

Laparo-Endoscopic Inguinal Hernia Repair: Clinical Applications and Technical Optimization

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Abstract

Laparo-endoscopic repair treats an inguinal hernia from the preperitoneal side and covers the myopectineal orifice with mesh. The two established approaches are transabdominal preperitoneal repair (TAPP) and totally extraperitoneal repair (TEP). When performed by experienced teams, both achieve recurrence rates similar to open mesh repair and are associated with less early pain, fewer wound problems, and a lower risk of chronic postoperative inguinal pain (CPIP). A posterior approach is particularly useful for bilateral hernias, recurrence after an anterior operation, and women, in whom a femoral defect may be overlooked. Long-term results after TAPP and TEP appear broadly comparable. The choice between them should take account of the hernia, previous operations, any need to inspect the abdomen, fitness for general anesthesia, the surgeon's experience, and readiness to convert. The durability of either procedure rests on the details of execution: the preperitoneal space must be fully developed, the cord structures parietalized, the mesh given sufficient overlap and stability, and the peritoneum closed securely after TAPP. This narrative review considers patient selection, the differences between TAPP and TEP, unresolved technical questions, prevention of recurrence and CPIP, management of complex presentations, and the role of training and new technology.

Keywords

Inguinal Hernia, Laparoscopy, Transabdominal Preperitoneal Repair, Totally Extraperitoneal Repair, Mesh Fixation, Chronic Postoperative Inguinal Pain

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1. Introduction

Inguinal hernia repair is one of the most common operations in general surgery. Recurrence once dominated assessment of success, but current decisions also consider chronic postoperative inguinal pain (CPIP), recovery of function, quality of life, and the burden of treatment on patients and health services [1]-[4]. In this review, CPIP means bothersome pain of at least moderate intensity that interferes with daily activity for 3 months or longer after surgery [2] [3]. Open anterior mesh repair remains reliable and can be performed under local anesthesia. Laparo-endoscopic surgery approaches the defect posteriorly and places a broad prosthesis in the preperitoneal plane. That view is especially helpful for bilateral hernia, recurrence after a previous anterior repair, and groin hernia in women.

TAPP and TEP are the established minimally invasive routes. Each aims for wide posterior coverage of the myopectineal orifice, although the route of entry and several operative hazards differ. International guidelines do not support one operation for every patient; they recommend matching the procedure to the hernia, the patient, available resources, and the surgeon's experience [1] [2]. A small incision is only one consideration. The more important issue is whether a posterior repair offers a clinical benefit in that case and whether the team can reproduce the required anatomical dissection.

2. Literature Identification

We undertook a targeted search of PubMed/MEDLINE, the Cochrane Library, and guideline repositories, updated to September 16, 2026. Eligible publications involved adults with primary or recurrent inguinal, femoral, or other groin hernias in elective or emergency settings. We considered recurrence, perioperative complications, CPIP, recovery, quality of life, and technical outcomes relevant to TAPP or TEP. Search terms included “inguinal hernia,” “groin hernia,” “TAPP,” “TEP,” “laparoscopic,” “laparo-endoscopic,” “mesh fixation,” “seroma,” “chronic pain,” “female,” “emergency,” and “robotic repair.” English-language studies and national guidelines available in English or Chinese were considered. Priority was given to randomized trials, systematic reviews, meta-analyses, large registries, and international or national guidelines. Pediatric series and studies limited to non-groin abdominal wall hernias were excluded. We also examined references cited by major guidelines and reviews. Because no new pooled estimate was planned, selection and synthesis were narrative.

3. Anatomical Basis and Operative Standardization

3.1. The Myopectineal Orifice

Indirect, direct, and femoral hernias all pass through Fruchaud's myopectineal orifice. From a posterior view, repair therefore extends beyond reduction or high ligation of the visible sac: the surgeon develops a continuous preperitoneal plane and places a prosthesis that covers every potential defect. Landmarks include the

inferior epigastric vessels, pubic symphysis, Cooper ligament, iliopubic tract, vas deferens or round ligament, gonadal vessels, and iliopsoas muscle. The external iliac vessels lie in the “triangle of doom” between the vas and gonadal vessels. Sensory nerves are vulnerable in the “triangle of pain,” lateral to the gonadal vessels and below the iliopubic tract. Blind fixation and needless dissection in these areas risk major vascular injury or persistent neuropathic pain [1] [5] [6].

