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PREOPERATIVE LOCALIZATION OF LANDMARKS IN LAPAROSCOPIC ETEP VENTRAL HERNIA REPAIR BY CONVENTIONAL METHOD AND ULTRASOUND-GUIDED METHOD - A COMPARATIVE STUDY

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ABSTRACT

Background: The enhanced-view totally extraperitoneal (eTEP) technique is an innovative approach developed by Jorge Daes in 2012 for inguinal hernia repair. This eTEP procedure was latter used by Belyansky for management of ventral hernias. Laparoscopic intraperitoneal onlay mesh (IPOM) was the preferred technique for the past three decades in treating ventral hernias laparoscopically. It has revolutionized hernia surgery by minimally invasive techniques. Although IPOM has a short learning curve, it has many disadvantages including, high cost of the prosthetic materials and adhesions to intra abdominal organs . Many of the pitfalls of IPOM procedure was overcome with the advent of eTEP procedure. But one of the main disadvantages of the eTEP retro-rectus (RS) technique is its longer learning curve. To overcome this, simplifying the critical steps of the procedure is essential. One such critical step in eTEP surgery is the introduction of the first trocar , which can be done in a ideal site , using ultrasound-based localization of abdominal wall landmarks. While traditional landmark-based techniques are commonly used to identify the primary port entry site, preoperative ultrasound-guided marking offers advantage of precise primary trocar entry, thereby facilitating a smooth and successful completion of the procedure1.

Methods: In this retrospective comparative study conducted between 2021 and 2024, 60 patients who underwent laparoscopic eTEP repair by single surgeon at Saveetha Medical College were analyzed. Thirty patients underwent conventional surface landmark–based localization of landmarks, while the remaining thirty underwent real-time preoperative ultrasound (US)–guided skin marking of key anatomical landmarks. Demographic and clinical variables assessed included type of hernia and body mass index (BMI), intraoperative parameters such as ideal trocar entry site , duration of surgery and intraoperative complications, and postoperative outcomes including pain scores, seroma formation, wound infection, and length of hospital stay. The primary outcome measures were ideal retro-rectus trocar placement and successful crossover, ease of suturing in M1 area. Secondary endpoints included intraoperative complications such as accidental pneumoperitoneum, neurovascular bundle injury at the linea semilunaris, deep inferior epigastric (DIE) vessel injury, and total operative duration and succusful completion of the procedure.

Results: A total of 60 patients were studied—30 in the USG-guided group and 30 in the conventional group. Both groups were comparable in age and hernia type distribution ($p > 0.05$). Gender distribution showed a significant difference ($p = 0.001$), with more females in the USG group and more males in the conventional group. The incidence of divarication was slightly higher in the USG group (40%) than in the conventional group (37%) ($p = 0.016$). Ideal primary port entry was achieved in all USG-guided cases (100%) compared to 70% in the conventional group ($p < 0.001$), where as in 30% of cases the trocar entry did not happen at the desired point. No neurovascular injuries occurred in either group. The mean time for anatomical landmark marking was significantly longer in the USG-guided group (7.5 ± 3.5 min) than in the conventional group (2.6 ± 1.8 min) ($p < 0.001$).

Conclusion: Ultrasound seems to be a useful tool for localization of landmarks in eTEP procedure which ultimately helps the surgeon to perform a successful surgery and it helps in decreasing the learning curve of eTEP technique

INTRODUCTION

In recent years, minimally invasive ventral hernia repair has undergone a notable evolution—shifting the focus from intra-peritoneal mesh placement toward extra-peritoneal techniques that work with native anatomy25. The eTEP method, first adapted from inguinal hernia surgery by Jorge Daes19 and later refined for ventral defects by Belyansky et al.16, enables placement of mesh in the retromuscular (retro-rectus) space while avoiding entry

into the peritoneal cavity6. This approach facilitates primary closure of the linea alba21,23, wide mesh coverage without fixation devices25, and seamless integration with component separation techniques such as transversus abdominis release (TAR)17.In the eTEP procedure, placement of the initial trocar in the retrorectus plane is one of the most critical steps for successful completion of the surgery 9. Ultrasound localization of anatomical landmarks helps to achieve this goal, and appears more precise than conventional surface marking1.

