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Original Research Article

A Study on The Concept and Access In E-TEP Hernia Repair: Is E-TEP A New Paradigm?

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Conflict of interest: Nil

Abstract:
Background: Hernias are a common surgical issue characterized by the protrusion of abdominal contents through a weakened abdominal wall. The extended Totally Extraperitoneal (e-TEP) technique has emerged as a modern approach to ventral and inguinal hernia repairs, allowing the large mesh placement in the retrorectus plane while minimizing intra-abdominal complications. Despite its potential benefits, challenges like retromuscular access and suturing in confined spaces persist.
Aim: This study aims at the effectiveness of the e-TEP technique in hernia repair, focusing on clinical outcomes, postoperative management, and risk factors for recurrence and complications.
Methods: A prospective study was conducted at the Department of General Surgery, Hi-tech Medical College and Hospital, Rourkela, from January 1, 2024, to June 30, 2024. Fourteen patients with ventral and inguinal hernias were treated using the e-TEP and e-TEP-RS techniques. The procedures, complications, and outcomes were recorded and analysed over a mean follow-up period of six months.
Results: The mean surgery duration was 210 minutes, with an average hernia defect size of 5.8 cm in width. A large mesh (mean size 486 cm^2) was used in all cases without additional fixation. Postoperative complications were minimal, resolving without intervention. There were no recurrences or significant complications like surgical site infections or bowel obstructions during the follow-up period.
Conclusion: The e-TEP technique is a safe and effective alternative for hernia repair, offering a tension-free repair with low complication rates. The findings suggest that e-TEP may provide a durable and minimally invasive option for hernia surgery.

Recommendations: While these results are promising, further research with a larger sample size and longer follow-up is needed to validate the long-term efficacy and safety of the e-TEP technique.

Keywords: Hernia Repair, e-TEP Technique, Ventral Hernia, Inguinal Hernia, Minimally Invasive Surgery, Mesh Placement.

Introduction

The term "hernia" refers to the protrusion of part of the abdominal cavity contents through a weakness in the abdominal wall [1]. The human abdomen, often weakened by laparotomy, can present iatrogenic opportunities for complex herniation [2]. Advances in abdominal wall reconstruction (AWR) have significantly progressed in recent decades, driven by a deeper understanding of core anatomy and functionality [3]. The modern approach emphasizes recreating a functional, dynamic, and anatomically sound abdominal wall by reconstructing the linea alba, leading to the development of innovative component separation techniques [4].

Retromuscular repairs have become the central focus of ventral and inguinal hernia surgery, particularly with the rise of the laparoscopic extended Totally Extraperitoneal (e-TEP) technique [1]. The e-TEP approach facilitates placing a large mesh in the retrorectus plane, reducing the risk of intra-abdominal complications and promoting recovery [2]. Although this method offers highly satisfying outcomes, it presents challenges such as obtaining retromuscular access and suturing in a confined space. Nevertheless, its feasibility and safety have been well-documented in ventral hernia repairs [5].

Tension-free midline approximation is the gold standard in ventral and inguinal hernia surgery. Component separation techniques (CST) like Transversus Abdominis Release (TAR) have been introduced to achieve tension-free midline closure by reducing the tension on the posterior rectus sheath during retrorectus repairs [6]. Despite its effectiveness, TAR's technical complexity can result in complications if not performed correctly. To avoid the need for TAR in laparoscopic e-TEP repairs, preserving the hernial sac can add crucial length to the posterior rectus sheath, facilitating tension-free midline closure without the risks associated with TAR [7].

The ongoing development of AWR techniques, including minimally invasive methods like laparoscopic and robot-assisted repairs, underscores the dynamic evolution of hernia surgery. These innovations aim to enhance surgical outcomes, reduce complications, and ensure durable hernia repairs.

The aim of the study is to explore the history of hernia surgery, the revival of reconstructing a functional and anatomically sound abdominal wall, the techniques of LVHR and laparoscopic inguinal hernia repair, and to assess clinical outcomes, postoperative management, and risk factors for recurrence and complications.

METHODOLOGY

Study Design: Prospective Study

Study Setting: The study took place at Department of General Surgery, Hi-tech Medical College and Hospital, Rourkela, spanning from 1st, January 2024 to 30th, June 2024.

Study Population: All patients with Ventral and Inguinal (Direct and Indirect) Hernia were included in the study during a span of 6 months' time admitted and operated.

Sample Design: Purposive Sampling

Study Sample: As many as study participants who are present during study period fulfilling the inclusion and exclusion criteria during the time of 6 months.

Inclusion Criteria:

- Patients eligible for laparoscopic surgery under general anaesthesia.
- All dimensions of hernia defect were measured in computed tomography scans prior to a hernia repair.
- Patients consenting for the study.

Exclusion Criteria:

- lesions on the skin covering the hernia sac
- presence of a concurrent stoma
- previous mesh repair surgery
- risk of intra-abdominal compartment syndrome associated with the presence of an extensive hernia sac
- history of laparotomies in which the scar extends from the xiphoid process of the sternum to the pubic symphysis.
- Patients not fit for general anaesthesia for long duration.

Study Tool: Clinical examination, USG of abdomen and pelvis/Inguinoscrotal region and/or CECT of abdomen/pelvis.

<u>Access in e-TEP:</u>

P.R.E.C.I.S.E:

- P- 'Positioning' for Perfection
- R- 'Retro Rectus Entry'

  'Rotating' 360 degrees during optical port insertion

  'Retraction' after incision of the skin and ARS
- E- 'Entry': parallel to abdominal wall
- C- 'Correct Crossover'
- I-'Intact sac'
- S-'Suturing' technique
- E- 'Estimate' the mesh size

P • 'Positioning' for Perfection

FIG 1: Port insertion site of Ventral hernia.

FIG 2: Port insertion site of Inguinal hernia.

R

- 'Retro RectusEntry'
- 'Rotating' 360 degrees during optical port insertion
- 'Retraction' after incision of the skin and ARS

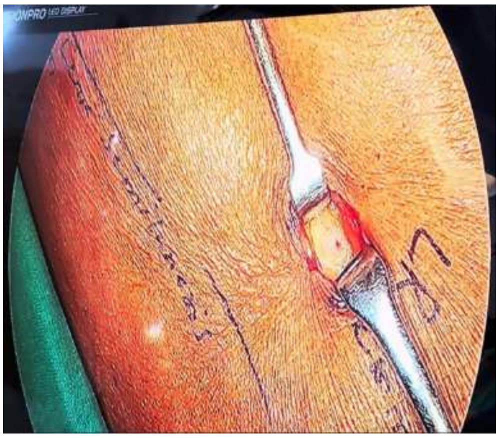


FIG 3: Exposure of ARS after subcutaneous fat incision.

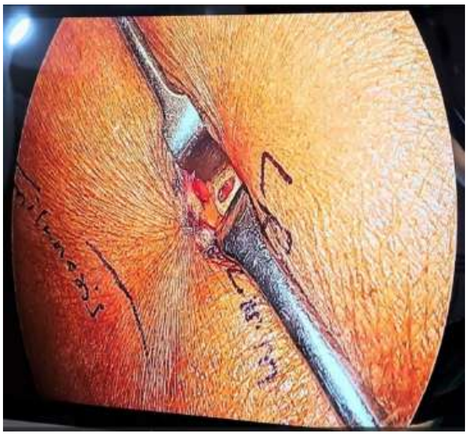


FIG 4: Incision in ARS given to expose Rectus muscle

FIG 5: Exposure of Rectus muscle.

FIG 6: Exposure of PRS.

E

- 'Entry': parallel to abdominal wall

FIG 7: Initial incision done Precoastally. **FIG 8:** Entry parallel to abdominal wall.

