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e-TEP for Inguinal Hernia: Our Technical Considerations and Surgical Experience

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Abstract

Background and Objectives: The enhanced-view totally extraperitoneal (e-TEP) approach was developed to address the restricted working space and ergonomic limitations associated with conventional totally extraperitoneal inguinal hernia repair. This study describes the evolution toward a modified symmetrical trocar configuration and reports the clinical outcomes of e-TEP repair in a consecutive patient series. *Materials and Methods*: We retrospectively analyzed 93 consecutive adult patients who underwent elective e-TEP inguinal hernia repair at the Clinical Emergency Hospital Bucharest, between January 2019 and December 2023. The cohort included unilateral, bilateral, primary, and recurrent inguinal hernias. The modified configuration incorporated two symmetrical 10-mm ports, allowing alternation of the laparoscope and adaptation of the viewing axis during dissection. The original e-TEP trocar configuration was used in 50 patients (53.8%), whereas the modified symmetrical configuration was used in 43 patients (46.2%). The transition occurred progressively during routine clinical practice. Operative time, conversion to open surgery, intraoperative and postoperative complications, length of hospital stay, and hernia recurrence within 12 months were assessed. Outcomes were analyzed descriptively for the overall cohort, with conversion and postoperative complications additionally summarized according to trocar configuration. No formal comparative statistical analysis was performed. *Results*: Seventy-three patients (78.5%) had unilateral and 20 (21.5%) bilateral hernias; 65 (69.9%) had primary and 28 (30.1%) recurrent hernias. According to the European Hernia Society classification, 48 hernias (42.5%) were lateral, 21 (18.6%) were medial, 16 (14.2%) were femoral, and 28 (24.8%) were combined lateral–medial defects. Conversion to open Lichtenstein repair was required in five patients (5.4%), including three of 50 patients (6.0%) in the original configuration group and two of 43 patients (4.7%) in the modified configuration group. Mean operative time was 68 ± 15 min for unilateral and 112 ± 20 min for bilateral repairs. No intraoperative complications were recorded. Postoperative complications occurred in two patients (4.0%) in the original configuration group (one seroma and one mesh infection requiring explantation) and in one patient (2.3%) in the modified configuration group (seroma). Median postoperative hospital stay was 1 day (IQR 1–2). Complete 12-month follow-up was available for all 93 patients, and no inguinal hernia recurrence was documented. *Conclusions*: The modified symmetrical trocar configuration represents a technical adaptation of the e-TEP approach that allows flexible optical access during preperitoneal dissection. The overall clinical outcomes support the feasibility of e-TEP repair in appropriately selected patients. However, the proposed ergonomic and

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visualization-related advantages of the modified configuration remain observational and warrant prospective comparative evaluation.

Keywords: e-TEP; inguinal hernia; totally extraperitoneal repair; laparoscopic hernia repair; trocar configuration; preperitoneal surgery; retromuscular approach; mesh repair

1. Introduction

Minimally invasive inguinal hernia repair has evolved through progressive refinement of the preperitoneal approach. The totally extraperitoneal (TEP) technique provides direct access to the myopectineal region without entering the peritoneal cavity, but its use may be limited by a relatively confined working space, restricted instrument mobility, and the proximity of the ports to the operative target. To overcome these constraints, Daes introduced the extended-view totally extraperitoneal approach (e-TEP), which enlarges the extraperitoneal working space and allows greater flexibility in trocar positioning [1,2]. The concept was subsequently developed into a broader retromuscular strategy based on the use of interconnected extraperitoneal planes and adaptable port placement according to the location of the defect and the ergonomic requirements of the procedure [3–6].

The original e-TEP approach described by Daes provides greater flexibility in trocar positioning than conventional TEP by allowing optical access at a greater distance from the myopectineal orifice [1,2]. Subsequent adaptations have explored variations in optical port positioning and working port distribution according to the anatomical target and operative requirements [5,6]. The modified configuration described in the present study incorporates two 10-mm ports positioned symmetrically relative to the midline, allowing the laparoscope to be alternated between them during dissection. This arrangement was developed to provide alternative viewing trajectories for lateral preperitoneal dissection and to facilitate contralateral access during bilateral repair. Rather than introducing a distinct surgical approach, the modification represents a technical refinement of established e-TEP principles.

Recent comparative studies have evaluated the clinical implications of this expanded working space. e-TEP has been investigated in primary and recurrent inguinal hernias, with particular attention to mesh behavior, operative exposure, and technical feasibility compared with conventional TEP [7,8]. The approach remains based on the principles of complete visualization of the myopectineal orifice and adequate preperitoneal dissection before mesh placement [9,10]. At the same time, e-TEP introduces specific technical challenges related to creation of the working space, lateral dissection, crossover between anatomical compartments, and selection of port sites [11,12]. Recent studies have further examined operative performance and technical applications of eTEP, including comparisons with conventional TEP, difficult inguinoscrotal hernias, and robotic approaches [13–15]. These data suggest that the value of e-TEP depends not simply on enlarging the operative field, but on whether the additional space improves exposure, triangulation, and reproducibility of the procedure [16].

Mesh deployment and fixation also remain closely related to the quality of preperitoneal dissection. Recent studies have assessed mesh migration, postoperative pain, non-fixation, and atraumatic fixation methods, indicating that prosthetic stability depends on adequate dissection, sufficient mesh overlap, and an appropriate fixation strategy [17–22]. This becomes particularly relevant in bilateral repair, where both myopectineal orifices must be approached through the same access and greater demands are placed on visualization and instrument handling [23]. In this setting, trocar geometry may have a direct practical influence on visualization, triangulation, instrument interference, access to the space of

Bogros, and the ability to approach the contralateral side without substantially reorganizing the operative setup. Despite the growing literature on e-TEP, comparatively little attention has been directed specifically toward how modifications of trocar configuration affect these technical aspects during routine inguinal hernia repair.