METHODS AND METHODOLOGY:

This retrospective cohort study was conducted in the Department of General Surgery, Saveetha Medical College and Hospital, among patients who underwent laparoscopic enhanced-view totally extraperitoneal (eTEP) ventral hernia repair between 2021 and 2024. A total of 60 patients were included in the study and divided into two groups of 30 patients each. In one group (n = 30), anatomical landmarks were identified using the conventional method, while in the other group (n = 30), ultrasound was used for precise anatomical landmark identification. The primary endpoints of the study were ideal placement of the initial trocar into the retro-rectus plane and successful superior cross-over to the opposite retro-rectus plane. The secondary endpoint was successful completion of the procedure without any intraoperative complications or safety events. The study population comprised patients undergoing laparoscopic eTEP ventral hernia repair in the Department of General Surgery, Saveetha Medical College and Hospital. The inclusion criteria were patients above the age of 18 years, any type of ventral hernia operated by laparoscopic retromuscular repair (RRRS) using the eTEP approach, including epigastric, umbilical, paraumbilical, incisional, suprapubic, reducible, and irreducible hernias, and patients willing to participate in the study. The exclusion criteria included patients below the age of 18 years, patients with obstructed or strangulated hernias, and patients who were not fit for laparoscopic surgery.

INSERSION OF THE PRIMARY TROCAR :

The anterior abdominal wall is composed of multiple layers, including the skin, superficial fascia, subcutaneous fat, flat muscle aponeurosis, transversalis fascia, extraperitoneal fat, and peritoneum, with the muscular layer being the most surgically relevant. It consists of the paired rectus abdominis muscles medially and the external oblique, internal oblique, and transversus abdominis muscles laterally, whose aponeurosis fuse to form the rectus sheath, the configuration of which differs above and below the arcuate line. Among the important anatomical landmarks, the linea semilunaris and linea alba play a crucial role in determining the site of primary trocar insertion during the enhanced-view totally extraperitoneal Rives–Stoppa (eTEP-RS) approach.

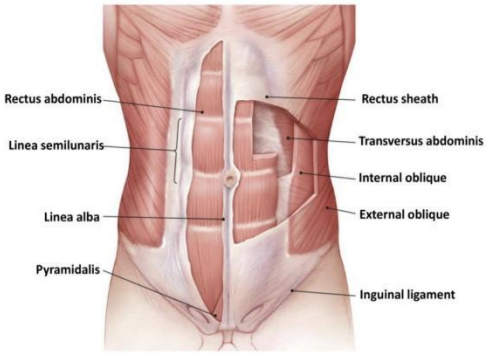

FIGURE 1- ANTERIOR ABDOMINAL WALL

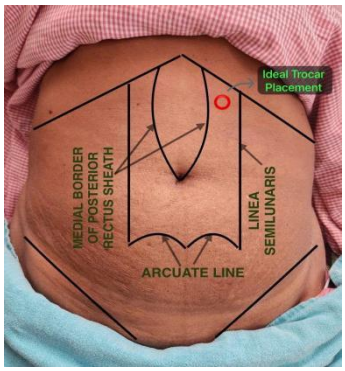

FIGURE 2 - FIRST TROCAR ENTRY MARKING

The first trocar is ideally introduced into the retrorectus plane, approximately 1–2 cm below the costal margin on either the right or left side, positioned as close to the linea semilunaris and as far away from the midline as possible. This location provides safe entry into the retrorectus space while preserving an adequate distance from the linea alba, thereby facilitating effective development of the retrorectus plane and creating sufficient working space for telescope manipulation or use of the port as a working port during the procedure.Proper placement of the primary trocar is essential for achieving a comfortable superior crossover into the contralateral retrorectus plane and facilitates repair of upper midline (M1) defects or associated rectus diastasis.

