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Regional Analgesia Techniques in Inguinal Hernia Repair: Continuous Paravertebral Block versus Epidural Anesthesia

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ABSTRACT

Background: Inguinal hernia repair is among the most common operations worldwide and increasingly performed in older, comorbid patients. Regional techniques shape perioperative stability, analgesia, opioid use, and discharge readiness. Epidural anesthesia (EA) provides reliable bilateral neuraxial blockade but carries sympathectomy-related hypotension, urinary retention, and motor weakness. Continuous paravertebral block (cPVB) offers unilateral, segmental somato-sympathetic blockade tailored to the surgical side and may preserve hemodynamics while maintaining analgesic quality.This review synthesizes anatomical and physiological foundations and appraises randomized trials and meta-analyses comparing cPVB with EA for inguinal hernia repair. Outcomes include pain scores, opioid-sparing effects, block reliability, hemodynamics, adverse events, mobilization, patient-reported recovery, and suitability for ambulatory pathways. We also address technique refinements (ultrasound guidance, catheter strategies), limitations (dermatomal spread variability, unintended epidural spread), and considerations in elderly and high-risk patients.

Conclusions: Evidence suggests cPVB achieves analgesia comparable to EA with fewer sympathectomy-related effects, facilitating earlier ambulation, reduced urinary retention, and smoother discharge. EA retains advantages in broad dermatomal coverage and predictability but may delay recovery in unilateral surgery. Ultrasound-guided, catheter-based PVB improves success and safety. Technique choice should be individualized to patient, surgical approach, and enhanced-recovery goals. Future work should prioritize multicenter comparative trials with standardized multimodal regimens, core outcome sets, long-term pain assessment, and cost-effectiveness

Keywords*: Regional Analgesia, Inguinal Hernia Repair, Continuous Paravertebral Block, Epidural Anesthesia*

INTRODUCTION

Inguinal hernia repair is among the most commonly performed operations worldwide, with a male lifetime risk near 27% and a clear rise with age [1,2]. While mesh-based, tension-free techniques have standardized the surgical approach, anesthetic strategy remains pivotal for safety, analgesia, mobilization, and discharge—especially in older or comorbid patients and in ambulatory settings [1,3].

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General anesthesia is often used for laparoscopic repair but may increase postoperative nausea/vomiting and delay recovery. Spinal anesthesia provides rapid, dense block yet carries hypotension and urinary retention—undesirable in day-case surgery. Epidural anesthesia (EA) has long been favored for lower abdominal surgery because it offers titratable, bilateral neuraxial blockade and excellent intraoperative conditions; however, its sympathectomy is linked to hypotension, urinary retention, and motor weakness that can impede early ambulation and prolong stay [3–5].

Paravertebral block (PVB), particularly via continuous catheter (cPVB), delivers unilateral segmental somato-sympathetic blockade aligned to the surgical side, aiming to preserve hemodynamics while maintaining analgesic quality. Ultrasound guidance and improved catheter technology have enhanced accuracy and reduced failures associated with landmark techniques, renewing interest in PVB for groin hernia surgery [6].

Key questions persist: whether unilateral segmental coverage adequately treats both somatic and visceral components; how cPVB and EA compare in opioid-sparing effect, hemodynamic stability, complications, and block reliability; and which technique best supports enhanced-recovery and same-day discharge in high-risk or elderly patients. This review evaluates these issues by integrating anatomical and physiological principles with comparative clinical evidence, and by highlighting priorities for future research and implementation in multimodal pathways [1,3,6,7].

Surgical Anatomy of the Inguinal Region

The inguinal canal is a 4 cm oblique passage running from the deep to the superficial ring. Its floor is formed by the inguinal ligament, the anterior wall by the external oblique aponeurosis, the posterior wall by transversalis fascia, and the roof by the arching fibers of the internal oblique and transversus abdominis muscles. Weakness of the posterior wall predisposes to direct hernias, while the course of the spermatic cord through the deep ring explains the path of indirect hernias [8,9].

Sensory innervation important for perioperative analgesia arises from the ilioinguinal and iliohypogastric nerves (L1) and the genitofemoral nerve (L1–L2). The ilioinguinal nerve supplies the upper medial thigh, groin, and genitalia; the iliohypogastric covers the suprapubic region; and the genitofemoral nerve divides into genital and femoral branches. Inadequate coverage of these nerves can lead to residual pain or chronic post-herniorrhaphy neuralgia [9,10].