Accordingly, the present study describes our experience with e-TEP inguinal hernia repair in a consecutive clinical series and focuses specifically on the evolution of trocar placement from the original configuration to a symmetrical arrangement developed during routine practice. We aimed to describe the technical rationale of this modification and to report the associated operative and postoperative outcomes in patients with unilateral, bilateral, primary, and recurrent inguinal hernias. We hypothesized that a symmetrical port configuration, by increasing the distance between the ports and the operative target and allowing the optical system to be alternated between the two 10-mm ports, would improve instrument triangulation and lateral visualization while facilitating bilateral access.

Rather than representing a distinct procedure, the symmetrical configuration described in this study is a technical adaptation of e-TEP intended to optimize port symmetry, surgeon ergonomics, and instrument triangulation. Its proposed advantages remain observational and require formal comparative evaluation.

2. Materials and Methods

2.1. Study Design and Setting

This retrospective, single-center observational study included consecutive adult patients who underwent elective inguinal hernia repair using the enhanced-view totally extraperitoneal (e-TEP) approach at the Clinical Emergency Hospital Bucharest (Spitalul Clinic de Urgență București—SCUB), Bucharest, Romania, between January 2019 and December 2023.

A total of 93 patients were included in the analysis, of whom 65 underwent repair for primary inguinal hernias and 28 for recurrent inguinal hernias. Among the patients with recurrent hernias, 15 had undergone previous open prosthetic repair, whereas 13 had undergone previous laparoscopic prosthetic repair. A total of 113 groin hernias were repaired in 93 patients. According to the European Hernia Society (EHS) classification, 48 hernias (42.5%) were lateral, 21 (18.6%) were medial, 16 (14.2%) were femoral, and 28 (24.8%) were combined lateral–medial defects. Both unilateral and bilateral hernias were included. All procedures were performed by a single surgeon using the same general operative principles, with progressive refinement of trocar placement during the study period.

The study was designed to describe the technical evolution of trocar placement during e-TEP inguinal hernia repair and to report perioperative and postoperative outcomes in the overall cohort. Particular attention was directed toward the transition from the original e-TEP port configuration to a modified symmetrical arrangement intended to improve operative ergonomics, lateral visualization, and access during bilateral repair.

2.2. Patient Selection

Patients were eligible for inclusion if they were aged 18 years or older, had a diagnosis of primary or recurrent unilateral or bilateral inguinal hernia, and were considered suitable for elective minimally invasive repair under general anesthesia.

Exclusion criteria included contraindications to general anesthesia, complicated inguinal hernias requiring emergency intra-abdominal assessment or bowel resection, previous pelvic radiotherapy, and clinical or anatomical conditions precluding safe development of the preperitoneal space.

Patients with a history of lower abdominal or pelvic surgery were assessed individually according to the type and extent of the previous intervention, anticipated preperitoneal fibrosis or adhesions, and the feasibility of safe extraperitoneal dissection. Previous extensive lower abdominal or pelvic surgery, including radical prostatectomy, was considered an exclusion criterion when severe preperitoneal fibrosis, dense adhesions, or significant anatomical distortion were anticipated to compromise safe access and dissection. A history of lower abdominal surgery alone did not preclude e-TEP repair when the preperitoneal plane was considered suitable for safe dissection.

For recurrent inguinal hernias, eligibility was determined according to the type of previous repair, anticipated preperitoneal fibrosis, and the surgeon's assessment of technical feasibility. Patients with recurrence following previous open or laparoscopic prosthetic repair were evaluated individually. Particular attention was given to the anticipated degree of fibrosis, adhesions, and anatomical distortion associated with previous posterior laparo-endoscopic repair (TEP or TAPP). Patients were considered eligible for e-TEP repair when safe extraperitoneal access and dissection were deemed technically feasible.

Elective surgery was postponed in patients presenting with active skin infections, local inflammatory lesions, or other conditions considered to increase the risk of surgical-site infection. Final eligibility was determined through preoperative clinical assessment, review of previous surgical history, and anesthetic evaluation.

Demographic and clinical variables recorded for descriptive analysis included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status, hernia laterality, primary or recurrent hernia status, and history of previous prosthetic repair.

2.3. Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and received a favorable ethical opinion from the Ethics Committee of the Clinical Emergency Hospital Bucharest (Spitalul Clinic de Urgență București—SCUB), registration No. 54700, dated 28 September 2026.

The ethical documentation corresponded to the project entitled "e-TEP for Inguinal Hernia: Our Technical Considerations and Surgical Experience."

Clinical data used for the retrospective analysis were handled in a deidentified manner. Informed consent for the surgical procedure was obtained from all patients according to institutional practice.

2.4. Surgical Technique

2.4.1. Preoperative Preparation and Patient Positioning

All procedures were performed under general anesthesia. Routine urinary catheterization was not required. Patients were instructed to empty the bladder immediately before surgery, whereas a Foley catheter (C. R. Bard, Inc., Covington, GA, USA) was used selectively when a prolonged or technically demanding procedure was anticipated.

Perioperative antibiotic prophylaxis was administered according to institutional practice. Low-molecular-weight heparin thromboprophylaxis was used selectively in patients with relevant thromboembolic risk factors. Standard preoperative skin preparation was performed in all cases.

The patient was positioned supine, with the hip joint aligned approximately with the central articulation of the operating table. After induction of anesthesia, the table was extended at the level of the hips to increase the distance between the xiphoid process and the pubis while maintaining the abdomen in a horizontal position.

For unilateral hernias, the arm contralateral to the hernia was positioned alongside the body. In bilateral cases, both arms were placed alongside the body.

A wide operative field was prepared to allow visualization of the principal anatomical landmarks, including the linea alba, both semilunar lines, the pubis, and the anterior superior iliac spines. These landmarks were used to guide trocar positioning and optimize access to the extraperitoneal operative field.

2.4.2. Evolution of Trocar Configuration

The initial trocar arrangement followed the e-TEP configuration described by Daes [1,2,5,6]. During routine use, several practical limitations were observed, particularly restricted visualization of the lateral Bogros space without division of the lateral arcuate line, frequent instrument collision or "swording," and reduced versatility during bilateral repair.

