New Day in Medicine
Новый День в Медицине
NDM

TIBBIYOTDA YANGI KUN

Ilmiy referativ, marifiy-ma'naviy jurnal

AVICENNA-MED.UZ

ISSN 2181-712X.
EiSSN 2181-2187

5 (79) 2025

ТИББИЁТДА ЯНГИ КУН
НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
NEW DAY IN MEDICINE

Илмий-рефератив, маънавий-маърифий журнал
Научно-реферативный,
духовно-просветительский журнал

УЧРЕДИТЕЛИ:

БУХАРСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ ИНСТИТУТ
ООО «ТИББИЁТДА ЯНГИ КУН»

Национальный медицинский исследовательский центр хирургии имени А.В. Вишневского является генеральным научно-практическим консультантом редакции

Журнал был включен в список журнальных изданий, рецензируемых Высшей Аттестационной Комиссией Республики Узбекистан (Протокол № 201/03 от 30.12.2013 г.)

5 (79)

2025

май

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Received: 20.04.2025, Accepted: 06.05.2025, Published: 10.05.2025

UDK 617-089.888.61

INNOVATIVE APPROACHES TO LAPAROSCOPIC INGUINAL HERNIA REPAIR: ADVANTAGES OF E-TEP OVER TAPP

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✓ ***Resume***

Modern laparoscopic hernia repair is evolving toward less invasive techniques. This study evaluates the benefits of the e-TEP method compared to the conventional TAPP technique in inguinal hernia treatment. Clinical analysis of 102 patients revealed that e-TEP is associated with reduced postoperative pain, faster recovery, and fewer complications. The e-TEP approach appears to be a safe and effective alternative when selecting the optimal endoscopic access route.

Keywords. laparoscopic hernioplasty, e-TEP, TAPP, minimally invasive surgery, inguinal hernia, mesh implant, postoperative recovery

ИННОВАЦИОННЫЕ ПОДХОДЫ К ЛАПАРОСКОПИЧЕСКОЙ ГЕРНИОПЛАСТИКЕ ПАХОВЫХ ГРЫЖ: ПРЕИМУЩЕСТВА E-TEP ПЕРЕД TAPP

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✓ ***Резюме***

Современная лапароскопическая герниопластика развивается в сторону всё менее инвазивных методик. В данной работе рассмотрены преимущества метода e-TEP по сравнению с традиционным TAPP при лечении паховых грыж. Анализ клинических данных 102 пациентов показал, что e-TEP обеспечивает меньшее послеоперационное болевое ощущение, ускоряет восстановление и снижает риски осложнений. Методика e-TEP представляет собой безопасную и эффективную альтернативу при выборе эндоскопического доступа.

Ключевые слова. Лапароскопическая герниопластика, e-TEP, TAPP, малоинвазивная хирургия, паховая грыжа, имплант, послеоперационное восстановление

LAPAROSKOPIK CHOV CHURRALARINI DAVOLASHDA INNOVATSION YONDASHUVLAR: E-TEP USULINING TAPPGA NISBATAN AFZALLIKLARI

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✓ ***Rezyume***

Ushbu tadqiqotning maqsadi — TAPP va e-TEP usullarida to‘r (mesh) implantlarini optimal joylashtirish orqali laparoskopik pax churralarini davolash natijalarini yaxshilashdan iborat. Tadqiqotga 102 nafar bemor jalb etildi: 53 nafariga TAPP, 49 nafariga esa e-TEP gernioplastikasi qo‘llanildi. Operatsiyadan keyingi og‘riq darajasi, churraning qaytalanish holatlari, surunkali og‘riqlar, bemorlarning tiklanish muddati hamda hayot sifati baholandi. e-TEP usuli TAPPga nisbatan kamroq og‘riq va tezroq tiklanishni ta’minladi. Uzoq muddatli natijalar esa ikkala usulda ham samarali va xavfsiz ekanligini ko‘rsatdi.

Kalit so‘zlar. Chov churrasi, laparoskopiya, TAPP, e-TEP, gernioplastika, to‘r implant, operatsiyadan keyingi og‘riq, churraning qaytalanishi

Relevance

Inguinal hernias represent a significant health burden, with lifetime occurrence estimated at 27% in en. Surgical repair is the only definitive treatment. Traditional open techniques (e.g. Lichtenstein repair) are effective but associated with notable postoperative pain and a risk of chronic groin pain in up to 10–30% of patients. Laparoscopic approaches, introduced in the 1990s, have the advantages of smaller incisions, less tissue trauma, and faster recovery, and they have demonstrated lower rates of chronic post-herniorrhaphy pain compared to open repair. Two main endovideoscopic techniques exist: TAPP, which enters the peritoneal cavity to place mesh in the preperitoneal space, and TEP, which avoids the peritoneal cavity entirely. An “enhanced-view” extended TEP (e-TEP) approach was developed in 2012 to facilitate laparoscopic repair of complex or bilateral hernias by creating a larger extraperitoneal working space.

Despite evidence that TAPP and TEP yield similarly low recurrence rates (around 1–2%) and comparable long-term outcomes, surgeons continue to seek ways to optimize these techniques. One critical factor is the positioning and fixation (or non-fixation) of the mesh implant. Proper mesh placement should cover all potential hernia defects at the myopectineal orifice (indirect, direct, and femoral areas) while avoiding injury to nearby nerves (within the so-called “triangle of pain”). Achieving this optimal mesh position can minimize the risk of recurrence and chronic pain. The e-TEP approach may aid in this regard by providing an expanded view of the preperitoneal space, potentially making it easier to correctly position a large mesh without intraperitoneal entry.

Given the prevalence of inguinal hernias and the morbidity associated with suboptimal repair (recurrence or chronic pain), it is highly relevant to compare TAPP and e-TEP techniques. This study addresses whether the newer e-TEP method offers measurable improvements in patient outcomes and explores how mesh implantation can be optimized in each approach. Ultimately, refining these endoscopic techniques could further improve postoperative recovery and quality of life for patients with this common condition.