<u>FOR CREATION OF RETRO-RECTUS SPACE:</u>

FIG 9: Entering the Retro-Rectus Space.

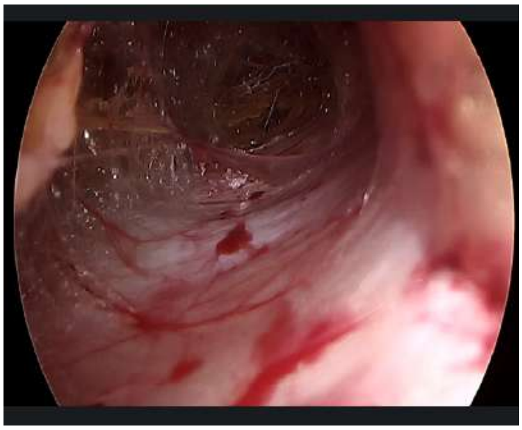


FIG 10: Creation of Retro-Rectus Space.

<u>CREATE THREE PORT BEFOREHEAD:</u>

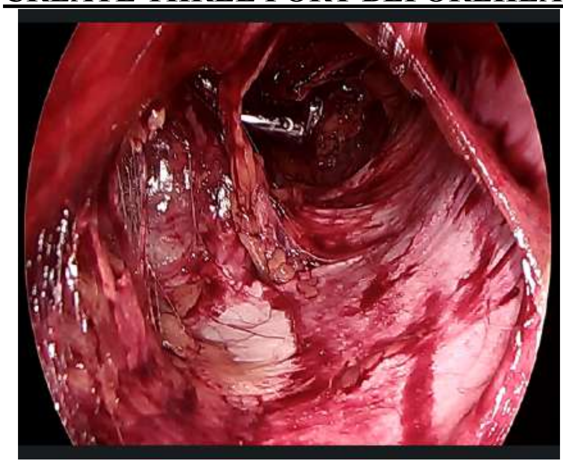


FIG 11: Lateral Port Placement.

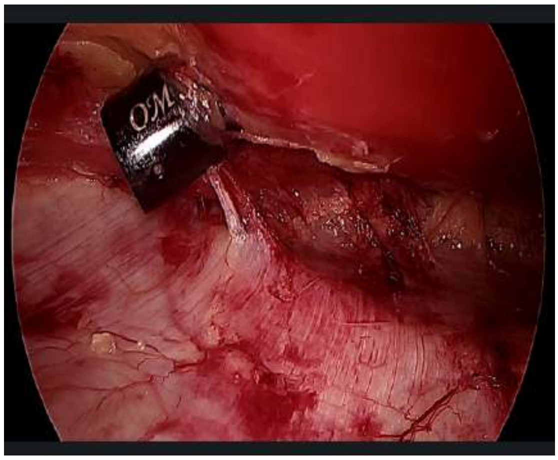


FIG 12: Opposite side Port Placement.

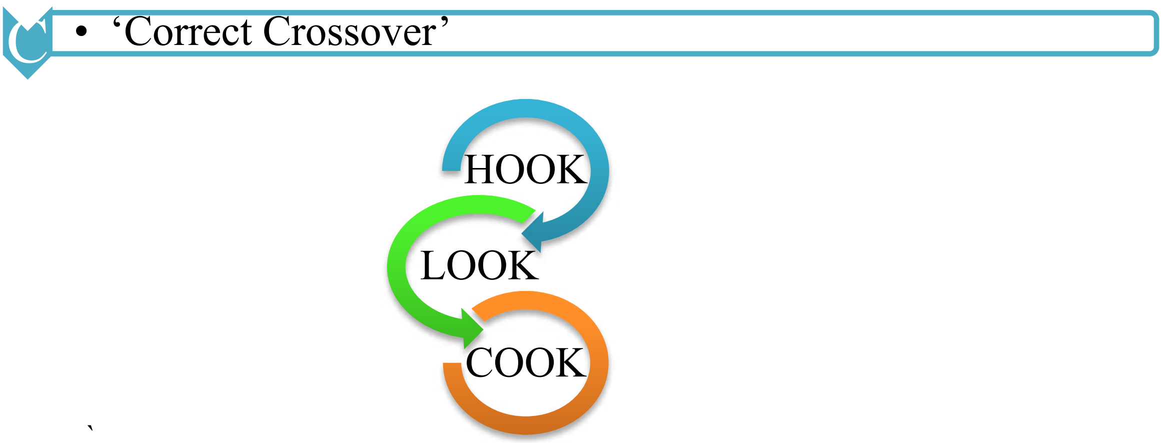


FIG 13: The trick of using an Electrosurgical hook or spatula.

The tip of the electrosurgical hook or spatula is passed into or under a layer of the tissue to be dissected, which is then hooked and tented up. Small portions of tissue are tackled so that an assessment of the tissue caught on the hook can be made before coagulation or cutting current is applied to the instrument. The hook can be used to clear unwanted tissue beside linear structures by passing the hook into the tissues parallel to the structure, and then rotating it to hook up strands of unwanted tissue. The tissue to be divided is held away from underlying tissue to prevent inadvertent damage. Short bursts of coagulating current can be followed using cutting current if the tissue has not already separated. The use of the hook can be summarized as “hook, look, cook.” [8]

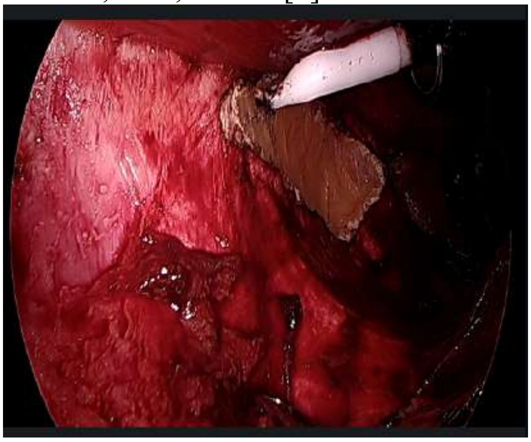


FIG 14: Crossing over to opposite side by dissecting the Falciform Ligament.

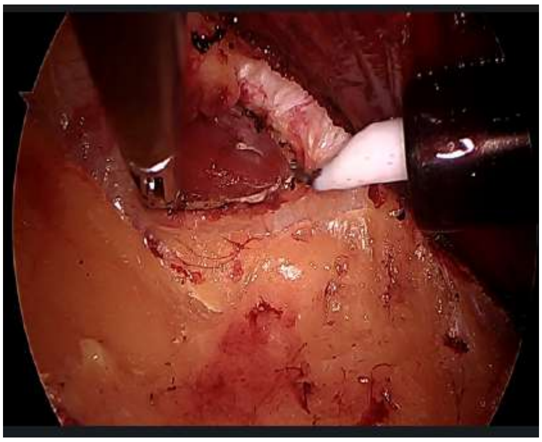


FIG 15: Opposite side Rectus muscle exposed.

I

• 'Intact sac'

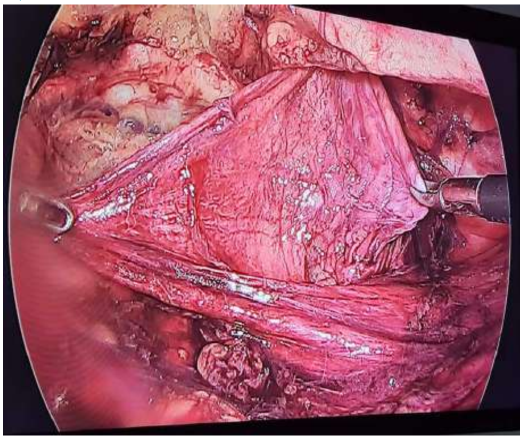


FIG 16: Sac Preservation done in Direct Inguinal Hernia.