These observations led to the progressive adoption of a modified symmetrical trocar configuration. The rationale of this modification was to increase the distance between the working ports and the operative target, improve triangulation, allow alternation of the optical system between two 10-mm ports, and facilitate contralateral access during bilateral repair.

The transition from the original to the modified trocar configuration occurred progressively during routine clinical practice and reflected the technical evolution of the procedure rather than a predefined comparative study protocol. Perioperative and postoperative outcomes were analyzed descriptively for the overall cohort, with conversion to open surgery and postoperative complications additionally summarized according to trocar configuration.

Before trocar insertion, 5 mL of 0.2% ropivacaine (2 mg/mL, Ropivacaine Kabi, HP Halden Pharma AS, Halden, Norway) was infiltrated layer by layer at each planned port site.

2.4.3. Initial Access to the Retrorectus Space

The first 10-mm trocar (ST-99-207, Seemann Technologies GmbH, Böttingen, Germany, when optical access was used) was inserted paraumbilically on the side contralateral to the hernia, or contralateral to the larger defect in bilateral cases.

The objective of initial access was to enter the rectus sheath and establish the retrorectus plane while preserving the posterior rectus sheath. When an optical trocar was used, access was obtained through a skin incision followed by controlled advancement through the abdominal wall layers, with the trajectory adjusted caudally once the posterior rectus sheath was identified.

When an optical trocar was unavailable, an open technique was used. After skin incision, the anterior rectus sheath was exposed and incised transversely over approximately 12 mm. The rectus muscle fibers were separated until the posterior sheath was identified. Digital blunt dissection was then performed in a caudal direction within the retrorectus plane, followed by insertion of a 10-mm trocar.

The retrorectus compartment was subsequently enlarged under direct vision, continuing inferiorly into the Retzius space.

2.4.4. Placement of the Working Ports

After establishment of the initial retrorectus working space, the position of the second trocar, a 5-mm working port (ST-99-206, Seemann Technologies GmbH, Böttingen, Germany), was determined laterally. When required, the intended insertion point was verified using a needle introduced through the semilunar line.

After insertion of the first working instrument—typically a hook (ST-99-575, Seemann Technologies GmbH, Böttingen, Germany), scissors (ST-99-011, Seemann Technologies GmbH, Böttingen, Germany), or Maryland dissector (ST-99-013, Seemann Technologies GmbH, Böttingen, Germany)—the Retzius space was progressively dissected under direct vision to enlarge the operative field and expose the anatomical landmarks of the lower posterior abdominal wall.

The third trocar, also measuring 10 mm, was positioned symmetrically to the first 10-mm port with respect to the midline. A 30° 10-mm laparoscope (Stryker 502-210-030, Stryker Endoscopy, San Jose, CA, USA) could subsequently be introduced through either of the two 10-mm ports, allowing the viewing axis to be adapted according to the stage of the procedure and the anatomical compartment being dissected.

During the later phase of the series, the optical trocar was replaced by a dissecting access balloon trocar (Spacemaker Pro, SMBTTOVLX, Covidien LLC, North Haven, CT, USA) for paraumbilical access. This facilitated more rapid development of the retrorectus and Retzius spaces and subsequently became the routine access technique.

2.4.5. Dissection of the Myopectineal Orifice

Once the extraperitoneal working space had been established, dissection proceeded according to the principles of the critical view of the myopectineal orifice [10].

The Retzius space was developed first, exposing the pubic region, Cooper's ligament, Hesselbach's triangle, and the femoral region. Inferior dissection was extended after mobilization of the bladder to create sufficient space for placement of the inferomedial portion of the prosthesis.

Medial dissection was continued to the midline and, when necessary, beyond the midline, particularly in large direct defects in which adequate medial mesh overlap could otherwise be difficult to obtain.

In direct inguinal hernias, the hernia contents were reduced and the resulting transversalis fascia pseudosac was selectively plicated and fixed to Cooper's ligament using a slowly absorbable barbed monofilament suture (STRATAFIX Symmetric PDS Plus, Ethicon, Inc., Somerville, NJ, USA) when considered appropriate for reducing postoperative seroma formation.

2.4.6. Lateral Preperitoneal Dissection and Bogros Space

The Bogros space was entered by dissecting between the inferior epigastric vascular pedicle and the hernia sac. The peritoneal sac was displaced cranially while the lateral preperitoneal compartment was progressively enlarged.

The dissection aimed to expose the lateral boundaries of the operative field while preserving the integrity of the peritoneum. Particular attention was paid to adhesions that could limit lateral mobilization, including those associated with previous lower abdominal surgery.

When visualization of the lateral Bogros compartment remained inadequate, the lateral portion of the arcuate line was selectively divided for several centimeters medial to the semilunar line, with care taken to preserve the peritoneum.

Division of the arcuate line established communication between the retrorectus and preperitoneal spaces, enlarged the operative field, and facilitated lateral visualization and mesh deployment.

With the modified symmetrical trocar configuration, adequate lateral exposure could often be achieved by changing the viewing direction and alternating the laparoscope between the two 10-mm ports. Consequently, division of the arcuate line was used selectively rather than routinely.

2.4.7. Neural Structures and Lateral Dissection

Dissection in the lateral preperitoneal compartment was performed with particular attention to the neural structures within the triangle of pain.

The femoral branch of the genitofemoral nerve and the lateral femoral cutaneous nerve were considered the principal structures at risk. The iliohypogastric and ilioinguinal nerves could also be encountered depending on the extent and level of dissection.

Electrocautery was used cautiously in these regions to minimize the risk of direct or thermal neural injury.

2.4.8. Management of the Indirect Hernia Sac

In indirect hernias, the hernia sac was progressively separated from the spermatic cord structures. Dissection was continued until the lateral inguinal fossa was adequately exposed.

The technical difficulty of this step varied according to the size of the sac and the presence of adhesions to the vas deferens, gonadal vessels, or surrounding tissues.