Aim of the study. The aim of this study was to improve the outcomes of laparoscopic (endovideoscopic) treatment of patients with inguinal hernias by determining the optimal positioning of mesh implants in TAPP and extended totally extraperitoneal (e-TEP) repair.

Materials and methods

A retrospective comparative study was conducted, including 102 adult patients (aged 19–78 years) who underwent laparoscopic inguinal hernia repair at our institution between January 2020 and December 2024. Of these, 53 patients received a TAPP repair and 49 patients underwent an extended-view TEP (e-TEP) repair. All surgeries were elective and performed for primary (non-recurrent) inguinal hernias. The inclusion criteria were adults 18–80 years old with a primary unilateral or bilateral inguinal hernia (direct or indirect) that was reducible, who consented to laparoscopic repair. Exclusion criteria included incarcerated or strangulated hernias requiring emergency open surgery, recurrent hernias (to avoid confounding from prior repairs), known coagulation disorders, pregnancy, or any contraindications to general anesthesia or laparoscopic surgery (such as severe cardiopulmonary disease).

All procedures were performed by experienced laparoscopic surgeons familiar with both TAPP and TEP techniques. The choice of TAPP vs. e-TEP was determined by surgeon expertise and logistical considerations; there was no patient randomization, though patient preference was considered when

possible. Patients in the TAPP group were positioned supine in slight Trendelenburg. TAPP was performed using three ports: a 10–12 mm camera port at the umbilicus and two 5 mm working ports in the lower abdomen (in the midclavicular lines or anterior axillary lines at or just below the level of the umbilicus). After diagnostic laparoscopy, a peritoneal flap was created, the hernia sac was reduced, and a mesh of size at least 15 × 12 cm was placed in the preperitoneal space, covering the entire myopectineal orifice. The mesh was flattened to cover all potential defect sites (indirect, direct, and femoral). In most TAPP cases we did not fix the mesh with tacks or glue, in line with evidence that mesh fixation is unnecessary for small- to moderate-sized hernia defects and avoiding fixation may reduce chronic pain. The peritoneal flap was then closed over the mesh with absorbable sutures or tacks to keep the mesh in the proper preperitoneal position beneath the peritoneum.

Illustration of the TAPP approach. A) Operating room setup for TAPP, with the surgeon (S) standing on the side opposite the hernia and the assistant (A) on the ipsilateral side, and monitors at the foot of the table. B) Typical port placement for TAPP repair (for a left-sided hernia in this example), showing a 12 mm camera port (purple) supraumbilically and two 5 mm ports (red for ipsilateral, blue for contralateral side) aligned roughly at the umbilical horizontal line. This transabdominal approach allows excellent visualization of intra-abdominal anatomy and the contralateral side, aiding in identifying occult hernias, but requires creation and closure of a peritoneal flap.

Patients in the e-TEP group underwent an endoscopic totally extraperitoneal repair using an enhanced-view technique described by Daes et al.. For e-TEP, patients were likewise positioned supine in Trendelenburg. Trocars were placed to develop an extraperitoneal working space: typically a 10–12 mm port was inserted just above or below the umbilicus into the preperitoneal plane (using an open Hasson technique or optical trocar) and two additional 5 mm ports were placed in the midline or slightly off-midline under direct vision in the created extraperitoneal space (often one just above the pubic symphysis and one midway in between). In some cases of bilateral hernia, additional 5 mm ports were placed to facilitate dissection on both sides. A space was dissected between the peritoneum and the abdominal wall (in the Retzius' and Bogros' spaces) to expose the hernia defect. After reduction of the hernia sac, a similarly sized polypropylene mesh (usually 15 × 12 cm or larger for bilateral repairs) was introduced into the extraperitoneal space. The mesh was positioned to cover the myopectineal orifice entirely, extending at least ~3–4 cm beyond the hernia defect margins in all directions (overlapping the pubic tubercle medially, the lateral space beyond the internal inguinal ring, and the Hasselbach's triangle area). In e-TEP, the peritoneum remains intact (aside from small intentional or inadvertent openings that were closed with clips if needed), and typically the intra-abdominal pressure itself and the abdominal wall hold the mesh in place without fixation, so no tacks or sutures were used unless necessary. The abdomen was desufflated and port sites closed.

Port placements for the totally extraperitoneal (TEP/e-TEP) repair. This diagram shows a common configuration for extraperitoneal inguinal hernia repair, with three midline ports: a sub-umbilical camera port (10 mm) and two 5 mm working ports placed in the lower midline. The surgeon creates and works within the preperitoneal space, introducing trocars without entering the peritoneal cavity. In the extended-view TEP (e-TEP), additional space can be gained by initial port placement slightly off-midline or above the umbilicus to begin the dissection, allowing a larger workspace and easier mesh placement for large or bilateral hernias. This approach avoids peritoneal incision and closure, which can translate to reduced postoperative pain and fewer intraperitoneal complications. (Illustration credit: Adapted from Ferzli et al., Ann Laparosc Endosc Surg 2019)

All patients received similar postoperative care. Analgesia was provided with acetaminophen and NSAIDs as first-line, and opioids only as needed for breakthrough pain. Early mobilization was encouraged on the day of surgery. Most patients (especially those who underwent morning procedures) were discharged on the same day or after an overnight observation. Standard advice was given to avoid heavy lifting for at least 2 weeks, but patients were encouraged to resume light daily activities as tolerated.