However, 1st trocar entry remains a notable challenge. If placed too laterally, the trocar may enter the external oblique, internal oblique or transverse abdominis muscles, potentially missing the retrorectus plane entirely. Conversely, a medial misplacement—especially in patients with significant diastasis can lead to entry into the prefalciform space or even direct injury to the linea alba. Additionally, inadvertent damage to neurovascular structures at the linea semilunaris can hinder further progress in the dissection10.Therefore, precise identification of anatomical landmarks is paramount for the successful initiation and continuation of the eTEP procedure. Historically, several methods have been employed to identify the linea semilunaris and other key structures:

Fixed Measurements – The linea semilunaris is estimated to lie approximately 5 cm from the midline in the upper abdomen and about 7 cm lateral to the umbilicus in patients without significant diastasis21.
Clinical Examination – Techniques such as head-raising10 or leg-raising tests may help delineate rectus muscle borders in thin individuals.
Ultrasound Imaging – Intraoperative or preoperative ultrasonography provides real-time visualization of key fascial planes and anatomical structures.
While the first two methods are frequently employed, they are essentially blind techniques and can be unreliable, particularly in patients with obesity, previous abdominal surgeries, or distorted anatomical planes. In contrast, the use of ultrasound guidance enables direct and dynamic visualization of the linea alba and linea semilunaris14, facilitating accurate marking of the ideal trocar insertion site. This ensures precise entry into the retrorectus space and reduces the risk of iatrogenic injury or failed dissection. Despite the established role of preoperative imaging such as CT scans or diagnostic ultrasound in surgical planning, limited studies have systematically evaluated the intraoperative use of ultrasound for real-time landmark identification during eTEP procedures2. This study aims to fill that gap by assessing whether ultrasound-guided localization of anatomical landmarks improves the accuracy of trocar placement, minimizes intraoperative complications, and enhances overall surgical outcomes compared to conventional methods.

STEPS OF CONVENTIONAL METHOD FOR LANDMARK MARKINGS:
In the Conventional Method for anatomical landmark localization - the separation of the rectus muscles is approximated using the "head raise" test. and leg rising test. The linea semilunaris site can be appreciated as a small depression between the rectus and lateral group of muscles in patients with low BMI , heavy manual workers, and fitness conscious individuals.This is then marked freehand by the operating surgeon, typically with a permanent marker.