3.2. Verifiable Dissection Endpoints

The adequacy of exposure is better judged from specific landmarks than from the apparent size of the cavity. On the medial side, the pubic symphysis and Cooper ligament should be visible and the dissection should cross the midline enough to accommodate mesh overlap. Laterally, the plane extends over the iliopsoas toward the anterior superior iliac spine; inferiorly, both Retzius and Bogros spaces require development. For an indirect sac, the peritoneum must be freed from the vas and gonadal vessels until the lower mesh edge can lie without tension. This parietalization is often incomplete when judged too early. Direct, femoral, and obturator sites should then be inspected deliberately. The critical view of the myopectineal orifice described by Daes and Felix is a useful way to verify and document these endpoints [5].

4. Clinical Positioning and Patient Selection

4.1. Situations in Which a Posterior Approach Is Especially Useful

A bilateral repair can be carried out through the same access sites, avoiding separate groin incisions. When an anterior repair has recurred, major guidelines recommend a posterior route because it leaves the scarred anterior plane undisturbed [1] [2]. Women require particular care: femoral hernias are more frequent and may be missed during an anterior operation, whereas TAPP and TEP expose and cover the femoral canal during the usual dissection. Patients who place a high value on early recovery or a lower risk of CPIP may also prefer a laparo-endoscopic repair, provided that general anesthesia is acceptable and an experienced team is available [1]-[3].

None of these considerations amounts to an absolute indication. For a man with a primary unilateral hernia, either a well-performed open anterior mesh repair or a laparo-endoscopic repair may be appropriate. Discussion should cover the type of anesthesia, the surgeon's experience, direct cost, expected convalescence, and differences in pain and wound morbidity. Many men with an asymptomatic or minimally symptomatic hernia can initially be observed safely, although symptoms often progress and some will later request repair [7]. The diagnosis alone should not substitute for a shared decision.

4.2. Conditions Requiring Caution

Important limitations include inability to tolerate general anesthesia or pneumoperitoneum, an uncorrected major coagulopathy, and lack of a suitably trained

team. Previous pelvic, lower abdominal, or preperitoneal surgery and pelvic radiotherapy can obscure the plane, but none is an absolute contraindication in every patient. Experienced centers may also use a laparoscopic approach for large scrotal, sliding, incarcerated, or strangulated hernias. In such cases, tissue planes, bowel viability, contamination, physiological reserve, and the team's ability to alter the plan determine whether it is sensible to proceed. Conversion is a means of controlling risk, not evidence that the operation has failed.

5. Choosing between TAPP and TEP

5.1. TAPP

TAPP begins within the peritoneal cavity. The surgeon raises a peritoneal flap, develops the preperitoneal plane, deploys the mesh, and closes the flap. Its broad intraperitoneal view is useful when the diagnosis is uncertain, the other groin needs inspection, or bowel viability is in question. It also offers more working room in a sliding hernia or complex recurrence. Risks specific to entry into the abdomen include visceral injury, complications of adhesiolysis, exposed mesh contacting bowel, and internal herniation through an incompletely closed peritoneum. The main technical difficulty is creating a flap large enough for dissection and then closing it without tension.

5.2. TEP

TEP keeps the operation within the extraperitoneal space and ordinarily avoids the peritoneal cavity. Direct contact with viscera and the potential for intraperitoneal adhesions may therefore be reduced. Early in the procedure, however, the available space is narrow and the view is unfamiliar to surgeons trained in conventional laparoscopy. A peritoneal tear can rapidly collapse the working cavity, particularly during the learning period. Previous lower abdominal surgery adds difficulty in some patients but does not invariably rule out TEP. Reliable performance requires accurate entry into the plane, a sound mental map of posterior groin anatomy, and a predetermined response when the space is lost.

5.3. Comparative Evidence

The 2024 Cochrane update included 23 studies with 2266 participants. It did not show a convincing difference between TAPP and TEP in serious adverse events, recurrence, or CPIP; certainty for these outcomes was low or very low. Conversion to another form of repair appeared more common during TEP [8]. The evidence therefore gives no basis for declaring one route superior in all cases. TAPP is often convenient when the abdomen must be assessed or the anatomy is complicated. TEP is well suited to an uncomplicated elective hernia in the hands of a surgeon familiar with the extraperitoneal view. Units that favor TEP still need an explicit conversion pathway, including the ability to proceed by TAPP or convert promptly to open repair. **Table 1** sets out the practical differences.

Table 1. Practical comparison of TAPP and TEP.