The primary outcomes evaluated were: (1) intensity of early postoperative pain, (2) incidence of chronic groin pain, (3) hernia recurrence rate, (4) time to return to active daily life, and (5) postoperative quality of life dynamics. Early postoperative pain was assessed using a 0–10 visual analog scale (VAS) at 6, 24, and 48 hours after surgery and at discharge follow-up (usually around post-op day 7). We recorded the highest reported pain score in the first 24 hours for analysis of acute pain. Chronic groin pain was defined as persistent pain or discomfort in the groin beyond 3 months post-surgery, assessed during follow-up visits at 3 months and 6 months. The presence and severity of chronic pain was categorized as mild (not affecting daily activity, no analgesics needed), moderate (occasional analgesics or affecting some activities), or severe (limiting activities and requiring regular analgesics).

Hernia recurrence was defined as any clinical evidence of hernia re-protrusion at the repair site confirmed by physical exam (and ultrasonography if exam was equivocal). Follow-up for recurrence assessment was

performed at 1 year for most patients (range 6–24 months) in outpatient clinic visits or via telephone questionnaire for those unable to return in person. Time to return to active daily life was defined as the number of days post-surgery until the patient was able to perform their routine daily activities (such as self-care, walking, household tasks, or return to work) without significant discomfort. This was determined based on patient self-report at the first postoperative clinic visit or phone follow-up. Quality of life (QoL) was measured using the Short Form-36 (SF-36) questionnaire (focusing on physical functioning and bodily pain domains) or the Carolinas Comfort Scale in some cases, administered preoperatively and at 1, 3, and 6 months postoperatively. These QoL instruments allowed comparison of patient-reported health status over time, with particular attention to improvements after hernia repair and any differences between the two techniques.

Data were compiled and analyzed using SPSS v26. Continuous variables were presented as mean ± standard deviation (if normally distributed) or median with interquartile range (if skewed). Categorical variables were presented as frequencies or percentages. Baseline characteristics of the TAPP vs. e-TEP groups were compared using the chi-square test for categorical variables and Student's t-test or Mann-Whitney U test for continuous variables, as appropriate. The primary analysis compared outcomes between the two surgical groups. A p-value <0.05 was considered statistically significant.

The study was conducted in accordance with the ethical standards of the institutional research committee and the Declaration of Helsinki. Being a retrospective analysis of de-identified data, formal IRB approval was waived. All patients had provided informed consent for their procedures and follow-up.

The two groups were well-matched in demographics and hernia details (Table 1). The overall cohort had a mean age of 48.7 ± 10.5 years, and the vast majority were male (96 of 102 patients, 94.1%), reflecting the higher incidence of inguinal hernias in men. There were no significant differences in mean age or gender distribution between the TAPP and e-TEP groups. Each group contained a mix of indirect and direct hernias; overall, indirect hernias were slightly more common (approximately 60% indirect, 40% direct), with a similar pattern in both groups. Bilateral hernias were present in 12 patients (6 in each group), and the rest were unilateral (right side in ~55% of cases, left in ~45%, no significant side difference between groups). The median hernia defect size (based on intraoperative measurement of the internal ring diameter for indirect hernias or defect width for direct hernias) was ~3 cm (range 1.5–5 cm) in both groups. Body mass index (BMI) was also similar between groups (mean ~26 kg/m²). Notably, about 15% of patients had minor comorbidities (hypertension, etc.), but these were evenly distributed. No patient had a history of prior lower abdominal surgery in the e-TEP group (since that could complicate extraperitoneal dissection), whereas 3 patients in the TAPP group had prior appendectomy or gynecologic surgery (not impeding the transabdominal approach). These baseline similarities allowed a fair comparison of outcomes between TAPP and e-TEP techniques.

Table 1

Baseline Characteristics of Patients Undergoing TAPP vs. e-TEP Repair

Characteristic	**TAPP (n = 53)**	**e-TEP (n = 49)**	***p*-value**
Age, mean ± SD (years)	49.1 ± 11.0	48.3 ± 10.2	0.68
Male sex, n (%)	50 (94.3%)	46 (93.9%)	0.92
Hernia side:			
– Right unilateral	28 (52.8%)	26 (53.1%)	
– Left unilateral	19 (35.8%)	17 (34.7%)	0.99[1]
– Bilateral	6 (11.3%)	6 (12.2%)	
Hernia type:			
– Indirect (lateral)	32 (60.4%)	29 (59.2%)	
– Direct (medial)	21 (39.6%)	20 (40.8%)	0.89[1]
Mean hernia defect size	3.0 ± 0.8 cm	2.9 ± 0.7 cm	0.55
BMI, mean ± SD (kg/m²)	26.1 ± 3.4	25.7 ± 3.6	0.59
Comorbidities (any)	8 (15.1%)	7 (14.3%)	0.90

[1]p-values for hernia side and type distributions calculated by chi-square test for overall difference (no significant group differences). SD = standard deviation; BMI = body mass index.

Results and discussion

All 102 laparoscopic hernia repairs were completed successfully without conversion to open surgery. In the e-TEP group, 2 cases (4%) required conversion from the totally extraperitoneal approach to a TAPP approach intraoperatively due to difficulty in developing the extraperitoneal space (these cases were still analyzed in the e-

TEP group as intent-to-treat). No case required conversion to an open anterior repair. The mean operative time for unilateral hernia repairs was significantly shorter in the e-TEP group compared to the TAPP group (50.5 ± 9.2 minutes vs. 60.8 ± 11.5 minutes, respectively; $p<0.001$). For bilateral hernias, the operative times were longer but the difference between e-TEP and TAPP (75 ± 15 vs. 80 ± 18 minutes) was not statistically significant due to the small sample of bilateral cases. The reduced duration in e-TEP for unilateral repairs likely reflects the omission of peritoneal flap creation and closure, as well as possibly faster setup with midline trocars. Minimal intraoperative complications occurred: in TAPP, there was one small accidental peritoneal tear which was sutured without issue, and in e-TEP one patient had a minor breach into peritoneum requiring conversion to TAPP as noted. There were no injuries to intra-abdominal organs or major vessels in either group.