For open inguinal herniorrhaphy, dermatomal coverage from T9–L2 is recommended to accommodate anatomic variability and visceral afferents. Both epidural anesthesia and paravertebral block aim to block contiguous segments to ensure overlap and avoid islands of preserved sensation [10,11]. This neuroanatomy supports the rationale for unilateral segmental blockade with PVB versus the bilateral neuraxial blockade of EA, and guides catheter placement when continuous techniques are used.

Anesthesia Modalities in Inguinal Hernia Repair

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Several anesthetic options are available for open inguinal hernia repair, and selection depends on patient comorbidities, surgical approach, and goals for early discharge.

General anesthesia (GA) provides controlled airway management and is preferred for laparoscopic procedures. However, GA is associated with postoperative nausea, respiratory complications, and delayed mobilization in older or high-risk patients [12,13].

Spinal anesthesia (SA) offers rapid onset and dense block but can produce hypotension, urinary retention, and post-dural puncture headache, making it less ideal for ambulatory surgery where early mobilization is critical [14,15].

Epidural anesthesia (EA) delivers bilateral neuraxial blockade with adjustable dosing and excellent surgical conditions. Yet its sympathectomy can lead to hypotension, urinary retention, and motor blockade that delay discharge [16,17].

Paravertebral block (PVB)—especially with a continuous catheter (cPVB)—provides unilateral somatic and sympathetic block matching the surgical field. It preserves hemodynamic stability and reduces urinary retention and motor weakness, enabling earlier ambulation and same-day discharge [18,19]. Ultrasound guidance has improved accuracy and reduced complications compared with landmark techniques [20].

Comparative studies and meta-analyses suggest that PVB offers analgesia equivalent to EA with fewer side effects and similar or better opioid-sparing effects, although block failure or incomplete dermatomal spread remain concerns [21,22]. In enhanced-recovery pathways, cPVB may therefore represent a favorable alternative to EA for unilateral inguinal hernia repair, particularly in elderly or comorbid patients [23].

Randomized controlled trials and meta-analyses have compared continuous paravertebral block (cPVB) with epidural anesthesia (EA) for open inguinal hernia repair. Overall, these studies demonstrate **comparable analgesic efficacy** while highlighting notable differences in side-effect profiles.

Analgesic Quality and Opioid Use

Multiple trials show similar postoperative pain scores between cPVB and EA at rest and during mobilization for the first 24 hours, with both techniques providing significant opioid-sparing effects [24–26]. **Hemodynamic Stability**

EA frequently causes hypotension due to bilateral sympathetic blockade. In contrast, cPVB's unilateral, segmental block preserves vascular tone, resulting in lower incidence of clinically significant hypotension and reduced vasopressor use [27,28].

Recovery and Mobilization

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Earlier ambulation and shorter time to first voiding are consistently reported with cPVB, supporting its use in ambulatory pathways. Urinary retention and motor block—common with EA—are markedly less frequent with cPVB, facilitating same-day discharge [29,30].

Adverse Events and Complications

cPVB has a low but recognized risk of pleural puncture or pneumothorax, particularly with landmark techniques. Ultrasound guidance reduces these events and improves block success [31]. EA carries risks of epidural hematoma, infection, and post-dural puncture headache, which—although uncommon—can prolong hospitalization [32].

Evidence to date supports cPVB as an effective alternative to EA for unilateral inguinal hernia repair, offering similar analgesia with fewer sympathectomy-related side effects and faster recovery. Limitations include small sample sizes, heterogeneous techniques, and variable reporting of long-term outcomes. Larger multicenter trials are warranted to confirm cost-effectiveness and patient-reported outcomes [33].

Technique and Ultrasound Guidance

Epidural anesthesia is performed at mid- or low-thoracic/lumbar levels using a midline or paramedian approach with loss-of-resistance to identify the space. Incremental dosing and attention to antithrombotic guidelines reduce the risk of hypotension or inadvertent dural puncture. Catheter placement permits titration for both intra- and postoperative analgesia [34].

Paravertebral block (PVB) targets the thoracic paravertebral space adjacent to the transverse process, anesthetizing spinal nerves and the sympathetic chain on the surgical side. Landmark approaches are effective but less predictable; **ultrasound guidance** allows visualization of the transverse process, internal intercostal membrane, and pleura, improving accuracy and reducing complications such as pneumothorax. Continuous catheters threaded 2–3 cm enable prolonged infusion for postoperative analgesia and facilitate early mobilization [35,36].

Catheter management for both techniques should include low-concentration long-acting local anesthetic within a multimodal regimen, with standardized monitoring for block level and hemodynamics to support day-case pathways [37].