When the peritoneal sac was inadvertently opened, the resulting pneumoperitoneum was managed within the already developed extraperitoneal working space. Dissection of the indirect sac was generally performed after establishment of a sufficiently large working domain to minimize the effect of accidental pneumoperitoneum on operative exposure.

Large inguinoscrotal sacs that could not be completely reduced were proximally ligated and divided when necessary.

2.4.9. Parietalization of the Spermatic Cord Structures

Reduction of the hernia sac was followed by complete parietalization of the spermatic cord structures. The peritoneal sac was carefully separated from the vas deferens medially and the gonadal vessels laterally.

Parietalization was considered adequate when the peritoneal reflection had been sufficiently mobilized to allow the inferior margin of the mesh to lie flat without being displaced or folded during exsufflation.

This step was intended to reduce the risk of interposition of the peritoneal sac beneath the inferior prosthetic margin and subsequent mesh folding.

Cord lipomas or prehernial lipomas encountered at the internal inguinal ring were dissected and reduced from the intended prosthetic field before mesh placement.

2.5. Mesh Placement and Fixation

For e-TEP repair, medium-weight or heavyweight polypropylene meshes (medium-weight: Swing-Mesh SMH2, SMH2 151510 S, Lamed GmbH, Oberhaching, Germany; heavy-weight: PROLENE Polypropylene Mesh, PMH, Ethicon, Inc., Somerville, NJ, USA) were used. The medium-weight macroporous polypropylene mesh measured approximately 15 cm in width and 13–15 cm in height.

The prosthesis was introduced in a rolled configuration and unfolded within the prepared preperitoneal space. Mesh positioning was adjusted to ensure complete coverage of the myopectineal orifice, with adequate overlap of the direct, indirect, and femoral compartments.

Before completion of the procedure, the mesh was inspected to ensure appropriate adaptation to the three-dimensional contour of the posterior inguinal region, without folding or displacement.

Mesh fixation was generally performed using cyanoacrylate adhesive (Glubran 2, GEM S.r.l., Viareggio, Italy) as an atraumatic fixation method. In selected patients with large direct defects classified as EHS M2–M3, in whom medial mesh stability was considered

insufficient, the prosthesis was extended beyond the midline and additionally secured with helical tacks (ProTack, 174006, Covidien LLC, Mansfield, MA, USA).

In patients requiring conversion to open Lichtenstein repair, mesh placement and fixation were performed according to the principles of the open anterior approach. The distribution of mesh types and fixation methods is reported in Section 3.3.

2.6. Postoperative Management and Follow-Up

Postoperative analgesia consisted of nonsteroidal anti-inflammatory drugs and, when clinically required, opioid analgesics during hospitalization.

Patients were followed at approximately 1 month, 6 months, and 12 months after surgery. The 1-month follow-up consisted of an outpatient clinical examination focusing on wound healing and early postoperative complications. At 6 months, follow-up information was obtained by telephone assessment.

At 12 months, outcome information was collected using a structured postal questionnaire assessing suspected hernia recurrence, reinterventions, postoperative complications, groin pain or discomfort, return to normal daily activities, and patient satisfaction.

The structured questionnaire used for the 12-month assessment is provided as Supplementary Material S1.

2.7. Outcome Measures

The principal perioperative and postoperative variables assessed in the study included operative time, conversion to open surgery, intraoperative complications, postoperative complications, postoperative length of hospital stay, and recurrence during follow-up.

Operative time was recorded separately for unilateral and bilateral repairs.

Conversion was defined as abandonment of the minimally invasive extraperitoneal approach with completion of the procedure by open Lichtenstein repair.

Postoperative complications were recorded according to clinical severity and classified using the Clavien–Dindo system where applicable.

The analysis also considered the distribution of unilateral versus bilateral repair, primary versus recurrent hernia, and previous prosthetic repair.

Because the study was descriptive and lacked a concurrent control group, the clinical performance of the overall e-TEP approach was assessed through operative feasibility, successful completion of the procedure, conversion to open surgery, and observed perioperative morbidity. Conversion to open surgery and postoperative complications were additionally summarized descriptively according to trocar configuration, without formal statistical comparisons between the two configurations. The proposed technical advantages of the modified symmetrical arrangement were therefore considered intraoperative observations rather than objectively measured comparative outcomes.

2.8. Statistical Analysis

Descriptive statistical analysis was performed using Microsoft Excel for Microsoft 365 (Version 2408, Microsoft Corporation, Redmond, WA, USA).

Continuous variables were summarized according to their distribution and the type of data available. Variables with approximately symmetric distributions were expressed as mean ± standard deviation (SD), whereas variables more appropriately represented by non-parametric descriptive statistics were reported as median and interquartile range (IQR).

Categorical variables were summarized as absolute frequencies and percentages.

Baseline and clinical characteristics included age, BMI, ASA classification, hernia laterality, primary or recurrent hernia status, and history of previous prosthetic repair. Operative

time was expressed as mean ± SD and reported separately for unilateral and bilateral repairs. Postoperative length of hospital stay was summarized using the median and IQR. Conversion to open surgery, intraoperative complications, postoperative complications, and recurrence during follow-up were reported as absolute numbers and percentages. Conversion to open surgery and postoperative complications were additionally summarized descriptively according to trocar configuration.

Because the study was designed as a retrospective descriptive case series without a predefined concurrent comparison group, no formal inferential hypothesis testing was performed. Consequently, no *p*-values, confidence intervals for between-group differences, or comparative effect estimates were calculated.

3. Results

3.1. Patient Characteristics

A total of 93 patients underwent elective inguinal hernia repair using the e-TEP approach during the study period. Of these, 85 were male (91.4%) and 8 were female (8.6%). The mean age was 53 ± 8.2 years, with a range of 29–78 years.

According to body mass index (BMI), 45 patients (48.4%) had a BMI < 25 kg/m^2, 38 (40.9%) had a BMI between 25 and 30 kg/m^2, and 10 (10.7%) had a BMI > 30 kg/m^2. Regarding American Society of Anesthesiologists (ASA) physical status, 60 patients (64.5%) were classified as ASA I, 28 (30.1%) as ASA II, and 5 (5.4%) as ASA III.