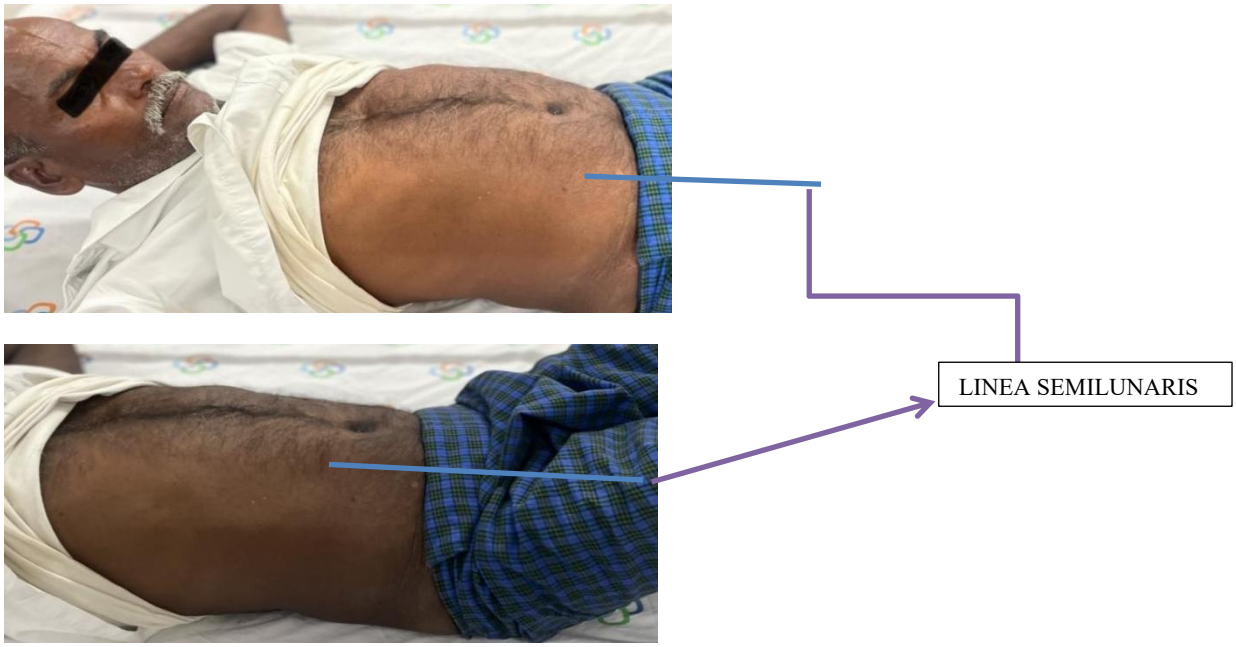

Figure 3 - Picture Of Head/Leg Raising Test

A conventional method to identify the linea semilunaris involves marking it approximately 7 cm lateral to the umbilicusand 5 cm lateral to the midline in the epigastric region. The arcuate line is typically marked about 5 cm below the umbilicus. In incisional or complex hernias, preoperative CT scans not only define the hernia defect but also allow accurate visualization and marking of anatomical landmarks such as the rectus width and semilunar lines. However, in primary ventral hernias, there is no level 1 evidence for the CT imaging of the defects. In such cases, ultrasound (US) proves highly effective, offering real-time identification of key landmarks. This is especially valuable in obese patients, where conventional surface marking becomes unreliable. Depending on the surgeon's preference, landmark markings based on CT or ultrasound can be done either before or after induction of anesthesia.

STEPS OF USG-GUIDED METHOD FOR LANDMARK MARKINGS:
In the ultrasound-guided marking technique, a 10–15 MHz linear ultrasound probe is used by the operating surgeon to identify key anatomical landmarks—namely the linea alba, linea semilunaris, medial insertion of the

posterior rectus sheath (PRS), and the arcuate line. These structures are then carefully marked on the skin with a permanent marker prior to induction of general anesthesia or after induction, to guide accurate placement of the primary trocar.