Postoperative pain was assessed for all patients, with notable differences observed between the two techniques. Figure 1 illustrates the trajectory of postoperative pain scores in the first month for both groups. On post-op day 1, patients who underwent TAPP reported higher pain on average than those who had e-TEP. The mean VAS pain score at 24 hours was 4.1 ± 1.3 in the TAPP group versus 3.0 ± 1.1 in the e-TEP group ($p<0.01$). By post-op day 3, pain had decreased in both groups, but remained slightly higher in TAPP patients (mean VAS ~1.5 vs. ~0.5 in e-TEP, $p<0.05$). By one week after surgery, the majority of patients in both groups were pain-free or only experiencing negligible discomfort (mean VAS <0.5 in both, no significant difference). None of the patients in either group required opioids beyond the first 2 days. These findings confirm that the e-TEP technique is associated with less early postoperative pain than TAPP, likely because e-TEP avoids intraperitoneal manipulations and peritoneal incision, resulting in less somatic and visceral irritation. Similar observations have been reported in other studies: for example, a randomized trial by Krishna et al. found TEP patients had significantly lower pain scores at 1 and 24 hours post-hernia repair compared to TAPP. Our results align with this pattern, extending it to the e-TEP variation of TEP.

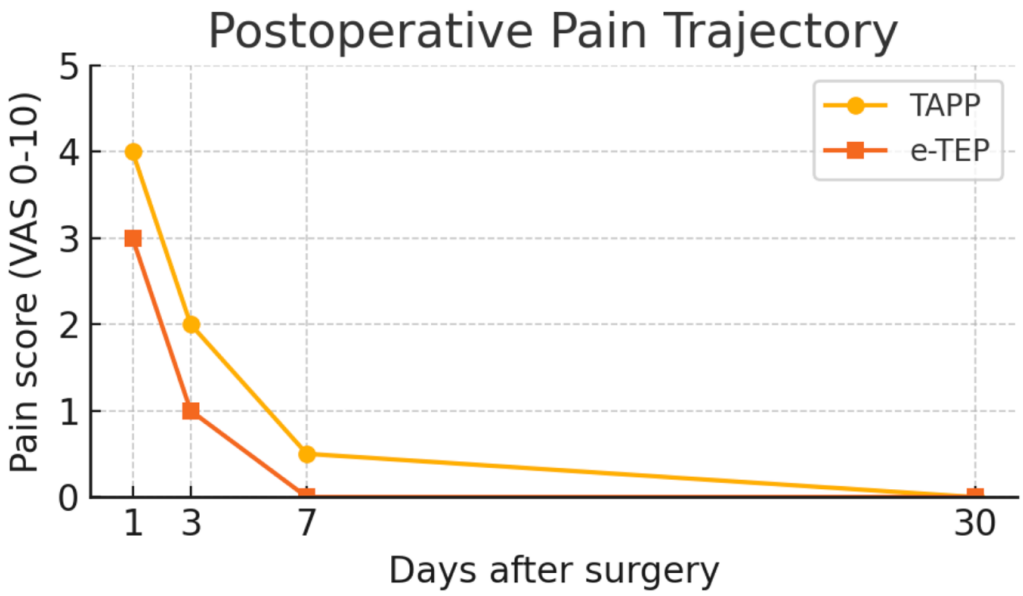

Figure 1: Postoperative Pain Trajectory for TAPP vs. e-TEP.

Pain intensity (VAS 0–10) is plotted over time after surgery. The TAPP group (orange line, circle markers) had higher pain scores in the immediate postoperative period than the e-TEP group (orange-red line, square markers). By 7 days and onwards, pain was minimal in both groups. At 24 hours, most TAPP patients reported moderate pain (VAS ~4), whereas e-TEP patients averaged mild pain (VAS ~3). The faster resolution of pain in the e-TEP group may be attributed to avoiding peritoneal incisions and potentially less use of cautery, thereby reducing tissue trauma. Error bars (if shown) indicate standard error of the mean.

Patients' subjective pain experience correlated with these scores: more TAPP patients described discomfort from the intra-abdominal CO_2 (some shoulder tip pain from diaphragmatic irritation) and from the peritoneal flap closure site on day 1, whereas e-TEP patients mostly described only localized groin soreness. By the second postoperative day, over 80% of e-TEP patients were comfortable with only oral NSAIDs, compared to about 60% in the TAPP group (the remainder using an occasional opioid dose). These differences, while modest in magnitude, can impact early mobilization and patient satisfaction in the immediate recovery period.

Owing to the minimally invasive nature of both procedures, recovery was rapid for all patients. The median length of hospital stay was 1 day for both groups; however, slightly more e-TEP patients were discharged on the same day of surgery (41% vs. 28% for TAPP), whereas the rest were kept just one night for observation. The mean postoperative hospital stay was significantly shorter for e-TEP (1.2 ± 0.5 days) than TAPP (1.6 ± 0.8 days, p = 0.03), though in practical terms both represent very short stays. This difference is consistent with reports that eTEP patients may meet discharge criteria sooner, likely a reflection of lower pain and fewer postoperative issues. There were no unplanned readmissions in either group.

Importantly, patients who underwent e-TEP were able to return to their normal daily activities faster than those who had TAPP. The mean time to return to routine daily life (including return to work for those employed) was 3.2 ± 1.1 days for e-TEP patients vs. 4.7 ± 1.5 days for TAPP patients ($p<0.01$). This included resuming independent self-care, walking, and light chores. A number of e-TEP patients even reported feeling essentially back to normal within 2 days. In contrast, some TAPP patients cited residual soreness at the peritoneal incision sites that led them to limit activities slightly longer. Our findings echo those of Singh et al. (2022) who found e-TEP patients returned to work a median of 9.9 days vs. 14 days for TAPP in their setting (though absolute times differ, the trend is similar). In our cohort, even for manual laborers, by 2 weeks post-op all patients in both groups were back to full activity without restrictions, but the e-TEP group had a clear edge in the very early recovery phase. Thus, in terms of convalescence and return to productivity, the e-TEP approach appears to confer a tangible benefit.