Seventy-three patients (78.5%) presented with unilateral inguinal hernias and 20 (21.5%) with bilateral hernias. Primary inguinal hernias were present in 65 patients (69.9%), whereas 28 patients (30.1%) underwent surgery for recurrent hernias.

Among the 28 patients with recurrent hernias, 15 (53.6%) had undergone previous open prosthetic repair, whereas 13 (46.4%) had undergone previous laparoscopic prosthetic repair. Demographic, clinical, and operative characteristics of the study population are summarized in Table 1.

Table 1. Demographic, clinical, and operative characteristics of the study population.

Parameter	Value
Patient characteristics (n = 93)	
Male sex	85 (91.4%)
Female sex	8 (8.6%)
Age, years	53 ± 8.2
Age range, years	29–78
BMI < 25 kg/m^2	45 (48.4%)
BMI 25–30 kg/m^2	38 (40.9%)
BMI > 30 kg/m^2	10 (10.7%)
ASA I	60 (64.5%)
ASA II	28 (30.1%)
ASA III	5 (5.4%)
Unilateral hernia	73 (78.5%)
Bilateral hernia	20 (21.5%)
Primary hernia	65 (69.9%)
Recurrent hernia	28 (30.1%)
Previous prosthetic repair	28 (30.1%)
Hernia anatomical type (EHS classification, n = 113)	
Lateral (L)	48 (42.5%)
Medial (M)	21 (18.6%)
Femoral (F)	16 (14.2%)
Combined lateral–medial (L + M)	28 (24.8%)

Table 1. *Cont.*

Parameter	Value
Trocar configuration (n = 93)	
Original e-TEP trocar configuration	50 (53.8%)
Modified symmetrical trocar configuration	43 (46.2%)

Data are presented as n (%) or mean ± standard deviation, as appropriate. Percentages are calculated based on the number of patients (n = 93) or groin hernias (n = 113), as indicated. BMI, body mass index; ASA, American Society of Anesthesiologists; EHS, European Hernia Society; e-TEP, enhanced-view totally extraperitoneal.

3.2. Trocar Configuration and Operative Technique

Of the 93 patients included in the study, 50 (53.8%) underwent surgery using the original e-TEP trocar configuration described by Daes, whereas 43 (46.2%) underwent surgery using the modified symmetrical configuration. Patient positioning was standardized to maximize the distance between the xiphoid process and the pubis and to facilitate access to the extraperitoneal working space (Figure 1).



Figure 1. Patient and operating-table positioning for e-TEP inguinal hernia repair. The patient is positioned supine with extension at the level of the hips to increase the xiphoid-to-pubis distance and facilitate extraperitoneal access.

The initial trocar arrangement followed the configuration described by Daes (Figure 2). During routine use, several technical limitations were observed, including restricted lateral visualization, instrument collision, and limited adaptability during bilateral repair.

To address these technical limitations, a modified symmetrical trocar arrangement was progressively adopted, incorporating two 10-mm ports positioned symmetrically relative to the midline and a laterally positioned 5-mm working port (Figure 3). This configuration allowed the laparoscope to be alternated between the two 10-mm ports according to the stage of dissection and the anatomical compartment being approached.

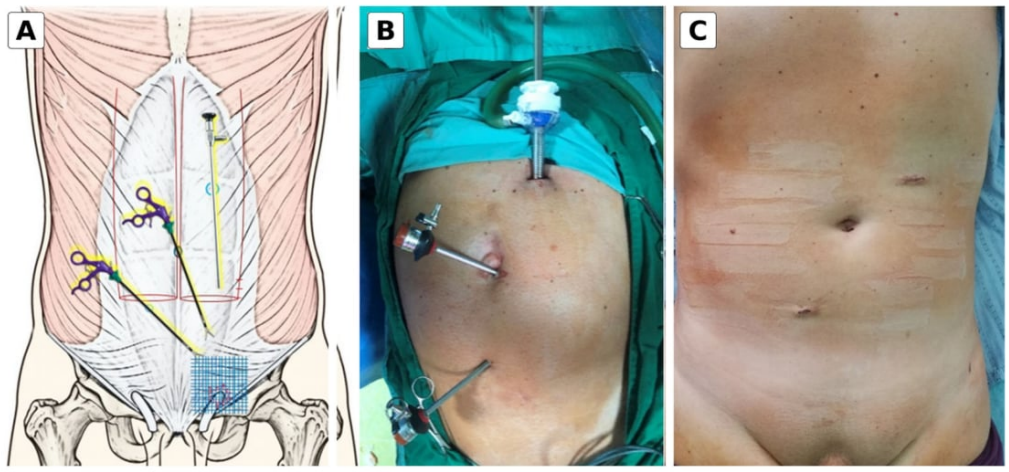


Figure 2. Initial e-TEP trocar configuration based on the original Daes arrangement. (**A**) Schematic illustration of port placement and the geometric relationship between the working ports and the operative target. (**B**) Intraoperative view showing the position of the trocars during unilateral repair. (**C**) Postoperative external view of the abdominal wall demonstrating the location of the port sites.