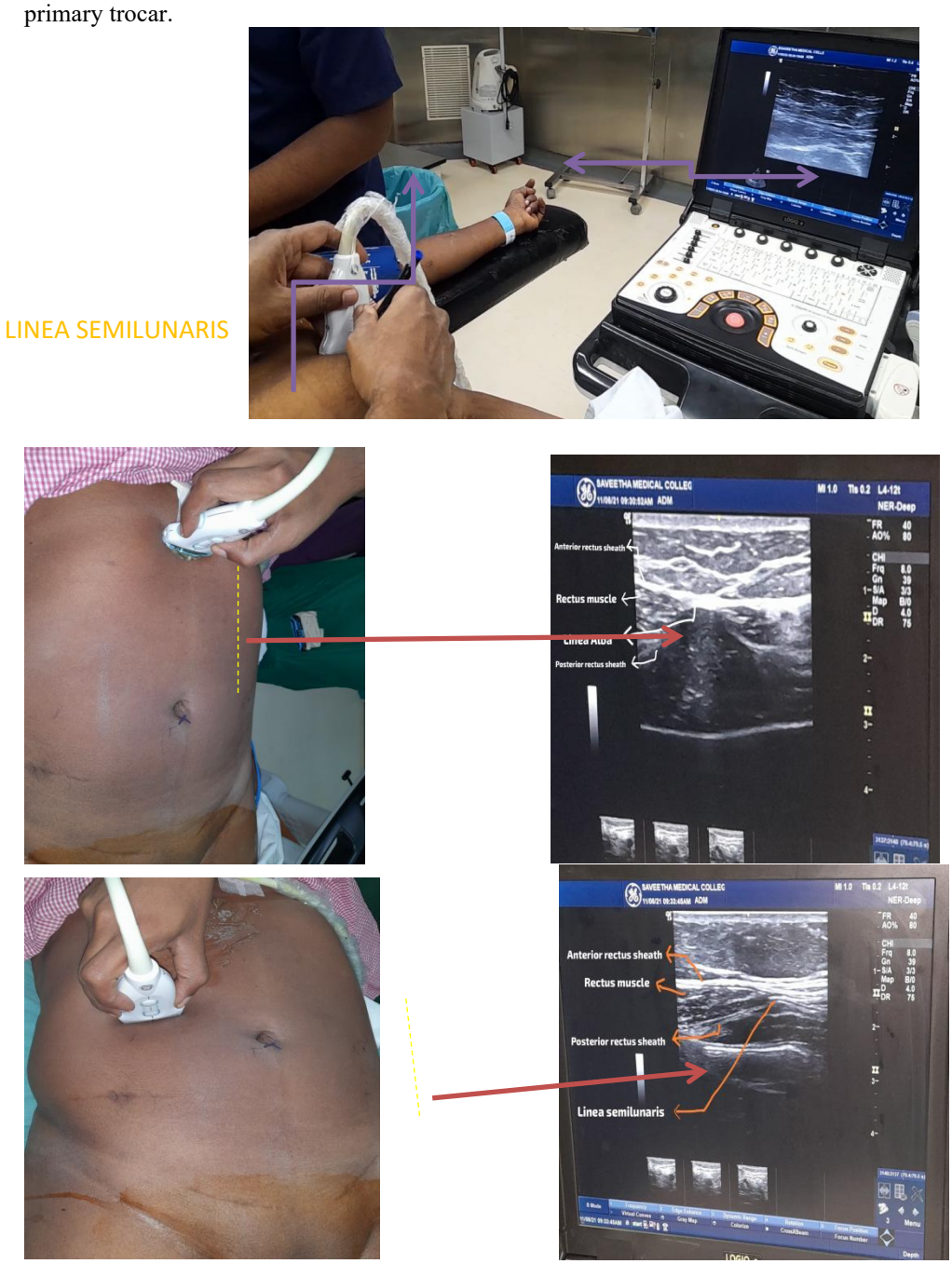

Figure 6 - Usg Guided Localisation

The process involves the following steps:
The linear probe is placed over the abdominal wall while the patient is still awake. The linea alba is first identified in the midline. In cases with diastasis recti, the width of the separation is measured by marking the lateral borders of the linea alba, which correspond to the medial insertions of the PRS.
Moving laterally, the rectus abdominis muscle is visualized. Its thickness and depth are assessed to understand how deep the retrorectus space lies.
The lateral edge of the posterior rectus sheath, which corresponds to the linea semilunaris, is then identified.
The probe is gradually slid laterally from the midline toward the midclavicular line in the epigastric region, allowing precise localization of the linea semilunaris as a second key landmark.
From this ultrasound assessment, the surgeon can gather crucial preoperative information, including the position and width of the linea alba,the extent of divarication (width and length),the depth and accessibility of the retrorectus space-and the location, size, and content of the hernia defect.This method significantly enhances anatomical accuracy and improves safety in trocar placement for the eTEP approach.

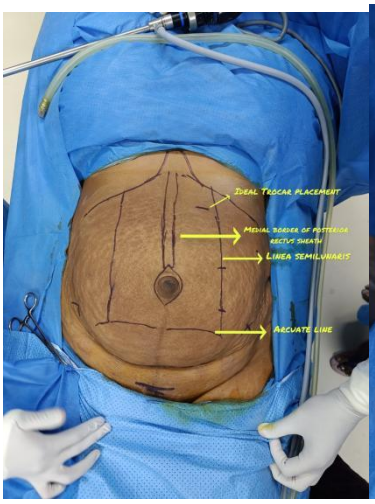

Figure 7 - Post Usg Guided Anatomy

Figure 8 - Post First Trocar Placement

RESULTS:

The two groups were comparable in terms of age distribution, hernia type, and defect size, with no statistically significant differences ($p > 0.05$). Most patients were aged 30–50 years in both groups. The ultrasound-guided (USG) group had a significantly higher proportion of females (67%) compared with the conventional group, which had a predominance of males (63%) ($p = 0.020$). Umbilical hernia was the most common hernia type in both groups, followed by paraumbilical and incisional hernias. Most patients had defect sizes of 3–4 cm. Divarication of recti was observed in 40% of the USG group and 37% of the conventional group, with a statistically significant difference between the groups ($p = 0.016$).