Domain	TAPP	TEP	Practical implication
Route	Peritoneal entry followed by preperitoneal dissection	Entirely extraperitoneal	Both place mesh in the same definitive plane
Main strengths	Wide view, familiar orientation, abdominal assessment	Avoids routine peritoneal entry	Benefits depend on correct execution
Useful settings	Complex recurrence, uncertain anatomy, selected emergencies	Elective uncomplicated hernia in experienced hands	These are preferences, not absolute rules
Characteristic difficulties	Visceral access and peritoneal closure	Creation and maintenance of the working space	A conversion plan is required for either approach
Long-term outcomes	Broadly similar to TEP	Broadly similar to TAPP	Choose according to patient factors and expertise

6. Technical Determinants and Areas of Debate

6.1. Management of the Hernia Sac and Parietalization

A small indirect sac can usually be separated completely without disturbing the vas deferens or gonadal vessels. The distal part of a large inguinoscrotal sac may be densely adherent, and persistent dissection there increases bleeding and cord injury. When complete reduction is unsafe, proximal division with the distal sac left in place is accepted practice, although supporting evidence is of very low certainty and seroma may be more frequent [9]. The relevant endpoint is adequate release of the proximal peritoneum from the cord so that the inferior margin of the mesh lies flat. Removal of every distal layer is unnecessary. In a direct hernia, recognizing the lax transversalis fascia also helps avoid confusing it with bladder or residual sac.

6.2. Mesh Size, Overlap, and Deployment

The prosthesis must cover the entire myopectineal orifice with a margin beyond each potential defect. Coverage is determined by the dissection, mesh dimensions, behavior of the material, and its position after desufflation; labels such as “light-weight” and “heavyweight” do not answer those questions. Guidance for TAPP and TEP recommends at least a 10 × 15 cm mesh for a typical adult and a larger prosthesis for a large defect [10]. This is a planning threshold, not a remedy for limited dissection. Medially, the mesh should cross the pubic symphysis. Its lower edge covers Cooper ligament and the femoral canal, while its lateral part extends well beyond the internal ring. No number of extra tacks will correct a folded mesh or an inadequately developed plane.

6.3. Fixation or Non-Fixation

Many TAPP and TEP repairs do not require fixation. HerniaSurge recommends securing the mesh for a large medial defect, especially an EHS M3 hernia, because medial displacement and recurrence are a greater concern [1] [2]. Meta-analyses suggest that selected patients treated without fixation do not have more recur-

rences and may return to daily activity sooner [11]-[13]. Because smaller defects contribute much of these data, they should not be generalized to every large direct hernia. If fixation is used, it should be limited and placed outside the triangles of doom and pain. Depending on anatomy, availability, and cost, options include sutures, tissue adhesive, self-gripping prostheses, or carefully positioned mechanical devices. Glue may cause less CPIP than traumatic fixation, although confidence in that estimate and its applicability are variable [14].

6.4. Direct-Defect Closure and Seroma Prevention

A large direct hernia leaves a cavity in which fluid can collect, sometimes mimicking an early recurrence. Closing or inverting the attenuated transversalis fascia may reduce seroma and perhaps recurrence, but only a few heterogeneous studies support the practice [15]. It remains an option for selected defects rather than a required step. Careful hemostasis, limited dissection, appropriate handling of a large sac, and flat deployment of the mesh are still the main preventive measures. Most seromas disappear over several weeks or months and an asymptomatic collection can be observed. Repeated aspiration risks infecting the mesh and should be reserved for persistent symptoms, uncertainty about the diagnosis, or selected large collections treated under sterile conditions.

6.5. Peritoneal Closure and Intraperitoneal Safety

At the end of TAPP, the peritoneum should be reapproximated continuously without undue tension. This keeps bowel away from the mesh and prevents a loop from entering the preperitoneal space. If the flap will not meet easily, further mobilization or repair of a tear is safer than forced closure. Energy devices require restraint near the vas, gonadal vessels, bladder, and external iliac vessels. Before removing the ports, each site should be checked for bleeding. Fascial closure is advised for trocar sites 10 mm or larger, especially at the umbilicus, although the evidence supporting this recommendation is limited [16]. Major vascular or visceral injury must be controlled immediately, with conversion whenever required; finishing laparoscopically is never the priority.

