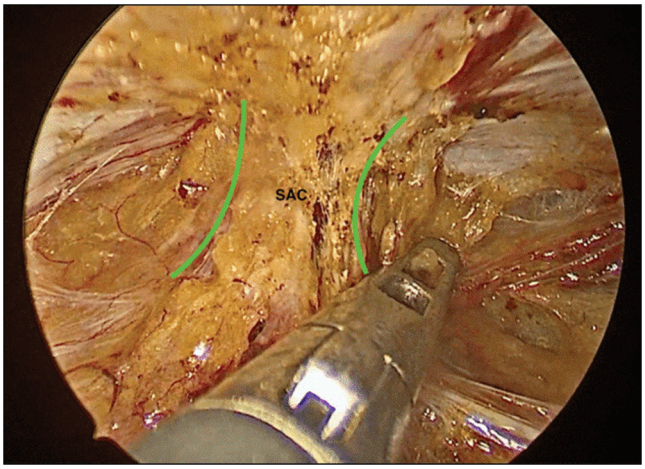

Figure 9: Hernia sac

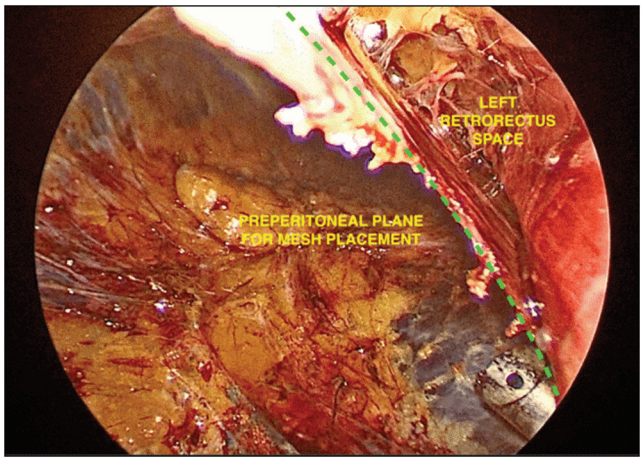

Figure 10: Final caudocranial view of dissected preperitoneal space and left extraperitoneal retrorectus space access

Figure 11: Polypropylene mesh placement in preperitoneal space

Postoperative course:

On the day of surgery, patients were administered IV antibiotics and IV analgesics. The patients were discharged on POD1 with the prescription of oral PPI and pain killers for 7 days. Patients were instructed to avoid heavyweight lifting for at least 3 weeks. Patients were examined by an attending surgeon in the outpatient clinic on the 7th day, and sutures were removed. A telephonic interview was performed 1 month after surgery. Patients were asked questions about degree of pain/discomfort, use of analgesic, restriction in any daily activities, and the necessity to consult a surgeon for pain/ recurrence.

Table 3: Perioperative data

Perioperative data	Mean
Size of the hernia defect (cm^2) ± SD	7.34 ± 1.83
Rectus diastasis	0
Operative time (min) ± SD	93.4 ± 10.89
Mean size of the mesh (cm^2) ± D	217.5 ± 52.21
Pneumoperitoneum creation	5
Peritoneal holes requiring repair	3
Contents (preperitoneal fat/omentum)	9/6
Conversion to open	0
Conversion to eTEP (bailout)	2
Length of hospital stay	1
Postoperative follow-up (days)	55 ± 13
Seroma	1
SSI	0
Recurrence	0

Clinical trial registry

This work is a retrospective analytical study. No clinical trials were involved.

Results

Outcomes

All 15 patients had no untoward intraoperative events. No conversions to open. Postoperatively, there were no surgical site occurrence or surgical site occurrence requiring procedural intervention as defined by Haskins *et al.*[14] which includes SSI, seroma, wound dehiscence, enterocutaneous fistula, wound cellulitis, non-healing incisional wound, fascial disruption, skin or soft tissue ischemia, skin or soft tissue necrosis, wound serous or purulent drainage, stitch abscess, seroma, hematoma, and infected or exposed mesh. There were no readmissions, no mortality, and no recurrences on telephone interview performed 1 month after surgery. Conversion from eTEP-PP to eTEP was done in two patients. The thin peritoneum made preperitoneal flap creation difficult in these two patients, and eTEP repair was performed as a bailout option. Perioperative data: Table 3.

Discussion

Minimally invasive treatment options for midline ventral hernias are eTEP-RS, IPOM, and recently TAPP for ventral hernias. Other techniques reported in literature include transabdominal retromuscular repair (TARM), transabdominal partially extraperitoneal repair (TAPE),

and endoscopic mini/less open sublay technique/repair (EMILOS).[15] Broadly, all these can be divided into three techniques based on the location of mesh placement: intraperitoneal, preperitoneal, and retrorectus. Other than these three techniques is the premuscular onlay technique, in which the mesh is placed over the abdominal wall closure.