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Per USG (n = 30)	Conventional (n = 30)	P value
Age group (years)			
20–30	5 (17%)	5 (17%)	1.000
30–40	12 (40%)	13 (43%)	0.793
40–50	13 (43%)	12 (40%)	0.793
Gender			
Male	10 (33%)	19 (63%)	0.020*
Female	20 (67%)	11 (37%)	0.020*
Type of Hernia			
Epigastric	4 (13%)	5 (17%)	0.718
Umbilical	12 (40%)	11 (37%)	
Paraumbilical	7 (23%)	7 (23%)	
Incisional	7 (23%)	7 (23%)	
Size of Defect			0.971
2–3 cm	8 (27%)	8 (27%)	
3–4 cm	13 (43%)	14 (47%)	
4–5 cm	9 (30%)	8 (26%)	
Divarication of Recti			0.016*
With divarication	12 (40%)	11 (37%)	
Without divarication	18 (60%)	19 (63%)	

Table 2. Operative Outcomes and Port Entry Characteristics

Variable	Per USG (n = 30)	Conventional (n = 30)	P value
Primary Port Entry			
1)Ideal port entry	30 (100%)	21 (70%)	<0.001*
2)Medial entry (1–2 cm medial to ideal point, inside retrorectus space)	0 (0%)	8 (27%)	<0.004*
3)Entry into falciform space	0 (0%)	0 (0%)	
4)Lateral to linea semilunaris	0 (0%)	1 (3%)	
5)Neurovascular bundle injury	0 (0%)	0 (0%)	
Time taken for anatomical landmark marking (minutes), Mean ± SD	7.5 ± 3.5	2.6 ± 1.8	<0.001*
Time taken for completion of surgery (hours:minutes)	2 h 30 min	2 h 50 min	

The ultrasound-guided (USG) group achieved an ideal primary port entry in all patients (100%), whereas only 70% of patients in the conventional group had ideal port placement ($p < 0.001$). Medial port entry within the retrorectus space occurred in 27% of the conventional group but was not observed in the USG group ($p = 0.004$). No cases of entry into the falciform space or neurovascular bundle injury were noted in either group, while one patient (3%) in the conventional group had lateral entry beyond the linea semilunaris. The mean time required for anatomical landmark marking was significantly longer in the USG group (7.5 ± 3.5 minutes vs. 2.6 ± 1.8 minutes; $p < 0.001$). However, the overall operative time was shorter with USG guidance (2 hours 30 minutes) compared with the conventional technique (2 hours 50 minutes).

DISCUSSION:

In recent years, the eTEP technique has gained increasing recognition as an advanced, potentially gold-standard option for laparoscopic ventral hernia repair16. Unlike traditional intraperitoneal mesh placement, eTEP places the mesh within the expansive retro-rectus preperitoneal space, which helps reduce visceral contact and improves outcome6.Ultrasound is a sensitive, cost-effective imaging tool for identifying abdominal wall landmarks like lenia semil;unaris, defects and rectus diastasis, making it a favored adjunct in operation theaters2. High-resolution linear probes especially assist in defining diastasis borders, enhancing crossover accuracy22.

Our study highlights the importance of ultrasound-guided localization of anatomical landmarks in the eTEP-RS procedure. Although many surgeons may not be initially familiar with operating an ultrasound machine, learning to use a linear probe for assessing the abdominal wall anatomy is relatively straightforward, with a short learning curve1,24.In laparoscopic surgery, adherence to ergonomic principles is essential for achieving optimal surgical efficiency and safety6. This holds true for the eTEP-RS technique as well. While the eTEP approach allows for flexible trocar placement, the location of the primary port remains critical. When the primary port is placed ideally, it offers several significant advantages:

- Improved field of vision.
- Avoidance of instrument clashing (“sword fighting”)
- More efficient and successful crossover dissection secondary to increased space availability.
- Reduced risk of accidental intraperitoneal entry.
- Overall smoother surgical workflow.
- All of these benefits are achievable with accurate preoperative ultrasound marking, reinforcing the value of this simple yet powerful technique in enhancing both safety and surgical outcomes.

CONCLUSION:

Ultrasound-guided landmark localization significantly improves the accuracy and safety of primary trocar placement in laparoscopic eTEP ventral hernia repair. Despite a modest increase in preoperative marking time, it eliminates port misplacement and reduces difficulty during crossover maneuvers and avoids various complications. Ultrasound-guided marking is a simple, effective, and reproducible technique that should be considered for routine use, especially in anatomically challenging cases , M1 hernias, M1M2 divarication , obese patient, poor abdomen wall strength and during the learning phase of the eTEP approach.

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