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Ultrasound guidedRetrolaminar Block in the Era of Fascial Plane Blocks: Anatomical Basis, Techniques, Current Evidence, Limitations and Safety Considerations in Lumbar Spine Surgery: *A mini review*

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Abstract

Effective postoperative pain management is essential for improving recovery, reducing opioid requirements, and minimizing complications after lumber spine surgery, Although epidural analgesia , its invasive nature, technical demands, and potential complications have encouraged the development of less invasive ultrasound-guided fascial plane blocks. Among these techniques, the ultrasound-guided retrolaminar block (RLB) has gained increasing attention as a posterior interfascial approach in which local anesthetic is deposited between the lamina and the deep paraspinal muscles. Its proposed mechanism involves spread within the retrolaminar plane and variable extension into the epidural and intervertebral foraminal spaces, potentially affecting the dorsal and ventral rami of spinal nerves. In the current era of fascial plane blocks, RLB is positioned alongside techniques such as the erector spinae plane block (ESPB) and thoracic paravertebral block (PVB). Available evidence suggests that RLB may provide effective analgesia and reduce postoperative opioid consumption and pain scores after truncal surgery, while reported comparative findings suggest potential non-inferiority to PVB and possible advantages over ESPB in selected clinical settings. Its relatively superficial ultrasound landmarks and posterior approach may also make it technically feasible and associated with a favorable safety profile.

the analgesic mechanism and clinical value of RLB remain incompletely established. Anatomical studies show that injectate spread is variable and that paravertebral spread may be more limited than with conventional PVB, Therefore, further high-quality randomized trials are required to define the optimal technique, local anesthetic volume and concentration, duration of analgesia, safety, and comparative efficacy of RLB.

This thesis aims to evaluate the role of ultrasound-guided retrolaminar block in perioperative analgesia within the fascial plane blockade. It examines the anatomical rationale, mechanism of action, clinical efficacy, safety, and relative position of RLB among alternative regional anesthesia techniques, with the goal of clarifying its potential role in multimodal, opioid-sparing postoperative pain management.

Keywords: retrolaminar block; lumbar surgery; fascial plane block; erector spinae plane block; blockade of the chest fascial plane; postoperative analgesia; opioid-sparing analgesia; regional anesthesia; narrative review.

1. Introduction

The common treatments for moderate to severe postoperative pain following lumbar spine surgery neuraxial analgesia, wound infiltration, and systemic medications—each have disadvantages. With a needle target away from the neuraxis, interfascial plane blocks seek to provide regional analgesia [1, 2]. RLB and ESPB are still grouped together among posterior blocks in recent narrative evaluations [3]. While others discuss ESPB and fascial plane blocks more generally, one narrative review focuses on RLB in truncal surgery [2, 4]. RLB in lumbar spine surgery is the main topic of this review.

2. Anatomical basis

The retrolaminar block (RLB) is an interfascial technique based on injection of local anesthetic into the potential space between the posterior surface of the vertebral lamina and the overlying deep paraspinal muscles. Anatomically, the target plane lies deep to the erector spinae and transversospinalis muscle groups, with the lamina serving as a readily identifiable bony landmark during ultrasound-guided needle placement.[4]

The thoracic paravertebral space (TPVS), which contains the spinal nerves, sympathetic chain, and intercostal vessels, is bounded anterolaterally by the parietal pleura, posteriorly by the superior costotransverse ligament, medially by the vertebral body and intervertebral foramina, and superiorly and inferiorly by the heads of adjacent ribs. Because the RLB is performed posterior to the lamina, its analgesic effect is presumed to depend partly on anterior or lateral spread of injectate toward the TPVS, intervertebral foramina, and intercostal spaces.[5]

Cadaveric studies have demonstrated that retrolaminar injection produces consistent vertical spread in the plane between the posterior lamina and the transverse spinalis muscles. However, the pattern of further spread is variable: injectate may reach the paravertebral space, epidural space, intercostal spaces, and intervertebral foramina, thereby potentially affecting both dorsal and ventral rami of the thoracic spinal nerves. This variability suggests that RLB may produce analgesia through a combination of direct paraspinal nerve involvement and indirect paravertebral spread. Compared with the erector spinae plane block (ESPB), which is performed at the transverse process and relies on spread along the erector spinae plane, RLB targets the lamina and a more medial, deeper fascial plane. Magnetic resonance imaging and anatomical studies have shown that both techniques can produce epidural and neural foraminal spread over several levels; nevertheless, ESPB tends to produce more extensive lateral and craniocaudal spread, including intercostal spread, whereas RLB more consistently spreads within the retrolaminar space.[5-6]