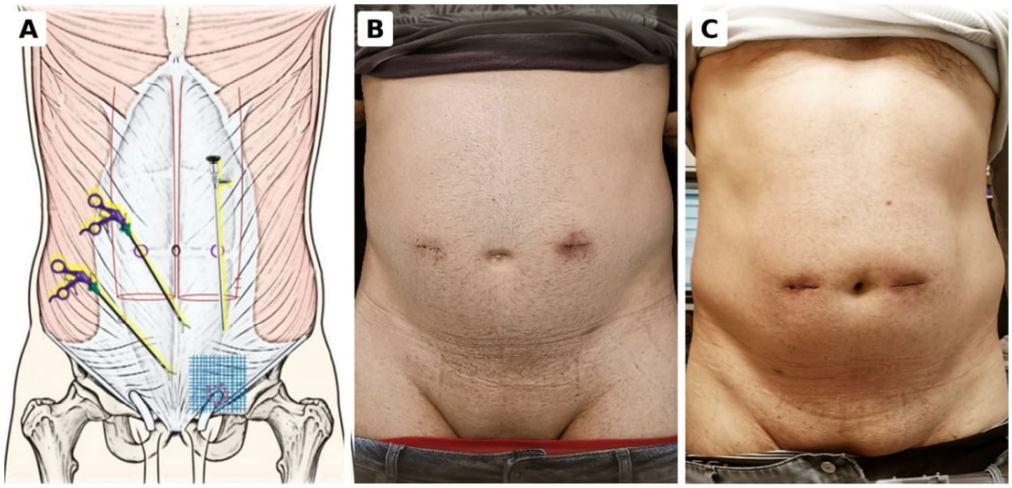


Figure 3. Modified symmetrical trocar configuration adopted during the study period. (**A**) Schematic illustration of port placement, showing the symmetrical relationship of the two 10-mm ports to the midline. (**B**) Clinical view of the abdominal wall after unilateral repair. (**C**) Clinical view showing the final symmetrical paraumbilical port-site distribution.

For bilateral hernia repair, an additional 5-mm working port could be placed symmetrically on the contralateral side, allowing access to both myopectineal regions without major reconfiguration of the operative setup (Figure 4).

The transition between the original and modified trocar configurations occurred progressively during routine clinical practice. Perioperative and postoperative outcomes were analyzed descriptively for the overall cohort, with conversion to open surgery and postoperative complications additionally summarized according to trocar configuration, without formal statistical comparisons. Consequently, the perceived improvements in instrument triangulation, lateral visualization, and operative ergonomics represent intraoperative observations rather than objectively measured comparative outcomes.

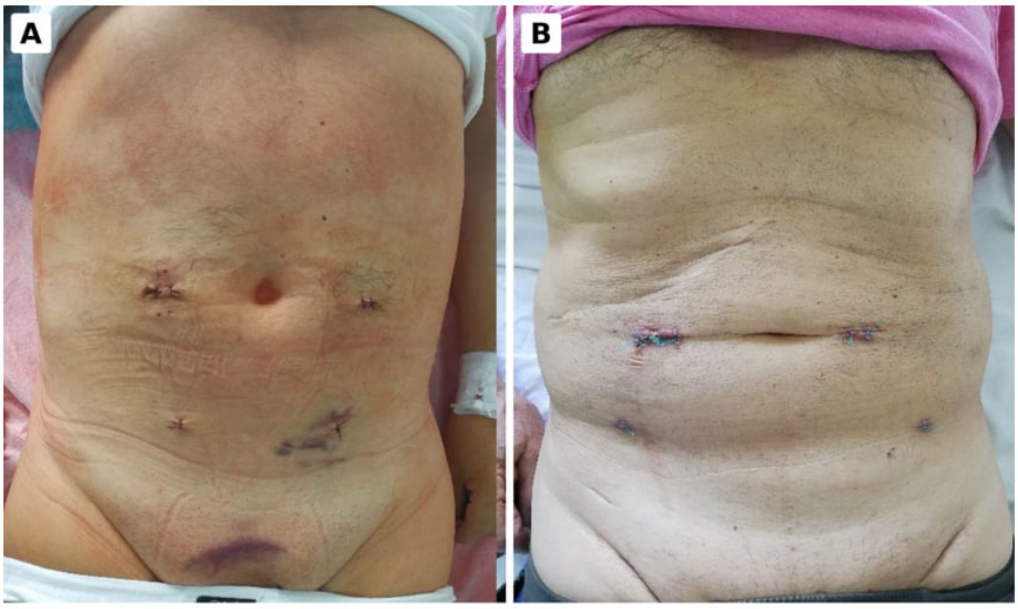


Figure 4. Bilateral e-TEP trocar configuration. (**A**) External postoperative view of the abdominal wall after bilateral repair. (**B**) External postoperative view in a second patient, illustrating the distribution of port sites used for bilateral access.

3.3. Operative Outcomes

Of the 93 patients included in the study, five (5.4%) required conversion to open Lichtenstein repair, resulting in successful completion of the e-TEP procedure in 88 patients (94.6%). Conversion was required in three of 50 patients (6.0%) in the original trocar configuration group and in two of 43 patients (4.7%) in the modified symmetrical configuration group. In one patient in the modified symmetrical configuration group with a history of lower abdominal surgery, dense adhesions were encountered during preperitoneal dissection, preventing safe continuation of the e-TEP procedure and necessitating conversion. Although the patient had been considered eligible for e-TEP based on preoperative assessment, the extent of adhesions became apparent intraoperatively. The remaining four conversions occurred in patients with large unilateral indirect inguinal hernias classified as EHS L3, three in the original configuration group and one in the modified symmetrical configuration group.

Across the overall cohort of 93 patients, medium-weight, macroporous polypropylene meshes were used in 80 patients (86.0%), whereas heavyweight polypropylene meshes were used in 13 patients (14.0%). These figures include both completed e-TEP procedures and cases converted to open Lichtenstein repair.

Among the 88 patients who completed e-TEP repair, mesh fixation was performed using cyanoacrylate adhesive alone in 74 patients (84.1%), whereas combined fixation with cyanoacrylate adhesive and helical tacks was used in 14 patients (15.9%). Additional mechanical fixation was reserved for selected patients with direct EHS M2–M3 defects in whom medial mesh stability was considered insufficient.

Mean operative time was 68 ± 15 min for unilateral repairs and 112 ± 20 min for bilateral repairs. These values are reported descriptively, as no predefined inferential comparison between unilateral and bilateral procedures was performed.

The median postoperative length of hospital stay was 1 day (IQR, 1–2 days), with a range of 1–6 days.

3.4. Perioperative and Postoperative Complications

No intraoperative complications were recorded in either trocar configuration group.