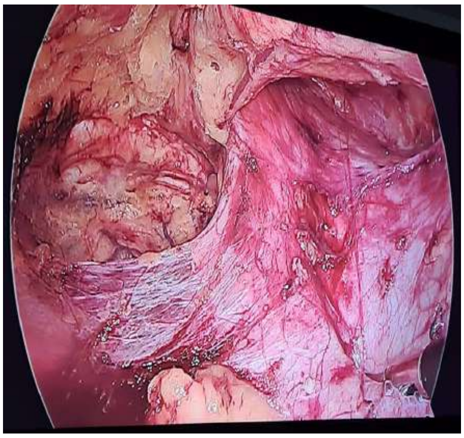
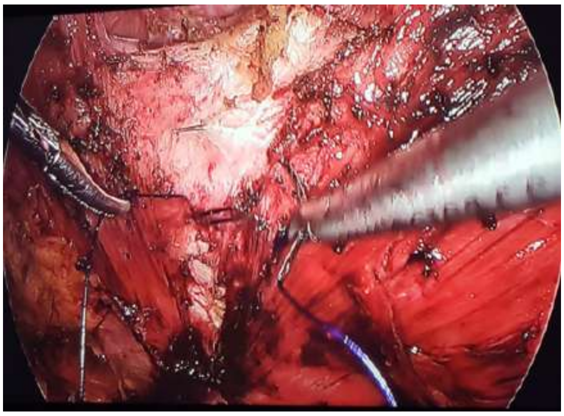


FIG 17: Sac Preservation done in Indirect Inguinal Hernia.

S

• 'Suturing' technique



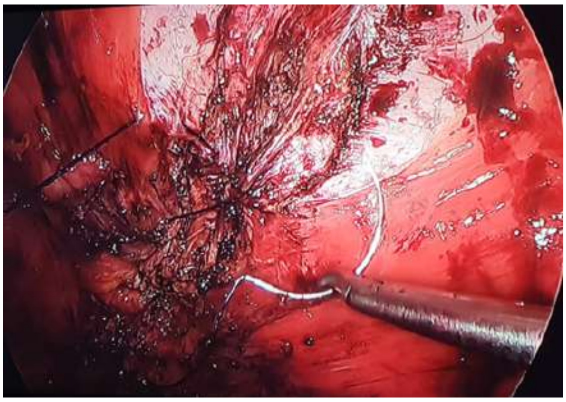


FIG 18: Closure of anterior defect below Upwards.

FIG 19: Closure of Divarication done with defect closure done with 2-0 bard suture.

E
- 'Estimate' the mesh size

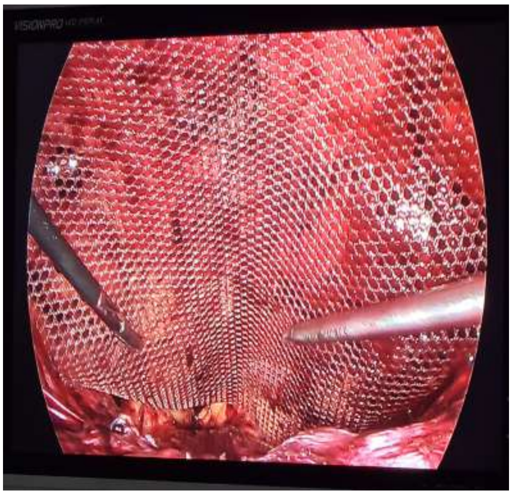


FIG 20: Polypropylene Mesh spread and fixed.

EHS Classification of Ventral hernia:

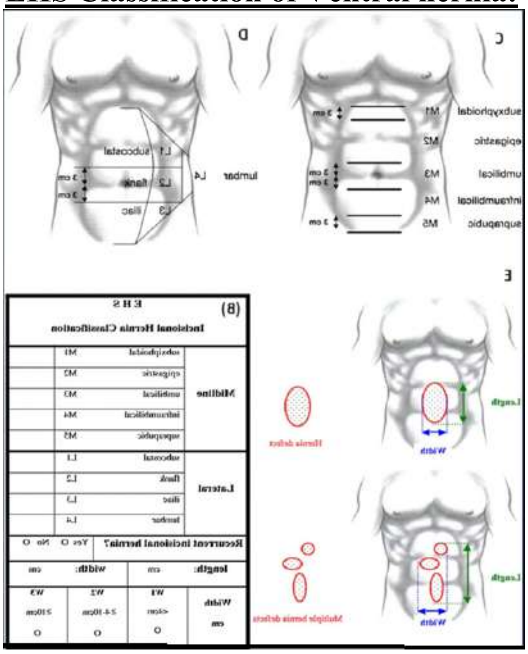


FIG 21: (A) European hernia society classification of primary abdominal wall hernia, (B) European hernia society classification of incisional hernia, (C) five zone classification of midline incisional hernia, between the two lateral margins of the rectus muscle sheath, (D) four zone classification of lateral incisional hernia, lateral to the rectus muscle sheaths(E) definition of width and length of incisional hernia for single and multiple hernia defects.[9]

Procedures of LVHR:

- Step 1: Entering the retro rectus space and port placement.
- Step 2: Crossing the midline to opposite side.
- Step 3: Connection of both retro rectus space.
- Step 4: Identifying the anatomical landmarks
- Step 5: Dissecting the hernial sac and closure the defect.
- Step 6: Transverse abdominis release.
- Step 7: Deploying and anchoring the mesh

- Step 8: Taking out sutures and port closure

Positioning of patient on OT table for Ventral Hernia:

FIG 22: The patient is placed supine with arms tucked by the side and extended at the hips to enable instrumentation without hindrance from the pelvis and thighs.[9]

Step 1: Entering the retro rectus space and port placement:

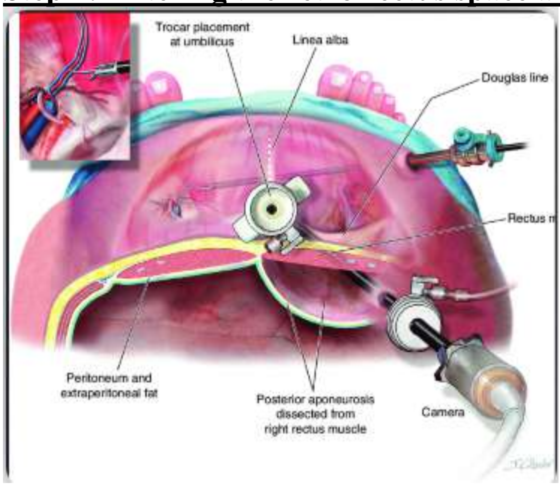


FIG 23: Port insertion site by Dr Jorge Daes in his research paper.[10]

FIG 24: Intra-Op photo of infraumbilical hernia port insertion marking.

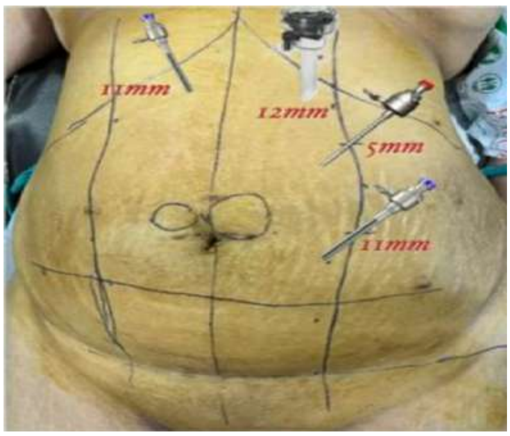


FIG 25: Intra-Op photo of for supraumbilical hernia port marking.