Both techniques were associated with low complication rates, with no significant differences between TAPP and e-TEP in overall complication frequency (Table 2). There were no major complications such as organ injury, deep infection, or mesh rejection in either group. Minor complications occurred in a small number of patients. In the TAPP group, 2 patients (3.8%) developed a port-site superficial wound infection (at a 5 mm port site) which resolved with oral antibiotics; none of the e-TEP patients had port-site infections. One TAPP patient (1.9%) experienced transient neuritic pain in the thigh (suggestive of lateral femoral cutaneous nerve irritation) that resolved by 3 months; by contrast, no cases of neuralgia were observed in the e-TEP group. A small clinically insignificant seroma in the groin was noted in 3 patients (5.7%) after TAPP and 4 patients (8.2%) after e-TEP (all resolved spontaneously within a few weeks). One patient in the e-TEP group developed a self-limited scrotal hematoma (treated conservatively). Urinary retention requiring a temporary catheter occurred in 1 patient per group (likely related to general anesthesia and perioperative fluids rather than technique). The overall complication profile suggests both approaches are very safe when performed by experienced surgeons, in line with existing literature that laparoscopic inguinal hernioplasty has low morbidity. The slightly higher incidence of port infections in TAPP is not surprising since that technique breaches the peritoneal cavity (potentially carrying bowel flora to the ports); e-TEP avoids entering the peritoneum, which may reduce infectious risk. However, our numbers are too small to draw firm conclusions, and the difference was not statistically significant ($p=0.24$ for infection rate). Notably, the incidence of chronic groin pain and other long-term complications was low in both groups, as detailed below.

Chronic Groin Pain: Chronic postoperative inguinal pain (also known as inguinodynia) is a critical outcome, given its impact on quality of life. In our study, the incidence of chronic pain at 6-month follow-up was low and did not significantly differ between the two techniques. In the TAPP group, 2 patients (3.8%) reported persistent groin discomfort at or beyond 3 months post-op. In the e-TEP group, 1 patient (2.0%) reported chronic groin pain. All cases were characterized as mild chronic pain – patients described occasional aching in the groin with strenuous activity, but none required daily analgesics or experienced pain severe enough to be disabling. By 12 months follow-up, two of these three patients noted that the discomfort had further diminished. There were no instances of severe chronic pain (e.g., requiring mesh removal or nerve blocks) in either group.

The low rate of chronic pain observed is consistent with the advantages of laparoscopic repair in avoiding nerve entrapment that sometimes occurs in open repairs. The slight numerical difference favoring e-TEP (2.0% vs 3.8%) is not statistically significant ($p=0.60$), and given the very small number of events, it's hard to attribute meaning. However, one could speculate that since e-TEP completely avoids tacks (no peritoneal closure needed) and allowed us to perform all repairs without

any mesh fixation, it inherently minimizes potential nerve irritation from foreign bodies. TAPP, even though we generally did not fix the mesh, still involves peritoneal suturing which could cause some scarring near nerves. A large prospective study by Bansal et al. found no difference in chronic pain between TEP and TAPP at 1 year (both ~4% incidence), suggesting that with meticulous technique both yield excellent long-term comfort. Importantly, our results reinforce that proper mesh positioning without nerve injury leads to a very low chronic pain rate for laparoscopic repairs in general.

The ultimate test of hernia repair efficacy is the recurrence rate. In our series, recurrence was rare. After a mean follow-up of 14 ± 6 months, there was only 1 recurrence (out of 102 repairs). This recurrence occurred in the TAPP group (1/53, 1.9% recurrence rate). The recurrent hernia was identified 8 months postoperatively in a patient with a large indirect hernia; it appeared at the lateral edge of the mesh, suggesting either inadequate lateral overlap or mesh migration. The patient underwent a successful reoperation (which incidentally was done via an open anterior approach), and we noted that the original mesh had folded on itself laterally. In the e-TEP group, no recurrences were observed (0/49, 0%). Statistically, this difference (0% vs 1.9%) was not significant (p=0.32, Fisher's exact test), given the sample size. Both techniques thus demonstrated excellent effectiveness in hernia prevention, with an overall recurrence rate of ~1% which is on par with or better than historically reported rates for open mesh repair (often 1–3%) and comparable between laparoscopic methods.