Postoperative complications occurred in three patients. Two patients developed postoperative seromas and were managed conservatively. One patient developed a mesh infection classified as Clavien–Dindo grade IIIb. In the original trocar configuration group, postoperative complications occurred in two of 50 patients (4.0%), comprising one seroma and one mesh infection. In the modified symmetrical configuration group, one of 43 patients (2.3%) developed a postoperative seroma.

The mesh infection was diagnosed approximately 2 months after surgery on the basis of persistent wound discharge and local inflammatory signs. Initial conservative management with antibiotic therapy was unsuccessful, and complete mesh explantation was subsequently required. Mesh removal was performed through an open surgical approach, followed by favorable clinical evolution.

3.5. Follow-Up

Complete 12-month follow-up was available for all 93 patients (100%). No inguinal hernia recurrence was documented during the follow-up period.

Because the 12-month assessment relied on a structured postal questionnaire rather than systematic clinical or imaging examination, the possibility of asymptomatic or unreported recurrence cannot be excluded.

4. Discussion

The present study describes a five-year single-center experience with e-TEP inguinal hernia repair, focusing on the progressive transition from the original trocar arrangement to a modified symmetrical configuration. This technical adaptation was developed to address practical limitations encountered during routine surgery, particularly restricted lateral visualization, instrument interference, and limited adaptability during bilateral repair, while preserving the fundamental principles of posterior preperitoneal hernia repair. The clinical outcomes observed in the overall cohort support the feasibility of the e-TEP approach in appropriately selected patients. Conversion and postoperative complication frequencies were additionally reported according to trocar configuration to provide a more detailed description of the clinical experience. However, given the retrospective design, progressive adoption of the modified configuration, and absence of a predefined comparative analysis, the observed outcomes cannot establish the relative effectiveness or safety of either configuration. The perceived improvements in operative exposure, instrument triangulation, and surgeon ergonomics should therefore be interpreted as intraoperative observations rather than objectively demonstrated comparative benefits.

The rationale for modifying trocar placement derives directly from one of the principal limitations of conventional TEP: the restricted operative domain and the short distance between instruments and the target anatomy. The original e-TEP concept proposed by Daes expanded the extraperitoneal working space and introduced greater flexibility in port positioning [1,2,5,6]. Subsequent anatomical and technical developments emphasized the continuity between the retrorectus and preperitoneal planes and the possibility of adapting access according to the region requiring dissection [3,4]. In our experience, the initial Daes-based configuration was technically feasible but was associated with practical limitations, particularly instrument collision, reduced lateral visualization of the Bogros space, and difficulty adapting the same arrangement to bilateral repair. The modified symmetrical layout was developed in response to these specific problems rather than as a fundamentally different operation.

One of the practical advantages of the symmetrical configuration was the possibility of alternating the laparoscope between the two 10-mm ports. This changed the viewing axis without requiring a major reorganization of the operative setup and facilitated access to the lateral preperitoneal compartment. The ability to modify the optical perspective was particularly useful when exposure of the Bogros space was limited. The classical e-TEP approach permits selective division of the arcuate line to establish communication between the retrorectus and preperitoneal spaces [5,6]. In the present series, this maneuver remained available when required, but the modified port geometry often allowed adequate lateral visualization by changing the viewing angle alone. This observation is technically relevant because the value of e-TEP may lie not simply in creating a larger space, but in allowing the surgeon to use that space from different optical and instrumental trajectories.

Complete exposure of the myopectineal orifice remains central to any posterior inguinal hernia repair. Daes and Felix formalized this concept through the critical view of the myopectineal orifice, emphasizing systematic anatomical exposure before mesh deployment [10]. The modified trocar arrangement used in our series was intended to facilitate this process rather than alter its principles. In particular, improved access to the Retzius and Bogros spaces allowed broad dissection and adequate parietalization before prosthesis placement. Recent comparative studies of e-TEP and conventional TEP have similarly focused on whether the expanded working space translates into better operative access without compromising mesh stability or short-term outcomes [7,8,12,13]. The present findings are consistent with this technical rationale, although direct comparison with conventional TEP was not performed.

Bilateral repair represents a setting in which trocar geometry becomes particularly important. Twenty patients in our series underwent bilateral repair, and the symmetrical configuration allowed contralateral access with the addition of a corresponding working port rather than complete reconfiguration of the operative field. Comparative studies of bilateral TEP and TAPP have shown broadly similar clinical outcomes, although operative time and conversion patterns may differ between techniques [23,24]. In the study by Hidalgo et al., bilateral TEP and TAPP produced similar postoperative outcomes, while conversion to open surgery was more frequent in the TEP group and operative time differed between approaches [24–27]. More recent systematic evidence also suggests that both extraperitoneal and transabdominal approaches remain valid options for bilateral inguinal hernia repair, with technique selection influenced by surgical expertise and patient-related factors [28].

The mean operative time in our series was 68 ± 15 min for unilateral repair and 112 ± 20 min for bilateral repair. These values are compatible with the increased extent of dissection required when both myopectineal orifices are treated. The present study was not designed to compare unilateral and bilateral procedures statistically, and therefore the difference should be considered descriptive. Published evidence confirms that bilateral repair naturally increases technical demands and operative exposure, while remaining feasible through minimally invasive access [23,24]. Recent meta-analytic data comparing TEP and TAPP for bilateral hernias found no consistent difference in several major clinical outcomes, including recurrence, intraoperative complications, postoperative pain, seroma, wound infection, and length of hospital stay, reinforcing the importance of surgeon experience and operative standardization rather than assuming intrinsic superiority of one approach [28].

The broader literature on minimally invasive inguinal hernia repair also supports a cautious interpretation of technical refinements. A recent network meta-analysis of randomized studies found that both TEP and TAPP are effective minimally invasive approaches, with relatively low complication and recurrence rates overall [25]. Similarly, systematic comparison of transinguinal preperitoneal and minimally invasive techniques indicates

that the choice of operative strategy should be based on the balance between invasiveness, operative access, surgeon familiarity, and patient characteristics rather than on a single technical parameter [26]. The increasing diversity of laparoscopic and robotic configurations further illustrates this point. A network meta-analysis involving single-port, multi-port, laparoscopic, and robotic repairs showed that contemporary inguinal hernia surgery encompasses several technically distinct approaches, each with different access characteristics and resource requirements [27]. Within this context, the modified configuration described in the present study should be regarded as an ergonomic refinement of eTEP rather than as a competing procedure.