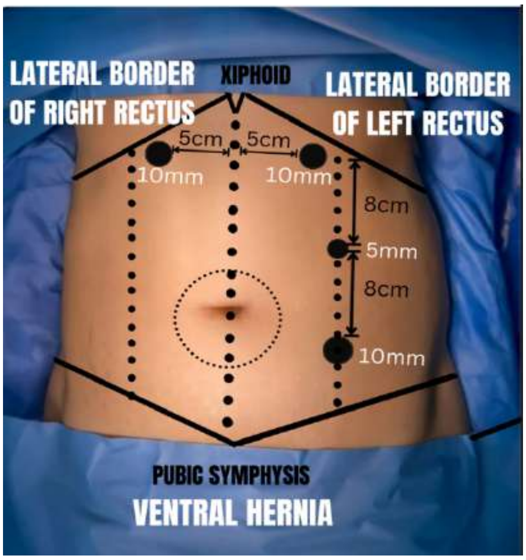


FIG 26: The port positions for ventral hernias, the TV monitor is placed at the foot ends.

We place the camera initially in the upper left port until the midline is crossed and both retro-rectus spaces are dissected. Thereafter, the camera is shifted to the right upper port for further dissection a suturing the defect.

Trocar placement:

Two 10mm Camera trocar.

Two 5mm operating trocar.

Step 2: Crossing the midline to opposite side.

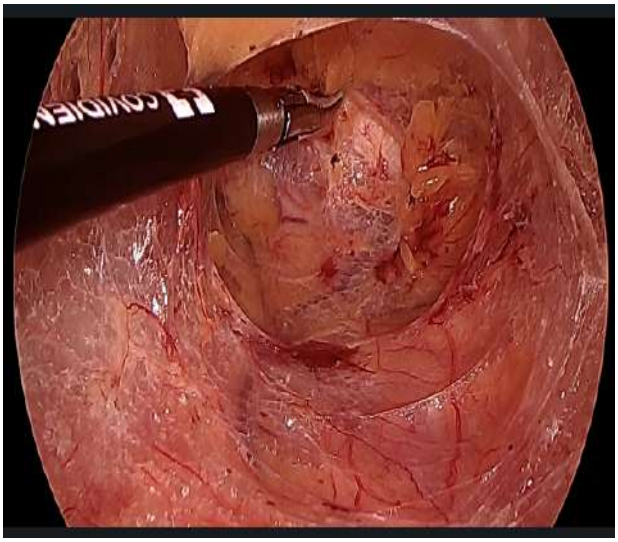


FIG 27: Crossing over the Hypogastrium Ligament from the Linea alba

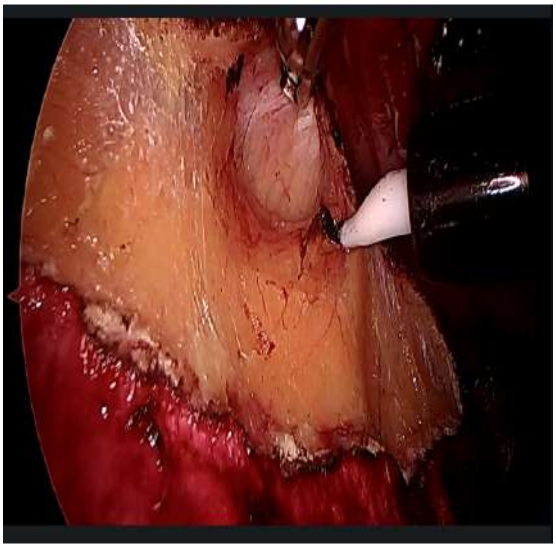


FIG 28: Swaying down the Falciform in the Preperitoneal space below the fat planes in Epigastric region.

MARSHMALLOW SIGN:

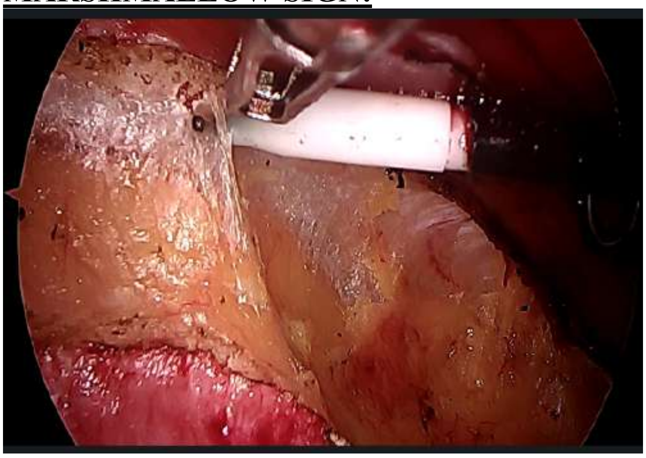


FIG 29: Flimsy connective tissue along with pad of fat while dissecting Falciform Ligament.

Step 4: Identifying the anatomical landmarks in ventral hernia:

Exploration and anatomical landmarks:

- Anterior Rectus Sheath (ARS)
- Rectus Muscle (RM)
- Posterior Rectus Sheath (PRS)
- Inferior Epigastric Vessels (IEV)
- Linea Semilunaris
- LAMP POST SIGN

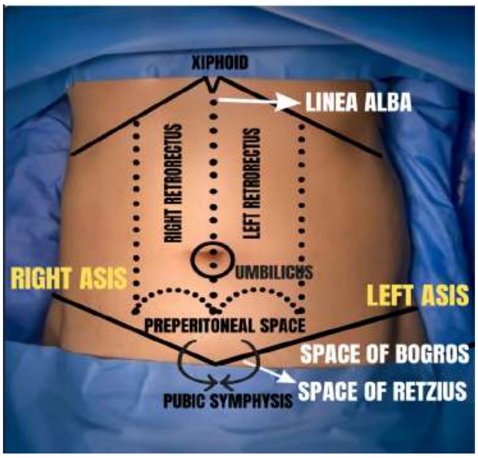
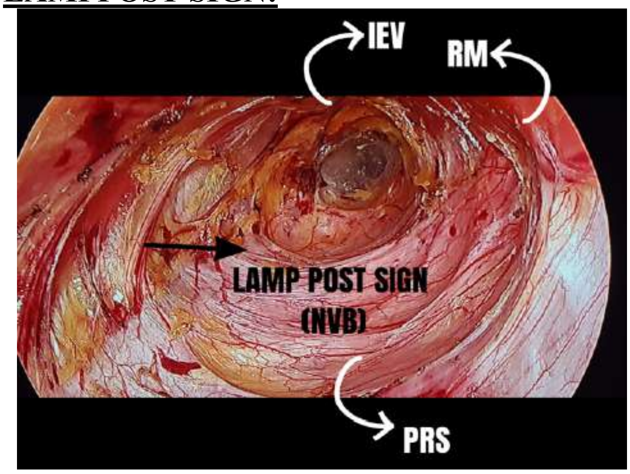


FIG 30: Anatomical Landmarks and Positions

LAMPPOST SIGN:



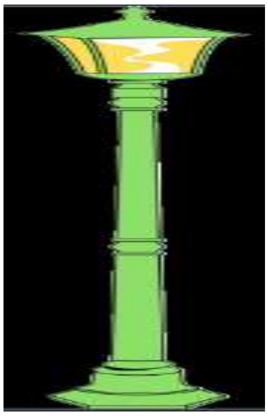


FIG 31: The "lamppost sign" signals the lateral most limit of dissection, to prevent iatrogenic injury to neurovascular bundles and Linea semilunaris. Note the Rectus muscle, the Posterior Rectus Sheath and the Inferior Epigastric Vessels.

VOLCANO SIGN:

FIG 32: After crossover, the medial edges of the divided posterior rectus sheaths are connected to each other by a strip of pre-peritoneal fat and peritoneum in the midline. These structures, along with the neck of hernia constitute the "volcano sign".