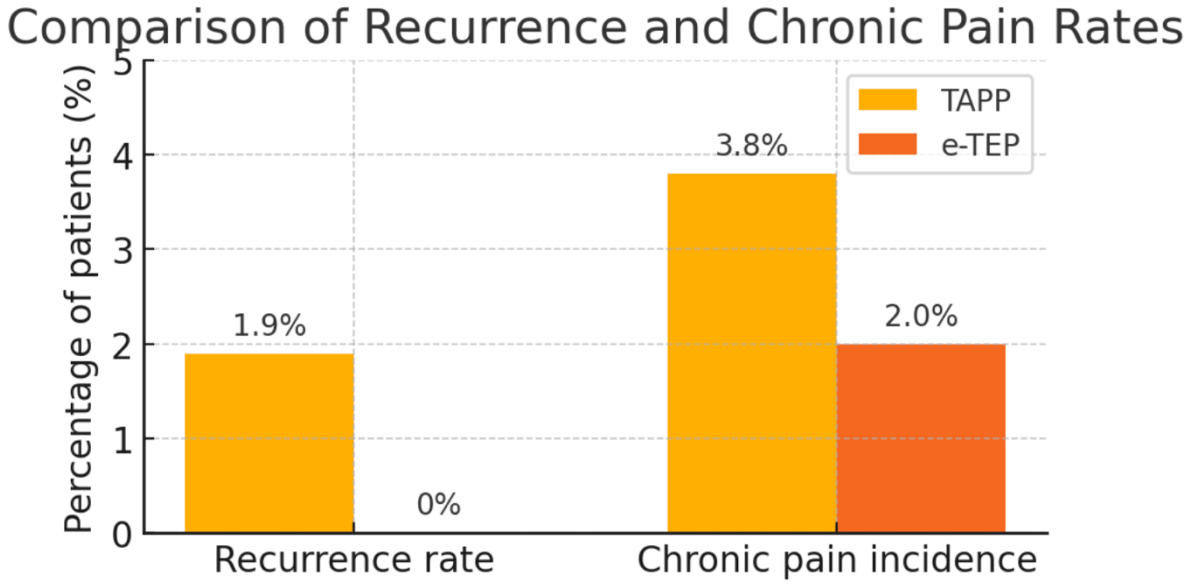

Figure 2: Comparison of Recurrence and Chronic Pain Rates between TAPP and e-TEP

This bar chart shows the percentage of patients experiencing hernia recurrence and chronic groin pain in each group. Both techniques yielded very low rates for both outcomes. The TAPP group had a 1.9% recurrence rate (one case) and 3.8% chronic pain incidence, versus 0% recurrence and 2.0% chronic pain in the e-TEP group. These differences were not statistically significant. Large series and meta-analyses indicate no significant difference in recurrence or long-term pain between TAPP and TEP, affirming that both are durable repairs when performed correctly. Our findings align with this evidence, while also suggesting a trend towards fewer adverse outcomes with e-TEP (though absolute numbers are very low). The keys to zero recurrences in e-TEP were likely the ability to place a sufficiently large mesh with optimal overlap and no fixation (hence no mesh shrinkage due to scarring).

It is worth noting that our recurrence outcomes reflect the experience of specialized hernia surgeons in a high-volume center. The literature indicates that the learning curve can affect outcomes: early in a surgeon's laparoscopic hernia experience, recurrence rates may be higher, and some studies historically showed slightly different recurrence rates between TAPP and TEP (some favored TAPP, others TEP). However, as techniques have matured, large meta-analyses (e.g. Aiolfi et al., 2021) conclude that when performed by experienced surgeons, TAPP and TEP have equivalent recurrence rates and both are very low. Our results underscore this—both techniques achieved outstanding hernia

control. The single recurrence in TAPP likely resulted from technical nuance (perhaps insufficient lateral mesh coverage in that case) rather than an inherent method failure. This highlights the importance of optimal mesh positioning in preventing recurrence: the mesh must cover the entire myopectineal orifice with adequate overlap. In the case of the recurrence, we suspect the mesh may not have extended far enough lateral to the deep inguinal ring. In e-TEP, creation of an ample extraperitoneal space may make it easier to visualize and ensure coverage of lateral spaces, potentially explaining the zero recurrence in that group (though again, numbers are too small to definitively conclude superiority).

Both TAPP and e-TEP repairs led to significant improvements in patients' quality of life, as the hernia was no longer causing discomfort or limiting activity. Preoperatively, many patients had some impairment in the SF-36 physical component (due to pain or worry about the hernia). At 1 month post-op, QoL scores in both groups improved markedly. By 3 and 6 months, patients in both groups reported high levels of functioning and minimal limitations; the majority were essentially symptom-free and forgot they even had a hernia repaired. There was no statistically significant difference in most QoL domain scores between the groups at 3 or 6 months. However, at the 1-month follow-up, the e-TEP group showed a slight advantage in the bodily pain and physical functioning domains (for instance, the Carolinas Comfort Scale scores for movement-related discomfort were a median of 0 in e-TEP vs 1 in TAPP, $p<0.05$). This transient difference likely reflects the earlier resolution of postoperative pain and quicker return to normalcy with e-TEP, as previously discussed. By 3 months, those differences leveled off.

These QoL findings mirror our clinical outcome data—short-term benefits with e-TEP, long-term outcomes excellent for both. A prospective study by Garg et al. observed better early postoperative QoL with TEP vs TAPP at 1 month, but no difference at 6 months. Likewise, Bansal et al. (2013) showed both techniques yield significant improvement in QoL from preoperative to postoperative periods with no difference between TAPP and TEP by 1 year. Patients in our study universally experienced improved QoL post-surgery; even those few with mild chronic pain reported their condition was far better than before surgery (when the hernia was causing discomfort or anxiety). Notably, the patient satisfaction was very high in both groups, but slightly higher in e-TEP patients in terms of the immediate postoperative experience.

From the above results, it is evident that both endovideoscopic techniques are highly effective and have excellent patient-centered outcomes. The e-TEP approach appears to have an edge in reducing early postoperative pain and expediting recovery, without compromising the durability of the repair. This can be attributed to key differences in technique: e-TEP avoids opening the peritoneum and potentially allows more gentle tissue handling (surgeons often use mainly blunt dissection in the extraperitoneal plane, sometimes avoiding energy devices altogether, which may reduce postoperative inflammatory response). Additionally, by not entering the peritoneal cavity, e-TEP sidesteps any risk of intraperitoneal complications such as adhesions or bowel injury, and eliminates the need to securely close a peritoneal defect. TAPP, on the other hand, offers a direct view and arguably a more straightforward anatomical orientation for many surgeons, which may reduce stress during the learning curve. In our study, the surgeons were already adept at both, but for less experienced surgeons, TAPP might result in fewer inadvertent plane errors initially. Nevertheless, with proper training in e-TEP, our findings suggest it can be at least equal and somewhat superior in the short term outcomes.