IPOM involves a coated mesh in contact with the viscera (intraperitoneal inlay or intraperitoneal onlay) with either defect closure or bridging technique. Defect closure restores the normal abdominal wall contour, and the primary goal of the bridging technique is pain relief only.[16] IPOM involves securing the mesh to the abdominal wall by tacks or transfascial sutures/glue, or in combination. The downside of this technique is that the mesh is in contact with the bowel, which carries the risk of adhesion formation, causing pseudoobstruction, and transfascial sutures, causing suture-site neuralgia.[17]

Laparoscopic eTEP-RS for ventral hernia was developed as a minimally invasive approach to the gold-standard Rives–Stoppa repair. Rives–Stoppa repair and eTEP-RS utilize retromuscular space for mesh placement with closure of defect. Creation of this large retrorectus space involves division of the posterior rectus sheath on both sides. This retrorectus space provides a well-vascularized position where mesh prostheses become incorporated.[18] Closure of defect leads to equal pressure and tension distribution between the mesh and abdominal wall, which ensures full integration of the mesh prosthetic, resulting in a more durable repair.[19] In addition, for hernias with complex defects that require large mesh placement, eTEP provides access for the TAR procedure.[20] Reported complications related to the division of the posterior rectus sheath are as follows: linea alba dehiscence, posterior layer dehiscence, and complete blowout. These complications are avoided in TAPP repair of ventral hernia and eTEP-PP because it does not involve division of the posterior rectus sheath.

TAPP for ventral hernia: Based on the technique of TAPP for inguinal hernia, where the mesh is placed in the preperitoneal space, the same is being adapted in ventral hernia.[21] TAPP for ventral hernia is a novel surgical technique, and recent studies on TAPP in ventral hernia have shown good outcomes with awaited long-term results.[22] Preperitoneal space dissection allows sufficient overlap of 5 cm circumferentially to the repaired fascial defect without need for division of the posterior rectus sheath as in eTEP. The mesh is fixed with tissue glue/tacker or suture at cardinal points on the anterior abdominal wall. When compared to IPOM, the bowel and mesh are separated by the peritoneum, and there is no need of multiple tackers or transfascial sutures. Critical steps in TAPP is being in the right plane and suturing the peritoneal incision. Suturing is technically difficult because the camera is close to the incision site.[23] This is where eTEP-PP comes into play; it can help surmount these two challenges.

In eTEP-PP, the first step involves creation of the left retrorectus space, as discussed above in the surgical technique. As the left retrorectus space is dissected caudally, the left arcuate is reached and entry into the preperitoneal plane is performed, and this same plane can be dissected cranially above arcuates from hypogastric ports. This ensures being in the right plane. As there is no peritoneal opening to access this preperitoneal space, suturing the peritoneum is completely eliminated. Only the accidental peritoneal opening needs closure. Complications related to the division of the posterior rectus sheath are avoided as in TAPP.

Alpuche *et al.* described this new technique of the eTEP preperitoneal approach for primary midline ventral hernias and diastasis recti. We have adapted the same technique with excellent outcomes. The only difference was following the procedure of extraperitoneal space access through left retrorectus space and suprapubic ports placed under direct vision in all 15 cases. Alpuche *et al.* described the extraperitoneal space access and port placement with two variations. Patients with previous lower abdomen surgery had the retromuscular plane created, and in patients with no prior surgeries, 1-cm suprapubic incision, and under direct visualization, the pre-transversalis space was entered. This open technique access to the preperitoneal space by the extraperitoneal approach and preperitoneal mesh placement was first described by Li Binggen *et al*.[11] In our study, all 15 incidences of extraperitoneal space access through the left retrorectus space were performed, and suprapubic ports were placed under direct vision irrespective of the surgical history.

The major limitations of our study are the sample size and shorter follow-up. The problem of accidental peritoneal holes as in TAPP is not completely eliminated and requires repair. Long-term results of the same are awaited. The learning curve is short only in surgeons well-versed with eTEP and TAPP repair of ventral hernias. We shall adapt this technique in more number of cases and for management of diastasis recti in the future.

Conclusion

The eTEP-PP technique for primary ventral hernia is easily reproducible. Using this technique, we have reproduced excellent results in this case series for the first time in India. More studies are needed to establish this novel technique for primary midline ventral hernias. This technique may become the future standard for small-to-medium primary ventral hernia repairs.

Author contributions

Dr Abhimanyu Kapoor: Chief operating surgeon and Head of department, Surgical gastroenterology, Regency Hospital, Kanpur. All the surgeries were performed by Dr Abhimanyu Kapoor.

Rest of Authors: Part of surgical team, preoperative & postoperative care, follow up, data collection and the article drafting.

Ethical policy and institutional review board statement

This study was conducted in full accordance with the ethical principles set forth in the Declaration of Helsinki. The research protocol (IEC Reference No.: RHL-IEC-160128) was reviewed and approved by the Institutional Review Board (IRB) of Regency Hospital (IEC Registration No.: ECR/825/INST/UP/2016/RR-24), dated on Jul 16th, 2024. Informed consent was obtained from all participants prior to inclusion in the study.

Declaration of patient consent

Patient were enrolled in the study after duly signed informed consent.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Acknowledgement

Not applicable.

Abbreviations

eTEP-PP Extended totally extraperitoneal–preperitoneal repair
PeTEP Preperitoneal extended totally extraperitoneal repair
TEP Totally extraperitoneal repair
eTEP Enhanced-view totally extraperitoneal repair
eTEP-RS Enhanced-view totally extraperitoneal – Rives–Stoppa repair
TAPP Transabdominal preperitoneal repair
IPOM Intraperitoneal onlay mesh repair
LVHR Laparoscopic ventral hernia repair
PTFE Polytetrafluoroethylene
SSO Surgical site occurrence
SSOPI Surgical site occurrence requiring procedural intervention
EHS European hernia society

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