Step 5: Dissecting the ventral hernial sac:

The Ventral hernial sac is tried to mobilize as much as possible and preserve it for proper closure.

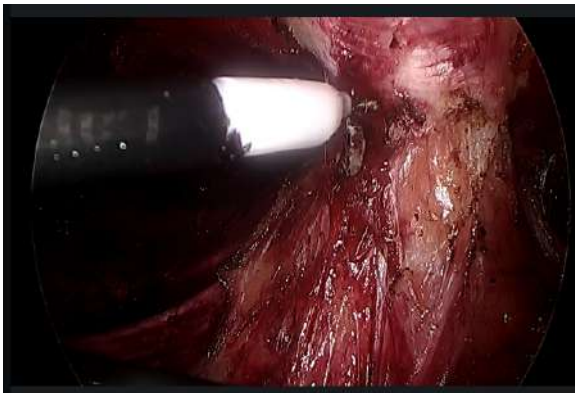


FIG 33: The pre-peritoneal fat and Peritoneum is stripped.

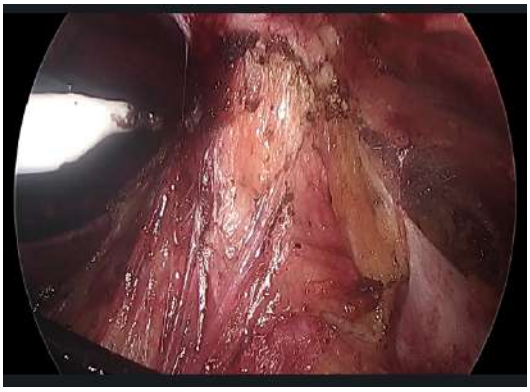


FIG 34: The hernial sac is exposed.

SUTURING TECHNIQUE:

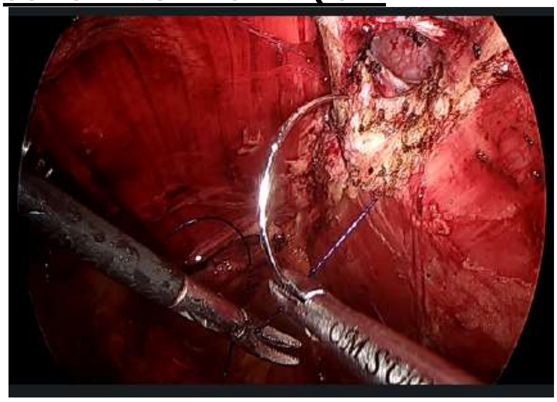


FIG 35: Closure of Linea Alba started.

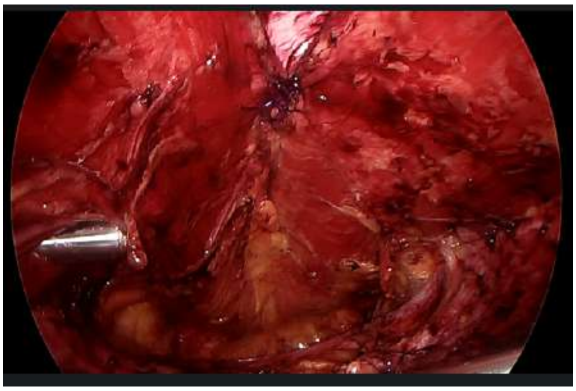


FIG 36: Closure done using Barb suture.

Step 7: Deploying and anchoring the mesh:

- A large polyprolene mesh.
- The mesh is inserted through camera trocar, placed properly in appropriate position, and fixed at pubis first with tackers or glue.
- The mesh should not be fixed at dangerous areas.

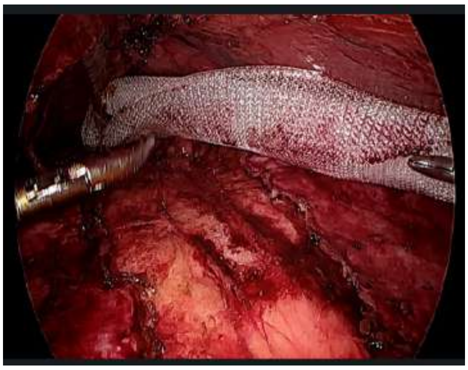


FIG 37: Intra-op photo of Mesh Placement started.

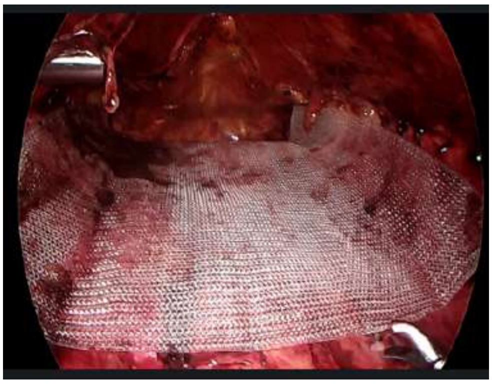


FIG 38: Intra-op photo of Mesh was completely spread over the hernial defect.

EHS Classification of Inguinal hernia:

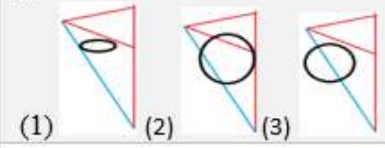
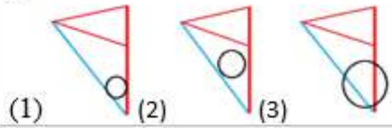
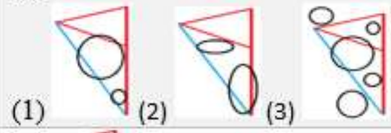
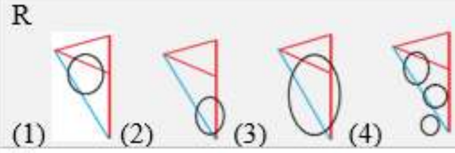
TYPE	SUBTYPE	DESCRIPTION	GHC	EHS
I	A (1) = Small Indirect B (2) = Large Indirect C (3) = Very Large Indirect	**SINGLE INGUINAL INDIRECT**	H 	L
II	A (1) = High Direct B (2) = Low Direct C (3) = Total Direct	**SINGLE INGUINAL DIRECT**	L 	M
III	A (1) = Indirect + Direct B (2) = Direct + Indirect C (3) = Femoral and/or >2	**MULTIPLE MIXED INGUINAL FEMORAL**	M 	-
IV		**FEMORAL**	 F	F
V	A (1) = High B (2) = Low C (3) = Total D (4) = Multiple	**RECURRENT INGUINAL FEMORAL**	R 	R
VI	- U E S D	**ABDOMINAL** UMBILICAL EPIGASTRIC SPEGILIAN DIASTASIS	A	
VII		**INCISIONAL**	I	

FIG 39: Inguinofemoral Hernia Classification Guarnieri 2010

Procedure for inguinal hernia repair:

- Step 1: Entering the retro rectus space and port placement
- Step 2: Crossing the midline to opposite side
- Step 3: identifying the anatomical landmarks
- Step 4: Dissecting the hernial sac
- Step 5: Deploying and anchoring the mesh
- Step 6: Taking out sutures and port closure

Step 1: Entering the retro rectus space and port placement

FIG 40: Port site positions for Left Inguinal hernias, the TV monitor is placed at the Right side of the patient. We place the camera the upper Right port and the midline is crossed. Left-hand working port is placed over the umbilicus and Right-hand working port on right flank [11].