These anatomical findings support the rationale for RLB as a fascial plane technique for truncal analgesia, but they also highlight an important limitation: the clinical effect may vary with injectate volume, injection level, and the extent of anterior spread. Therefore, a clear understanding of the retrolaminar anatomy is essential for interpreting both the potential efficacy and the limitations of this block.[6]

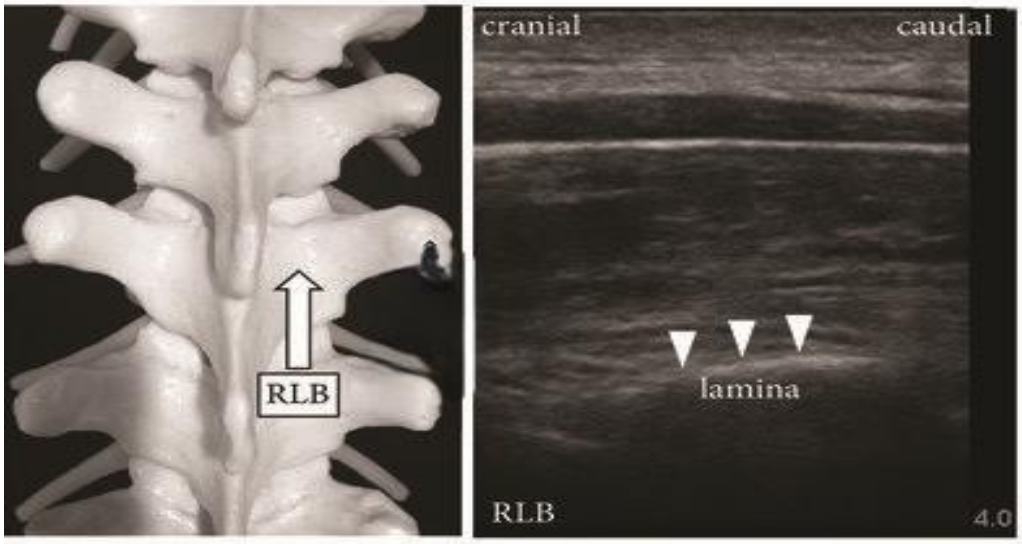
anatomical points:

• Injections into the lamina and injections beneath the erector spinae muscle at the transverse process may share a fascial space since the lamina, transverse process, and articular process are located in an almost continuous posterior plane. For this reason, ESPB and RLB are regarded as close relatives [7,8].

•Posterior paraspinal and incisional analgesia are anatomically warranted since the medial branch of the dorsal ramus supplies the multifidus and facet joints and passes the intersection of the transverse and superior articular processes.[9]

• Deep fascia and interstitial tissue must be traversed in order to reach the ventral ramus, lumbar plexus, or sympathetic chain; this has not been shown in lumbar RLB [7–10].

• No cadaveric or imaging studies specific to the lumbar spine have found RLB.



3. Mechanism of action:

The question of whether RLB or ESPB reach the paravertebral space has been widely examined in cadaveric and imaging studies. Since there were no lumbar spine-specific research, the following results are from the thoracic region and should be cautiously extended to the lumbar region:

• Cadaver study (2018): Following RLB and ESPB, dye and MRI in a fresh cadaver model revealed restricted and uneven anterior diffusion and usually equal diffusion in the posterior compartment [7].

• Cadaver Study (2018): According to a different comparison, RLB injections more frequently contacted nerve roots and reached paravertebral and epidural regions than ESPB injections [9]. This should be regarded as hypothesis generating because results differ from research to study.

• Cadaver study (2018): Safe access to the thoracic paravertebral space cannot be ensured, according to a human cadaver study of the retrolaminar technique [7,10].

• According to cadaveric investigations (2017–2018) and the 2021 ESPB narrative review, the virus travels through the transverse costal opening and, in certain cases, may penetrate the paravertebral and epidural compartments; the most reliable neural target is the dorsal rami [8,11,12].

• Research on human volunteers reveals that sensory loss following ESPB is typically restricted to the dorsal skin distribution [13], which is at odds with constant ventral coverage.