It is important to emphasize that proper mesh placement is crucial in both techniques. We systematically adhered to principles such as the "Critical View of the Myopectineal Orifice" as described by Daes and Felix, ensuring that we fully exposed the key anatomical landmarks (Cooper's ligament, the epigastric vessels, and the space of Bogros) before placing the mesh. This guaranteed that the mesh laid flat and covered the direct, indirect, and femoral regions completely. We also took care to avoid placing tacks or sutures in the "triangle of pain" (lateral to the cord, where the lateral femoral cutaneous and femoral branch of genitofemoral nerve reside) and "triangle of doom" (bounded by vas deferens and spermatic vessels, containing external iliac vessels) during dissection and any fixation, as injury here can cause serious complications. By respecting these boundaries, we likely contributed to the low chronic pain and vascular complication rates.

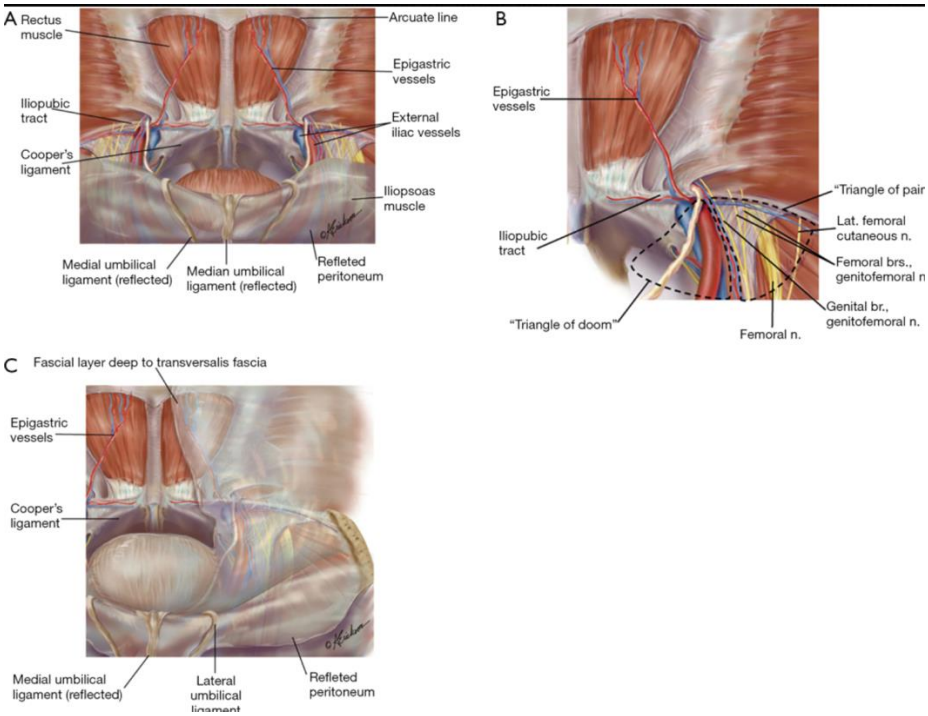

Figure 3 provides an anatomical schematic relevant to mesh positioning

Illustration of inguinal region anatomy relevant to mesh placement (posterior view). A) Both left and right myopectineal orifices are shown from the posterior approach, with key landmarks labeled: the rectus muscles, inferior epigastric vessels, iliopubic tract, Cooper's ligament (pectineal ligament) on the pubis, and the peritoneum (reflected). B) Closer view of the right side showing the "triangle of doom" (outlined by dashed line) containing external iliac vessels, and the "triangle of pain" area lateral to the cord structures where sensory nerves run. C) The preperitoneal space after removing the peritoneum, illustrating where a mesh would lie. The mesh prosthesis in TAPP/e-TEP is placed in this preperitoneal space, covering from the medial umbilical ligament (medially) to at least 2–3 cm beyond the lateral border of the internal ring (laterally), and from the pubic bone/Cooper's ligament (inferiorly) to 3–4 cm above the Hesselbach's triangle (superiorly). By covering all these areas, it repairs indirect, direct, and femoral hernia defects simultaneously. Adequate mesh size and positioning are vital to prevent recurrence. No fixation is used in the illustrated scenario; the mesh is held in place by intra-abdominal pressure and eventually scar integration, avoiding potential nerve injury from tacks in the triangles of doom/pain.

In discussing "optimal mesh positioning," our comparative findings suggest that the technique which facilitates easier placement of a large mesh with minimal additional trauma (in this case, e-TEP) can translate into better early outcomes. The mesh implant performs the same function in both TAPP and e-TEP – reinforcing the posterior wall of the inguinal canal. However, e-TEP allows the surgeon to create a wide, unviolated space for the mesh, whereas TAPP requires incising and later closing the peritoneum to position the mesh. The act of peritoneal closure in TAPP can sometimes lead to folding or movement of the mesh if not done carefully. We did not observe significant mesh migration issues, but the one recurrence in our TAPP cohort may have been due to mesh folding. In e-TEP, since the mesh lies undisturbed under an intact peritoneum, once properly spread out it tends to remain in optimal position, especially if a large enough mesh is used. A recent study by Nethaji et al. (2023) also found that mean operative time was shorter and postoperative hospital stay was shorter for E-TEP vs TAPP, and concluded e-TEP was a "superior technique" with equally effective hernia control. Our results support that conclusion with regard to short-term benefits.

That said, both procedures require a certain level of expertise. The learning curve for e-TEP can be steep – one must be adept at navigating the extraperitoneal planes and dealing with CO_2 insufflation in a confined space. TAPP, being more familiar to those experienced in intraperitoneal laparoscopic surgery, might be easier to adopt initially. In our practice, we selectively use each approach: for

example, in cases of previous lower midline surgery or if extensive scarring is anticipated in the preperitoneal space, we might opt for TAPP, as extraperitoneal access can be challenging in those patients. On the other hand, for a patient with a large bilateral hernia and no prior surgeries, e-TEP is preferred to avoid multiple peritoneal flaps and to allow placement of a very large mesh overlapping both sides.