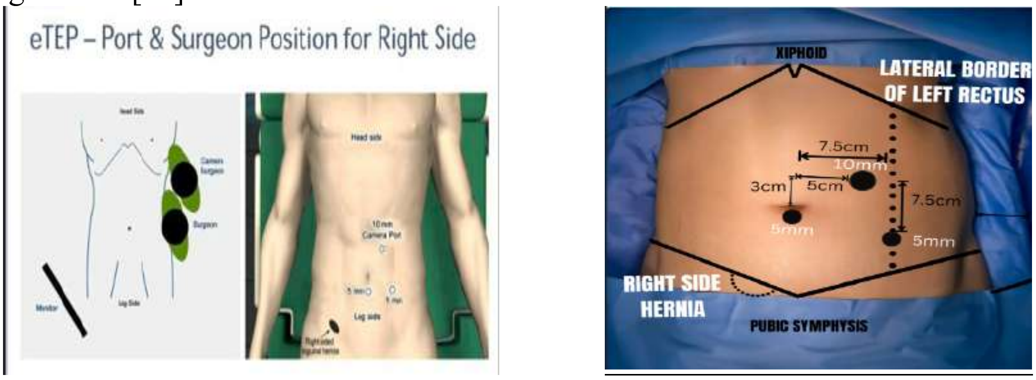


FIG 41: Port site positions for Right Inguinal hernias, the TV monitor is placed at the Left side of the patient. We place the camera the upper Left port and the midline is crossed. Right-hand working port is placed over the umbilicus and Left-hand working port on left flank [11].

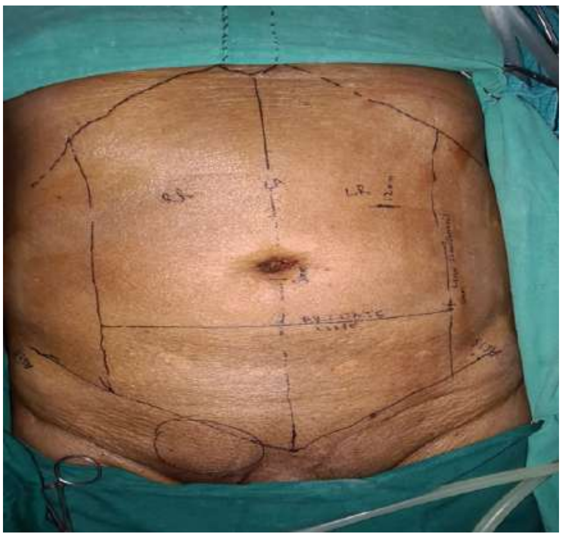


FIG 42: Intra-Op photo of Right Inguinal hernia port insertion marking.

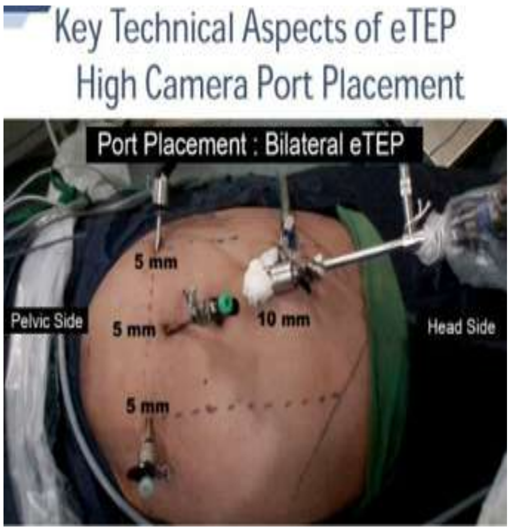


FIG 43: High camera port placement in Bi-lateral Inguinal Hernia [11]

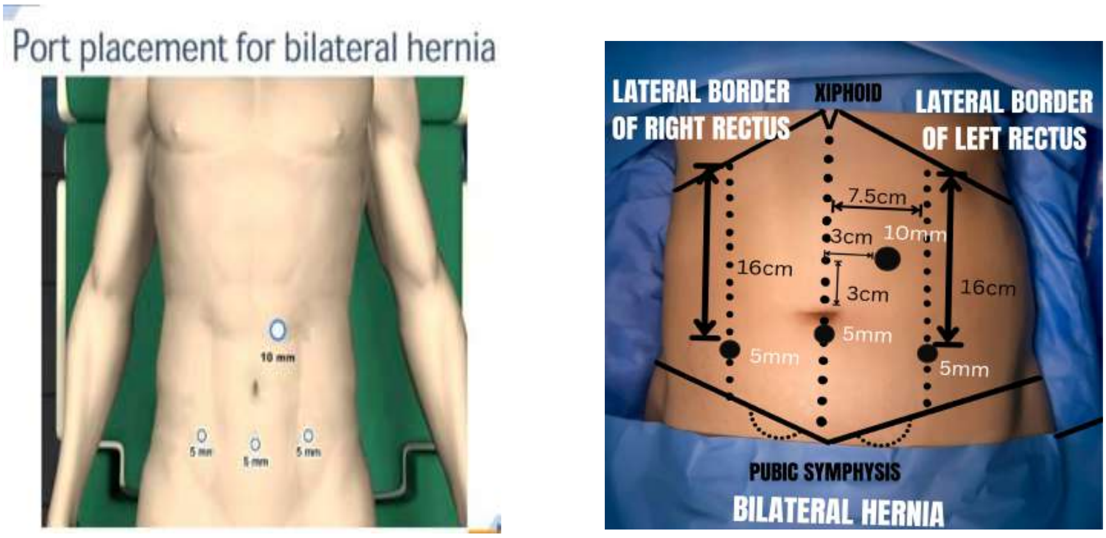


FIG 44: Port site positions for Bilateral Inguinal hernias, the TV monitor is placed at the foot ends of the patient. We place the camera the upper Left port and the midline is crossed. Later working ports are placed in triangulation to access either side for both Right and Left side hernias. [11]

Step 3: Identifying the anatomical landmarks in inguinal hernia:

Exploration and anatomical landmarks:

- Spaces of Retzius and Bogros:
- Arcuate line of Douglas:
- Triangle of Doom:
- Triangle of Pain:
- Corona mortis

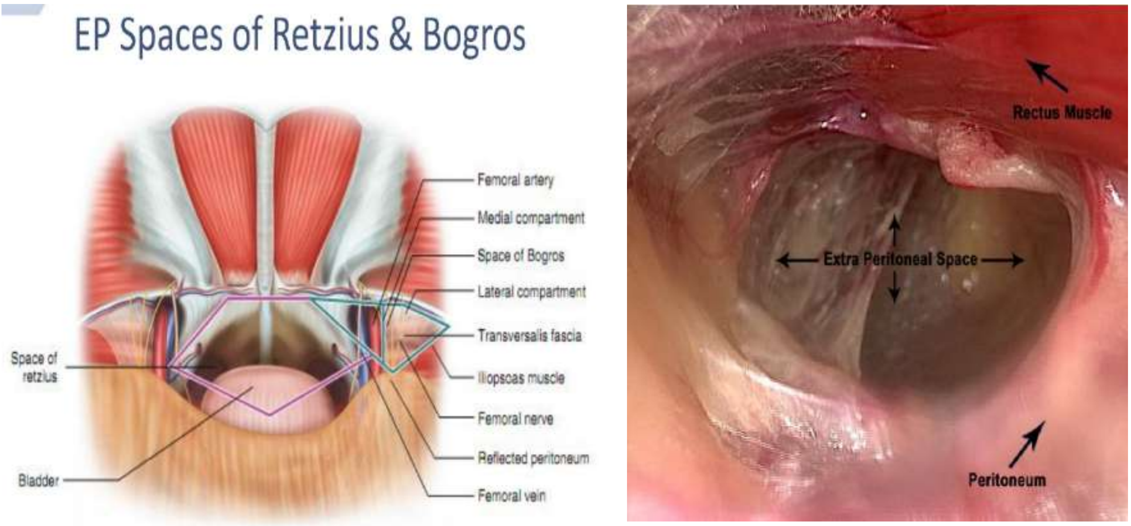
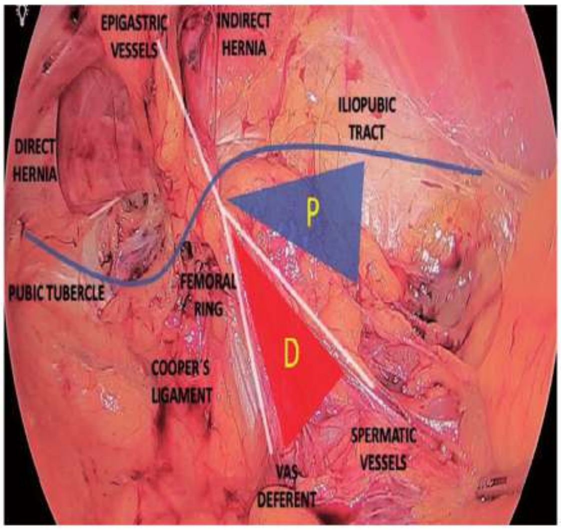