Mesh positioning is another aspect closely linked to adequate preperitoneal dissection. In our series, a large macroporous polypropylene prosthesis was deployed over the myopectineal orifice, generally with cyanoacrylate fixation, while helical tacks were reserved for selected large direct defects. The relationship between fixation strategy, mesh migration, and postoperative pain has been evaluated extensively in TEP repair [17–22]. Prospective and meta-analytic evidence suggests that routine penetrating fixation is not universally required when sufficient dissection and mesh overlap are achieved, while atraumatic fixation may reduce concerns related to postoperative pain [17,19–22]. These observations support the technical emphasis placed in our procedure on complete parietalization and creation of an adequate prosthetic bed before fixation.

Postoperative morbidity in the present series was low in absolute numbers. Two seromas were managed conservatively, whereas one patient developed a mesh infection requiring open mesh removal. Seroma formation is a recognized event after preperitoneal inguinal hernia repair and is influenced by defect size, residual dead space, and management of the direct hernia pseudosac. The selective plication of the transversalis fascia used in our practice was intended to reduce this residual space. The single mesh infection represents a clinically important complication, but its isolated occurrence does not allow identification of a specific causal factor. The absence of intraoperative complications in the present cohort is reassuring but should not be overinterpreted given the sample size and the single-surgeon setting.

The conversion rate of 5.38% also deserves consideration. One conversion was related to dense adhesions after previous lower abdominal surgery, while four occurred in patients with large unilateral inguinal hernias. These cases illustrate the importance of appropriate patient selection and the technical limitations that may persist despite enlargement of the extraperitoneal working space. Although conversions were reported separately according to trocar configuration, the descriptive nature of the study precludes conclusions regarding the influence of trocar configuration on conversion risk. Previous studies have similarly shown that large, recurrent, or inguinoscrotal defects may place greater demands on extraperitoneal dissection [8,14]. The possibility of conversion should therefore be regarded as part of safe operative decision-making rather than as failure of the minimally invasive strategy.

Several limitations must be acknowledged. First, the retrospective and single-center design limits causal interpretation and external generalizability. Second, all procedures were performed by a single surgeon, which improves technical consistency but also introduces operator-specific effects. Third, the study does not include a contemporaneous control group treated with conventional TEP or TAPP, and therefore no conclusion regarding comparative superiority can be drawn. Fourth, the transition from the original trocar arrangement to the modified symmetrical configuration occurred progressively during routine practice; without a predefined comparison between these configurations, the ergonomic advantages described remain primarily observational. Fifth, follow-up was limited to 12 months, which is adequate for early postoperative assessment but insufficient to characterize long-term recurrence fully. Furthermore, recurrence assessment at 12 months was based on a structured

postal questionnaire rather than systematic clinical or radiological examination, which may have limited the detection of asymptomatic or unreported recurrences. Finally, although the 12-month postal questionnaire included questions regarding groin pain, functional recovery, and patient satisfaction, validated disease-specific instruments for assessing chronic postoperative inguinal pain and health-related quality of life were not used. The absence of standardized patient-reported outcomes and objective ergonomic measurements represents an additional limitation that should be addressed in future prospective comparative studies.

Future studies should prospectively compare the modified symmetrical configuration with conventional TEP and other e-TEP layouts using predefined clinical and technical endpoints. Relevant outcomes should include operative time, conversion, intraoperative complications, postoperative pain, seroma, chronic groin pain, recurrence, mesh-related complications, and patient-reported recovery. Quantitative assessment of instrument collision, trocar-to-target distance, viewing angles, and surgeon workload could also provide objective evidence for the ergonomic advantages suggested by the present experience. Multicenter studies would be particularly valuable in determining whether the technique remains reproducible across surgeons with different levels of experience.

Overall, the present series supports the feasibility of e-TEP repair in appropriately selected patients. The principal contribution of the modified symmetrical trocar configuration is technical: it allows flexible optical access and provides alternative viewing trajectories for lateral and contralateral preperitoneal dissection while preserving the established anatomical principles of posterior inguinal hernia repair. These observations provide a rationale for further prospective comparative evaluation but do not establish the clinical or ergonomic superiority of the modified configuration over existing e-TEP arrangements, conventional TEP, or TAPP.

5. Conclusions

The modified symmetrical trocar configuration represents a technical adaptation of the e-TEP approach for elective groin hernia repair. Its progressive implementation in this retrospective single-center series allowed flexible optical access through two 10-mm ports and provided an alternative viewing trajectory for lateral and contralateral preperitoneal dissection while preserving the established anatomical principles of posterior hernia repair.

The clinical outcomes observed in the overall cohort support the feasibility of e-TEP repair in appropriately selected patients. However, although conversion to open surgery and postoperative complications were summarized descriptively according to trocar configuration, the study design does not allow the observed clinical outcomes to be attributed specifically to the modified arrangement. The proposed improvements in instrument triangulation, visualization, and surgeon ergonomics remain observational.

Prospective comparative studies incorporating standardized clinical, ergonomic, and patient-reported outcomes, together with extended follow-up, are required to determine whether this technical adaptation provides measurable benefits over existing e-TEP configurations.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/medicina62122330/s1: Supplementary Material S1: Twelve-Month Follow-Up Questionnaire After e-TEP Inguinal Hernia Repair.

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Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Multidisciplinary Digital Publishing Institute
ASA	American Society of Anesthesiologists
BMI	Body mass index
eTEP	Enhanced-view totally extraperitoneal
IQR	Interquartile range
SCUB	Spitalul Clinic de Urgență București (Clinical Emergency Hospital Bucharest)
SD	Standard deviation
TAPP	Transabdominal preperitoneal
TEP	Totally extraperitoneal

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