Overall, rather than a continuous paravertebral block, the evidence suggests a mechanism of posterior multicompartmental spread (dorsal ramus, potential paravertebral and epidural spread, and systemic resorption) [12,14]. Fascial plane block narrative reviews explain varied spread, sensory block.

The ESPB mechanism looks at the effects of multiple coupled processes, and analgesic mismatch and visceral coverage are contentious. While ESPB stained more spinal nerves, RLB was consistently distributed in the paravertebral region along the retrolaminar plane with a preference for dorsal and medial branches, according to a cadaveric investigation [15,16].

4. Technique:

Position and Probe: When the patient is awake, operate in the sitting or lateral position., but a curved transducer may be required in the lumbar region due to depth. Using the parasagittal or transverse orientation, count levels from the sacrum to identify the vertebral formations, laminae, and lumbar transverse and articular processes flanking them. A 20–22G blocking needle (often 50–100 mm) is inserted into the hyperechoic lamina, the deep layer underneath the multifidus, in a craniocaudal or latero-medial plane until the tip touches the membrane. A safe endpoint is bone contact; do not move medially or deeper; instead, keep the tip lateral to the interlaminar gap [4,5,15].

Inject 1-2 mL to ensure the plane lifts off the lamina after negative aspiration. Preoperative injections of 15 mL of bupivacaine 0.25%, 8 mg of dexamethasone, and 200 mg of magnesium sulfate were administered bilaterally and intraoperatively in the discectomy study (NCT07334288, NCT07166250). Fascial plane testing integrates dose, volume, and associated factors; the bilateral combination dose is assessed against the weight-based maximum dose. [16].

Practical points: Inject carefully, choose a level at or near the surgical segment, and only add a second level if greater craniocaudal coverage is required, as spread is vary.

5. Current clinical evidence

Four randomized trials provide direct evidence for RLB in lumbar surgery: three support RLB for analgesia or opioid sparing [17–19], and one supports ESPB [20]. Indirect evidence is derived from a meta-analysis in breast and thoracic surgery [21] and a dedicated narrative review of truncal surgery [22], which indicated reduced opioid use and pain scores with RLB than ESPB and non-inferiority to paravertebral block. Other research has reported RLB in lithotripsy [23], cervical radiculopathy [24], and cesarean section, when ESPB resulted in reduced pain levels at 6 and 12 hours [25]. The evidence for fascial plane blocking and ESPB is generally low level, according to narrative studies [26,27].

Significant restrictions on this evidence:

• There are only a few modest, 24- to 48-hour follow-up randomized trials in lumbar surgery.

•Adjuvants, medications, and volumes vary between trials (e.g., liposomal bupivacaine, dexamethasone and magnesium) [17,19].

• Systemic analgesia, paravertebral block, TLIP block, and ESPB are separate comparison criteria, which restricts pooling [18,20].

• There is inconsistent reporting of functional recovery outcomes, such as mobilization and discharge [17–20].

• Results are frequently reported with various labeling for similar locations since RLB and ESPB injections overlap physically.

According to the cautious conclusions of narrative reviews [22,26–28], lumbar RLB should be regarded as a technique with reasonable but low-certainty evidence, not comparable to ESPB, TLIP blocks, or neuraxial approaches.

6. Limitations

• Inconsistent spread: thoracic data indicate varied dissemination, and no lumbar cadaveric or imaging research of RLB was found [7,9,10,13,29].
• Mechanism uncertainty: no single mechanism has been shown; effects could include systemic absorption of local anesthetic, diffusion, and dorsal ramus blocking [12,14].

• covering of deeper or anterior structures has not been shown; posterior, incisional analgesia is anticipated.
•Systemic effects: bilateral injection causes the volume to double and raises questions regarding the toxicity of local anesthetics [30].

• RLB's actual benefit is diminished in many centers due to overlap with ESPB and TLIP block ideas, which have a stronger body of evidence [28,31].
•Surgical field: the block is positioned in close proximity to the surgical site, and the impact of anatomy on diffusion has not been investigated.

7. Safety considerations

• Intraspinal distribution: The lumbar spine's interlaminar space is large, and the spinal canal lies near the lamina. Epidural injection or dural puncture may be the outcome of deep or medial needle insertion. Keeping the tip on the bone and lateral to the interlaminar space, epidural spread has been defined as a fascial plane block [9,21].