FIG 45: Arcuate Line of Douglas is the line where Posterior rectus sheath ends. Located midway between umbilicus & pubic symphysis. Below the Arcuate line, the Rectus muscle is covered by Fascia Transversalis & Peritoneum. It can be cut laterally to gain access to lateral spaces.[11]



Triangle of pain (P) and triangle of doom (D). Own by the author.

FIG 46: Triangle of Pain and Doom [11]

Step 4: Dissecting the inguinal hernial sac:

- The Indirect inguinal hernial sac should be dissected carefully from the spermatic cord. It is essential to expose and always know where spermatic cord is located.
- The Direct inguinal hernial sac is easy to dissect.
- Cautious dissection done lateral and inferior to cooper ligament, as the iliac artery and vein will enter the femoral canal at this site.
- The hernial sac dissection is performed via traction contraction manoeuvres and fine coagulation. Sac ligation is dissection done anteriorly to avoid injury to spermatic cord and vas deferens.

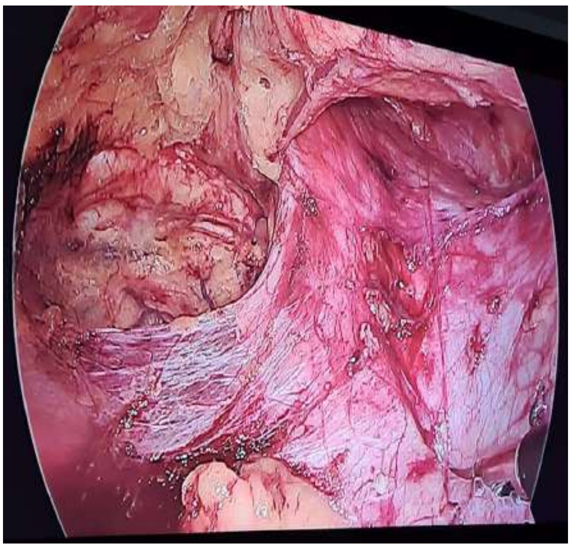


FIG 47: Intra-op photo of Direct Inguinal Hernia.

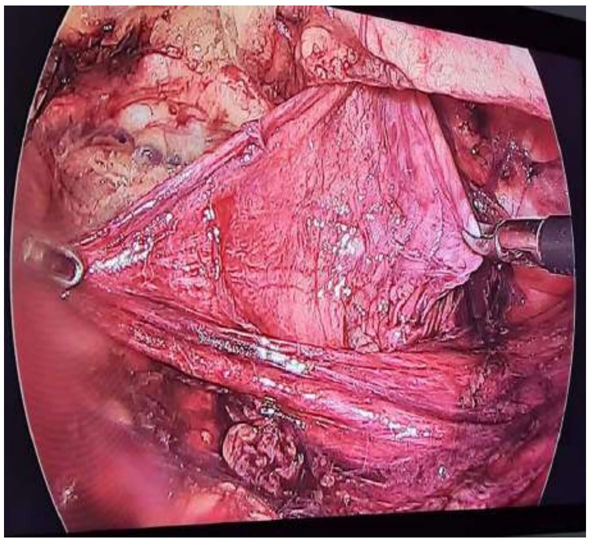


FIG 48: Intra-op photo of Indirect Inguinal hernia.

Step 5: Deploying and anchoring the mesh:

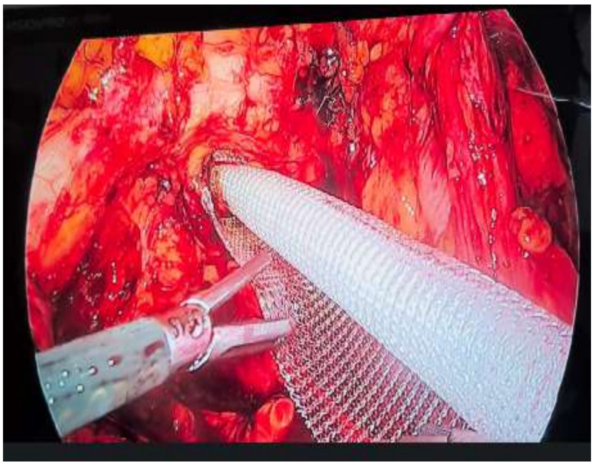


FIG 49: Intra-op photo of Mesh Placement started.

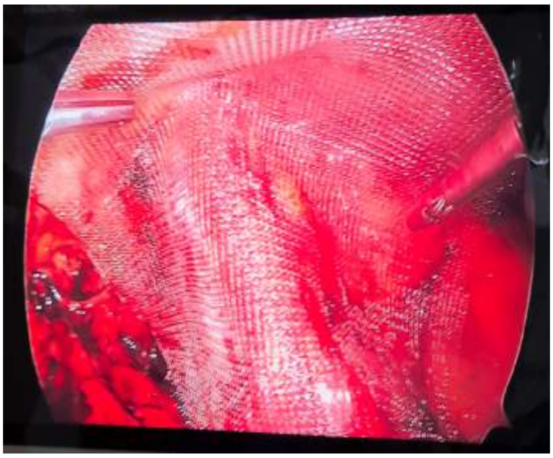


FIG 50: Intra-op photo of Mesh completely spread over the hernial defect.

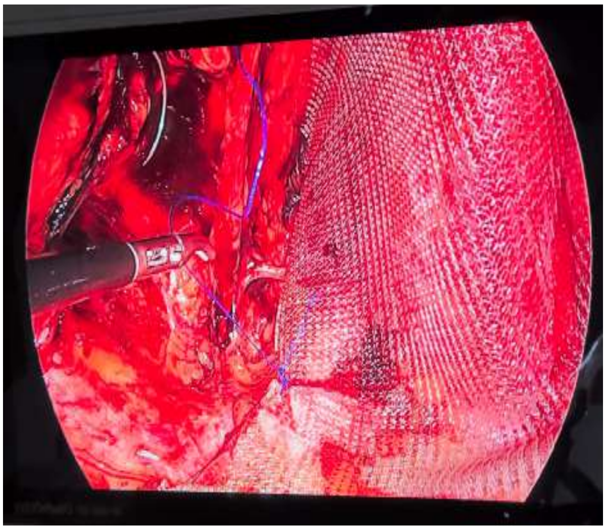


FIG 51: Intra-op photo of Mesh tied over hernial defect to avoid displacements.

RESULT

A total of 14 e-TEP and e-TEP-RS procedures were performed for hernia repair. The mean duration of the surgery was 210 minutes. The average size of the treated defect in the transverse dimension was 5.8 cm, with a defect area of 38.5 cm². The average size of the mesh used was 486 cm². Although the intention was to use the widest possible mesh, the width of the rectus muscle sheaths necessitated trimming the mesh to fit.