7. Outcomes and Prevention of Adverse Events

7.1. Laparo-Endoscopic versus Open Repair

An overview of systematic reviews concluded that laparoscopic repair causes less CPIP than open surgery and usually permits earlier recovery, with similar recurrence rates when operators are experienced [17]. A subsequent meta-analysis also found less CPIP after TAPP or TEP than after Lichtenstein repair and no clear recurrence difference [18]. Those clinical benefits come with greater demands on equipment and training. General anesthesia is usually necessary, direct hospital expenditure may be higher, and proficiency takes time. Earlier return to work can offset some costs outside the hospital, but economic findings depend heavily on reimbursement, occupation, local volume, and how societal costs are counted.

7.2. Recurrence

When a laparo-endoscopic repair recurs, the cause is often a correctable technical problem rather than failure of the posterior principle. Recognized mechanisms include an overlooked femoral or obturator defect, insufficient medial or inferior dissection, a small prosthesis, folding or migration, poor management of a large medial defect, and inconsistent performance during training. Prevention depends on the sequence as a whole: exposure, overlap, stable deployment, and fixation when the defect warrants it. After failure of a posterior repair, an anterior operation is generally chosen to avoid re-entering the same plane. Repeat posterior surgery is best confined to surgeons experienced in complex reoperative groin repair [1] [2].

7.3. Chronic Postoperative Inguinal Pain

CPIP reflects both biological injury and the patient's broader pain vulnerability. Preoperative pain, direct nerve trauma, penetrating fixation, inflammatory response to mesh, and psychosocial factors may contribute. Operatively, dissection below the iliopubic tract should be limited and fixation kept out of the triangle of pain. Persistent pain should prompt a structured search for recurrence, infection, mesh-related disease, hip pathology, and other non-hernia causes. Initial care may include medication, image-guided nerve blocks, and multidisciplinary pain treatment. Removal of mesh or fixation and selective neurectomy are reserved for refractory symptoms managed within specialist pathways, rather than offered early as routine measures [1] [2].

7.4. Other Complications

Deep medial dissection, prior pelvic surgery, and an undrained bladder increase the risk of bladder injury. The bowel is most vulnerable during entry into the peritoneum, adhesiolysis, and closure of the flap. Gonadal-vessel injury and excessive dissection of a distal sac may lead to testicular complications. Mesh infection is rare but difficult to eradicate. Sterile technique, avoidance of enteric contamination, and conservative management of uncomplicated collections help reduce that risk. Any team performing laparo-endoscopic repair must be prepared to recognize these uncommon events early and treat them without delay.

8. Special Populations and Complex Presentations

8.1. Women

Femoral hernia should be considered whenever a woman presents with a groin lump. A posterior repair exposes and covers the indirect, direct, and femoral compartments during the same operation. In a systematic review of women undergoing primary inguinal hernia repair, recurrence was lower after laparoscopic than open surgery [19]. A Danish nationwide study separately found fewer reoperations after laparoscopic repair of femoral hernia [20]. The populations and ques-

tions differ, so the two findings should not be treated as the same evidence. Decisions about the round ligament also depend on the case. Preservation is preferable when it does not impair dissection or mesh position, but it should not be pursued at the cost of a folded prosthesis or an inadequate peritoneal closure.

8.2. Bilateral and Recurrent Hernia

Bilateral hernia is a familiar indication for laparo-endoscopic repair because both sides can be treated through the same access. TAPP also exposes the contralateral groin, although a small peritoneal indentation does not automatically represent an occult hernia requiring repair. Treatment should depend on the likelihood of a true defect, the chance of later symptoms, and the patient's preference. For a recurrence, entering a fresh tissue plane is usually safest: posterior after a failed anterior repair and anterior after a failed posterior repair. Multiple recurrences, disabling mesh-related pain, and markedly distorted anatomy are reasons to refer the patient to a specialist hernia service.

8.3. Large Scrotal Hernia

Evidence for laparo-endoscopic treatment of a large scrotal hernia is sparse and comes mainly from low-level studies and expert consensus [9]. Recommendations must therefore be adapted to the individual and are best applied by teams accustomed to complex groin surgery. These hernias combine a long sac, adherent cord structures, considerable dead space, and a high likelihood of seroma. A minimally invasive attempt is feasible, but conversion should remain an early option if safe progress is not possible. Secure proximal dissection and adequate parietalization matter more than stripping out the entire distal sac. Leaving the distal portion can protect the cord, although seroma may then be more likely. A large medial component or uncertain mesh stability can justify firmer fixation and closer surveillance. Before surgery, patients should be told about seroma, possible testicular complications, and the chance that an open incision will be needed.