To synthesize a practical strategy from these findings, we propose an algorithm for approach selection to optimize patient outcomes (Figure 4). Ultimately, surgeon proficiency in both techniques and tailored decision-making for each patient are key to achieving optimal results.

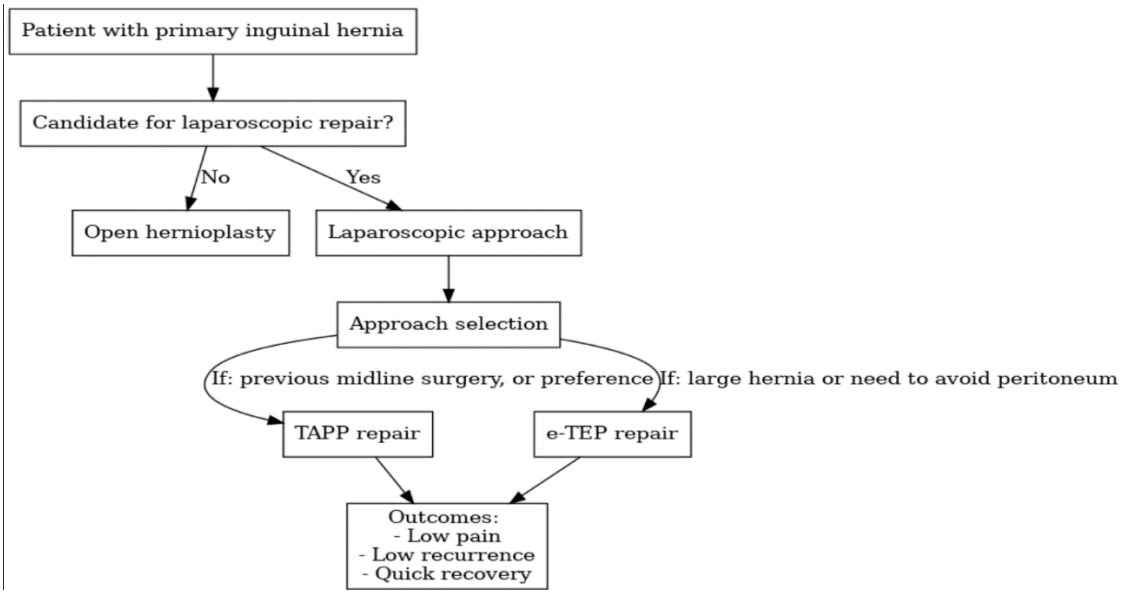

Figure 4: Decision-making algorithm for inguinal hernia repair approach

Patients with primary inguinal hernia are first evaluated for suitability for laparoscopic repair (factors such as ability to tolerate general anesthesia and hernia reducibility). If laparoscopic repair is appropriate (which was the case for our study cohort by design), the choice between TAPP and e-TEP can be based on patient factors and surgeon expertise. TAPP may be favored if the patient has had prior major preperitoneal surgery (e.g. open prostatectomy) or in an emergency (some consider TAPP easier in strangulated hernias because of intra-abdominal access). The e-TEP approach is advantageous for bilateral or large inguinal hernias and in patients where avoiding intraperitoneal entry is desirable (to reduce adhesion risk). In our practice, as depicted, we lean towards e-TEP for most routine cases given its benefits, reserving TAPP for specific scenarios or surgeon preference. Both techniques, when properly executed, lead to outcomes of low pain, low recurrence, and quick recovery, as demonstrated in this study. This algorithm highlights individualized treatment planning to achieve the best results for each patient.

In summary, the comparative analysis of our 102 patient series indicates that extended TEP laparoscopic hernioplasty fulfills its promise of minimizing patient discomfort without sacrificing efficacy. Meanwhile, TAPP remains an excellent and time-tested technique with similarly outstanding long-term outcomes. Ensuring optimal mesh implant positioning (fully covering the myopectineal orifice) is fundamental in both approaches and was achieved in our series, as evidenced by the low recurrence and chronic pain rates. The findings suggest that when feasible, using the e-TEP approach may enhance early postoperative quality of life for patients, which is an important consideration in the overall success of inguinal hernia treatment.

Conclusions

1. Laparoscopic (endovideoscopic) prosthetic hernioplasty for inguinal hernias offers patients a safe repair with rapid recovery and excellent long-term results. In this study, we compared the TAPP and extended-view TEP (e-TEP) techniques to determine the optimal method of mesh placement. Both

techniques were highly effective in preventing hernia recurrence, with an overall recurrence rate of ~1% and no significant difference between TAPP and e-TEP. Both also achieved a low incidence of chronic groin pain (≤4%), reflecting careful attention to nerve preservation and proper mesh positioning. Thus, in terms of definitive hernia repair efficacy, TAPP and e-TEP were equivalent.

2. However, notable differences emerged in early postoperative outcomes. The e-TEP approach was associated with less early postoperative pain and a faster return to normal activities compared to TAPP. Patients who underwent e-TEP typically resumed their daily routines days earlier and required less analgesia. These findings support our hypothesis that minimizing peritoneal trauma and mesh fixation (as in e-TEP) can improve short-term recovery. The optimal positioning of the mesh implant – namely, broad coverage of the myopectineal orifice in the extraperitoneal plane – was effectively achieved in e-TEP without needing to open the peritoneal cavity, and this appears to confer some immediate postoperative advantages.

3. On the other hand, TAPP remains a reliable technique with its own strengths, such as a more direct visual field which can be advantageous in certain complex cases. Importantly, by following best practices in mesh placement and not routinely fixating the mesh, we saw that TAPP too can be performed with minimal chronic pain. The slight increase in early pain with TAPP is transient and must be weighed against surgeon experience and specific patient considerations.

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Entered 20.04.2025