Table 1: Patient Demographic Data:

Patients Demoghraphics	Value, N (%)
Number of patients(%)	14 (100)
Gender(male/female)(%)	10/4 (71.4/28.5)
Age,mean(years)	45 (Range:20-75)
Body mass index(kg/m^2)	31.2 (Range:26.5-35.5)
ASA score,n(%)	
I	3 (21.4)
II	7 (50)
III	4 (28.5)
IV	0 (0)

Comorbidities,n(%)	
Hypertension	4 (28.5)
Type II Diabetes	5 (35.7)
Chronic obstructive pulmonary disease	2 (14.2)
Coronary heart disease	2 (14.2)
Smoking	4 (28.5)

The length of the mesh corresponded to the length of the dissected space. No additional methods were used to fix the mesh in any of the cases. One patient developed a flat hematoma in the retromuscular space on the second postoperative day, which was monitored with ultrasound (USG) and was completely resorbed within seven days.

Two patients were diagnosed with seromas, but these did not require any intervention. There were no recurrences during the follow-up period. At regular follow-up visits one month after the surgery, none of the patients reported any significant surgery-related pain.

Table 2: Perioperative Data:

Perioperative Data	**Mean Value**
e-TEP & e-TEP RS Procedures(n)	14
Procedure Time(min)	210(Range: 150-240)
Length of Post-op stay	3.5(Range: 2-6)
Hernia defect area(cm^2)	38.5(Range: 4-100)
Width of hernia defect(cm)	5.8(Range: 1-10)
Length of hernia defect(cm)	6.3(Range: 1-10)
Mesh area(cm^2)	486(Range: 250-825)
Width of mesh(cm)	8.3(Range: 6-15)
Length of mesh(cm)	9.8(Range: 6-15)
Hernia types,n(%)	
Primary Ventral hernia	6(42.8%)
Incisional hernia	1(7.14%)
Median	5(35.71%)
Lateral	0(0.00%)
Upper midline	0(0.00%)
Periumbilical	4(28.57%)
Lower midline	1(7.14%)
Concomitant diastasis recti	0(0.00%)
Inguinal Direct	3(21.42%)
Inguinal Indirect	4(28.57%)
Complications, n(%)	
Seroma	2(14.28%)
Hematoma	1(7.14%)
Surgical site infection	0(0.00%)
Wound dehisence	0(0.00%)
Skin necrosis	0(0.00%)
Prolonged ileus	0(0.00%)
Bowel obstruction	0(0.00%)
Respiratory complications	0(0.00%)
Deep vein thrombosis	0(0.00%)
Urinary infection	0(0.00%)
Conversion to open repair	0(0.00%)

30 days readmission to hospital	0(0.00%)
Recurrence	0(0.00%)
Death	0(0.00%)
Mean follow-up months	6(Range: 3-24)

DISCUSSION

The study performed a total of 14 e-TEP and e-TEP-RS procedures for hernia repair from January 1, 2024, to June 30, 2024. The mean duration of surgery was 210 minutes, indicating a moderately complex surgical procedure. The average size of the hernia defect was 5.8 cm in width, with a mean defect area of 38.5 cm², necessitating the use of a large mesh (average size 486 cm²) for adequate coverage. The study reported that, in each case, the mesh was trimmed to fit the anatomical space available without compromising the repair's integrity. Notably, no additional fixation methods were required to secure the mesh, which may imply an inherent stability provided by the e-TEP technique in the retrorectus space.

Postoperative outcomes were largely positive. Only one patient developed a flat hematoma in the retromuscular space, which was monitored with ultrasound and resolved without intervention. Additionally, two patients developed seromas, which did not require any invasive treatment. Importantly, no recurrences were observed during the mean follow-up period of six months, suggesting that e-TEP provides a durable repair for both ventral and inguinal hernias. There were no significant complications such as surgical site infection, wound dehiscence, bowel obstruction, or respiratory issues, indicating a low perioperative risk profile for the e-TEP approach.

These results suggest that the e-TEP and e-TEP-RS techniques offer an effective and safe option for hernia repair, particularly in cases requiring minimally invasive intervention. The low complication rates and absence of hernia recurrence during the follow-up period indicate that this method provides reliable long-term outcomes. The study's findings also suggest that the careful placement of a large mesh in the retro-rectus space, without additional fixation, can provide sufficient stability and tension-free repair, reducing the likelihood of postoperative complications and recurrence. However, the results should be interpreted with caution due to the small sample size and relatively short follow-up period. A larger, more diverse patient population and extended follow-up would be necessary to confirm the long-term efficacy and safety of the e-TEP technique. Overall, this study reinforces the potential of e-TEP as a new paradigm in hernia surgery, combining minimally invasive approaches with durable outcomes.

One study investigated the effectiveness of the e-TEP technique for laparoscopic retromuscular inguinal hernia repair, performing 102 operations. The study reported minimal complications, including six cases of self-limiting seromas, two conversions to open surgery, one wound infection, and three recurrences. The technique was associated with satisfactory outcomes, with no major complications encountered intraoperatively or postoperatively. However, it was noted that the operative time was longer initially due to the learning curve associated with the technique [12].

Another study focused on the e-TEP-RS technique for midline primary and incisional hernias, evaluating 58 patients with large and complex ventral abdominal hernias. Key outcomes measured included postoperative pain, morbidity, readmission, quality of life (QoL), and hernia recurrence. The study found no intraoperative morbidity, and the CCS QoL scores significantly improved from 34.6 preoperatively to 27.2 at six months postoperatively. While some complications such as seroma formation and prolonged ileus were reported, the e-TEP-RS technique demonstrated excellent results and acceptable morbidity rates. Only one case of supra-umbilical recurrence was reported, indicating the technique's potential for durable hernia repair [13].

A comparative study evaluated the e-TEP technique against laparoscopic intraperitoneal onlay mesh (IPOM) Plus repair for ventral hernias. In this prospective study of 92 cases, the e-TEP group had a longer operative time but demonstrated significantly less postoperative pain, a reduced analgesic requirement, and shorter hospital stays compared to the IPOM Plus group. However, there were two cases of recurrence in the e-TEP group, while none were observed in the IPOM Plus group. These findings suggest that while e-TEP offers advantages in terms of pain and recovery, the technique may require further refinement to minimize recurrence rates [14].

A modification of the classical TEP approach for inguinal hernia repair using the e-TEP technique was described in another study, involving 36 e-TEP procedures. The results indicated that the e-TEP technique had outcomes comparable to the classical approach in terms of pain and recovery time, with an average operating time of 38 minutes. Notably, no major complications were reported, and functional results were deemed excellent. This suggests that the e-TEP technique can be a valuable addition to the surgical armamentarium for inguinal hernia repair [15].

A study involving 171 patients who underwent the e-TEP approach for ventral hernia repair reported a mean defect area of 51.35 cm² and a mean mesh size used of 397.56 cm². The study reported a mean surgery duration of 176.75 minutes and a mean hospital stay of 2.18 days. Complications included seven cases of paralytic ileus, five cases of surgical site infection, and three cases of recurrence at six-month follow-up. Despite these complications, the study concluded that the e-TEP approach is a safe and feasible minimally invasive option for ventral hernia repair, avoiding mesh placement in the peritoneal cavity [16].

CONCLUSION

The study concludes that the e-TEP technique is a safe and effective method for hernia repair, offering a minimally invasive approach with low complication rates and no recurrences observed during the six-month follow-up. The technique allows for the placement of a large mesh in the retrorectus space, providing a tension-free repair without the need for additional fixation. Despite the small sample size, the positive outcomes suggest that e-TEP could represent a promising advancement in hernia surgery, offering durable results with a favorable perioperative risk profile. Further research with a larger patient cohort and extended follow-up is recommended to confirm these findings.

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