8.4. Incarcerated or Strangulated Hernia

Compared with elective uncomplicated repair, evidence for laparo-endoscopic management of incarceration or strangulation is limited; practice therefore draws on observational series, guidelines, and case-by-case judgment [21]. Emergency laparoscopy allows direct inspection of bowel after reduction and may disclose a femoral or contralateral defect. Choice of TAPP or TEP, and whether to use permanent synthetic mesh, depends on bowel viability, resection, contamination, and operator experience. Incarceration by itself does not rule out minimally invasive mesh repair. A posterior prosthesis may be reasonable in a clean field. With perforation, diffuse peritonitis, or heavy contamination, source control comes first, and tissue repair, delayed reconstruction, or an alternative material may be safer [21].

8.5. Older and Medically Complex Patients

Age alone is not a contraindication to laparo-endoscopic repair. Cardiopulmonary reserve, frailty, anticoagulation, cognitive vulnerability, and support after discharge are more relevant. A fit older adult may benefit from early mobilization after a minimally invasive repair, while general anesthesia and pneumoperitoneum still need to be considered. For a frail patient with a reducible unilateral hernia who cannot tolerate general anesthesia, open repair under local anesthesia may be the proportionate choice. Avoiding urinary retention, delirium, pulmonary problems, and venous thromboembolism may have greater clinical value than reducing the incision length.

9. Learning Curve and Quality Assurance

Surgeon experience has a measurable effect on outcome. Operating time alone is a poor definition of the learning curve; peritoneal tears, bleeding, conversion, recurrence, and CPIP give a fuller account of competence. Training can combine formal teaching of preperitoneal anatomy, video review, simulation, supervised progression, and clear thresholds for referral or conversion. A standardized operative note should record hernia type and defect size, the limits of dissection, parietalization, prosthesis and dimensions, fixation, treatment of the peritoneum, and intraoperative events. Selected images or brief video clips of the critical view provide auditable evidence that the anatomical standard was reached, rather than relying solely on the written assertion that the repair was complete.

10. Emerging Technologies and Future Priorities

10.1. Single-Port and Reduced-Port Approaches

Single- and reduced-port operations leave fewer visible incisions, but instrument crowding, poorer triangulation, and another learning curve may outweigh the cosmetic benefit. A 2025 network meta-analysis detected no clear difference in recurrence or major postoperative complications among single-port, multi-port, and robotic approaches. The most consistent advantage of single-port surgery was cosmetic, and interpretation was limited by selection bias and variation between techniques [22]. Port reduction is worthwhile only if exposure, mesh deployment, and control of bleeding remain uncompromised.

10.2. Robotic Repair

Robotic systems offer three-dimensional vision, wristed instruments, and straight-forward intracorporeal suturing. These features can be useful for difficult peritoneal reconstruction and may assist training. Comparative studies have not, however, demonstrated a consistent improvement over standard laparoscopy in recurrence, length of stay, or overall morbidity; operating time and direct cost are often greater [23]. The platform may have a role in selected complex cases and in developing minimally invasive skills, but novelty is not a reason to replace an effective TAPP or TEP service. Future comparisons should include long-term pain,

quality of life, and total cost, not only events around the operation.

10.3. From Competition between Procedures to Precision Repair

Research would be more useful if it addressed variation within each operation instead of repeatedly asking whether TAPP, TEP, or robotic repair is best overall. Clinically relevant questions include which large medial defects benefit from closure or fixation, how mesh characteristics interact with different anatomy, and which patients are likely to develop CPIP or a troublesome seroma. Imaging, structured assessment of operative video, and machine-assisted recognition of landmarks may help make quality control more objective. Recurrence and short-term morbidity should be reported alongside patient-reported outcomes, return to work, and longer-term economic consequences.

11. Conclusion

Laparo-endoscopic repair is now a standard option for inguinal hernia. The case for it is strongest in bilateral disease, recurrence after an anterior repair, and women; for a primary unilateral hernia, the choice remains individual. TAPP and TEP have similar major outcomes in the available evidence. Whichever route is used, durability depends on complete preperitoneal exposure, coverage of the whole myopectineal orifice, flat and stable mesh placement, restrained fixation when indicated, and appropriate management of the peritoneum. Further improvement is more likely to come from consistent training, auditable operative standards, and patient-relevant outcomes than from changing the number of ports or adopting a more elaborate platform.

Author Contributions

Lei Tang: Conceptualization, methodology, literature review, writing - original draft. Chuanchang Yin: Conceptualization, supervision, writing - review and editing. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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