Analgesic Efficacy: cPVB versus Epidural

Both epidural anesthesia (EA) and continuous paravertebral block (cPVB) provide effective perioperative analgesia for unilateral open inguinal hernia repair. Randomized data specific to hernia surgery show **non-inferior pain scores** with cPVB versus EA in the first 24–48 hours and similar or reduced opioid requirements with cPVB [38]. Meta-analyses across thoracic/abdominal wall procedures corroborate these findings, demonstrating comparable pain score at rest and with movement while highlighting fewer neuraxial side effects with PVB-based strategies [39,40]. In

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practice, EA remains highly predictable for broad dermatomal coverage, whereas cPVB offers targeted unilateral blockade with adequate spread across contiguous segments when catheter techniques and ultrasound guidance are used.

Hemodynamic and Physiological Considerations

Epidural anesthesia (EA) produces bilateral sympathectomy with vasodilation and reduced venous return, predisposing to hypotension and bradycardia—effects most pronounced in elderly or hypovolemic patients and often requiring fluids or vasopressors. These autonomic changes can also contribute to urinary retention and delayed mobilization. By contrast, continuous paravertebral block (cPVB) creates a unilateral, segmental sympathetic block that better preserves systemic vascular tone and typically results in lower rates of clinically significant hypotension and faster functional recovery suitable for ambulatory pathways [41–43].

Complications and Safety Profile

Epidural anesthesia (EA) is associated with hypotension, urinary retention, and motor block that can delay mobilization; rarer but serious events include accidental dural puncture with post-dural puncture headache, epidural hematoma, and infection. Large studeis highlight that while severe neuraxial complications are uncommon, their consequences can be substantial, emphasizing careful patient selection, asepsis, and adherence to anticoagulation guidelines [44,45].

Continuous paravertebral block (cPVB) generally causes fewer systemic effects because of its unilateral action. The principal technical risks are pleural puncture/pneumothorax and vascular puncture, with risk markedly reduced under ultrasound guidance and with experienced operators. Unintended epidural spread may occur but usually presents as a broader block rather than severe toxicity. Contemporary series and reviews report low complication rates when ultrasound is used and standardized catheter care is applied [40,42,46].

Impact on Recovery and Functional Outcomes

Compared with epidural anesthesia (EA), continuous paravertebral block (cPVB) is associated with earlier ambulation, lower urinary retention, and smoother same-day discharge—advantages that align with ambulatory pathways and enhanced recovery protocols. Trials in open inguinal hernia repair report faster mobilization and higher patient satisfaction with cPVB, largely due to preserved hemodynamics and minimal motor block. Although both techniques provide strong analgesia, cPVB tends to reduce opioid-related side effects (nausea, sedation), supporting quicker readiness for discharge. Beyond the immediate perioperative period, optimized segmental blockade and effective

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acute pain control may mitigate central sensitization and lower the risk of chronic post-herniorrhaphy pain, though long-term data remain limited [47–49].

Evidence from Clinical Trials and Meta-Analyses

Across unilateral inguinal hernia repair, randomized data indicate that cPVB achieves pain scores and opioid consumption comparable to EA while reducing sympathectomy-related adverse effects and facilitating earlier discharge [38]. Meta-analyses spanning thoracic and abdominal wall surgery corroborate equivalence in analgesia with fewer neuraxial complications under PVB-based strategies, and these findings are consistent with systematic reviews emphasizing ambulatory outcomes [39,40,42,43]. Single-center RCTs specific to herniorrhaphy further support non-inferiority of PVB vs EA, though heterogeneity in technique (volumes, levels, catheter protocols) and small sample sizes limit certainty; larger multicenter trials with standardized regimens and core outcomes are still needed [50,51].

Conclusion

Epidural anesthesia (EA) remains the gold standard for regional anesthesia in inguinal hernia repair. EA offers reliable, dense, and predictable bilateral block, ensuring stable intraoperative surgical anesthesia and effective postoperative pain control. Continuous paravertebral block (cPVB) can provide unilateral anesthesia with fewer sympathetic effects and may aid early ambulation and discharge; however, its segmental and sometimes inconsistent spread limits its suitability as a sole anesthetic technique for this procedure. Although ultrasound-guided catheter-based PVB improves safety and success rates, epidural anesthesia continues to provide the most dependable and versatile option for both intraoperative anesthesia and postoperative analgesia. Choice of technique should be individualized to patient comorbidities, surgical requirements, and institutional expertise, but EA remains the benchmark for comprehensive regional anesthesia in inguinal hernia repair.

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