•Pleura and retroperitoneum: While pneumothorax in the middle and lower lumbar spine is not a concern, upper lumbar injection necessitates ongoing needle imaging because the pleura may extend to the thoracolumbar junction [29].
Weight-based dosage estimations, staged injections, and the availability of lipid emulsion therapy are necessary for bilateral injections due to local anesthetic systemic toxicity (LAST).

• Hematoma and infection are uncommon, but anticoagulant and antiplatelet medication should adhere to deep block standards [23]; because the site is near the surgical area, stringent asepsis should be used.
• Motor and sensory changes: One study assessed the incidence of motor block, which can obstruct early postoperative neurologic evaluation following spine surgery.
Epidural or paravertebral spread has been seen, however hypotension and sympathetic denervation are less prevalent than neuraxial procedures. [24,25]
• General precautions include standard monitoring, aseptic procedure, ultrasound guidance for serial needle viewing, and operator expertise; the 2026 Fascial Plane Review places a strong emphasis on catheter technique, volume control, and toxicity prevention [25,32].

8. Conclusions and future directions

RLB is a straightforward superficial paravertebral block used in lumbar spine surgery that has not been demonstrated to penetrate the lumbar plexus but seems to function as a dorsal ramus block with some diffusion and systemic absorption. One trial supported ESPB with less assurance, although four small randomized trials evaluated lumbar discectomy, disk surgery, and fusion [17–20]. With consideration for epidural spread and neurological evaluation, RLB may be used in multimodal analgesia. Lumbar cadaveric and imaging investigations, sufficiently powered comparisons with ESPB and TLIP block, standardized dosage, functional and safety outcomes, and standardized nomenclature for posterior fascial plane blocks should all be part of future research [2,11,13,21,22,26,27,31].

9. Clinical applications of RLB in lumbar spine surgery

For lumbar discectomy and fusion, RRLB has been studied as a pre- or intraoperative block; four randomized trials have been found, all of which are small to moderate and generally positive. No narrative review has been devoted to lumbar RLB; the spine surgery narrative review [32] includes paraspinal methods in general. The evidence for lumbar RLB is more recent and sparse than for thoracic surgery.

Table(1) Retrolaminar block versus other block with different out come :

Year	First author et al. [reference]	Surgery and design	Comparison	Main outcome
2026	Zhang et al. [19]	Posterior lumbar interbody fusion; randomised, double-blind trial	Liposomal bupivacaine versus plain bupivacaine, both given by RLB	Liposomal bupivacaine improved static VAS over 48 h with no serious adverse reactions
2025	Kyenshilik et al. [20]	Lumbar spinal surgery; randomised trial, 80 patients	RLB versus ESPB	ESPB appeared more effective for analgesia; no differences in extra analgesia need, mobilisation, discharge or adverse effects
2025	Tas et al. [18]	Lumbar disc	PVB, TLIP block	TLIP and RLB

Year	First author et al. [reference]	Surgery and design	Comparison	Main outcome
		herniation surgery; randomised trial, 185 adults in four groups of 45	and RLB versus standard systemic analgesia	outperformed PVB for analgesia, opioid use and recovery quality
2024	Kamel et al. [17]	Posterior lumbar discectomy; randomised trial, 36 in the RLB group	Intraoperative bilateral RLB (15 mL bupivacaine 0.25% with dexamethasone and magnesium per side) versus control	Longer time to first rescue analgesic and lower 24 h ketorolac use ($P < 0.001$)

Practical points

None of them solved the problem.

• There are two current registrational trials: quadratus lumborum block versus RLB in lumbar disks (NCT07166250) and RLB combined to multimodal analgesia versus multimodal analgesia alone, with 24-hour morphine use as the primary outcome (NCT07334288). • These studies' descriptions of safety were inadequate. The problems of epidural dissemination and infection covered in Section 7 apply to the lumbar lamina because it is between the spinal canal and the surgical field. These opinions represent the authors' conclusions, not the findings of experiments.

The randomized trials' conclusion. Three out of four studies support RLB: it decreased the need for rescue analgesics following discectomy [17], performed better than paravertebral block for analgesia, opioid use, and recovery quality in disk surgery [18], and improved 48-hour pain scores when liposomal bupivacaine took the place of plain bupivacaine in fusion surgery. In lumbar surgery, the only direct comparison with ESPB was positive.

There were no variations in mobilization, discharge, or side effects after using ESPB for analgesia. In conclusion, RLB is a reasonable opioid-sparing component of multimodal analgesia for lumbar spine surgery, but there is little assurance because the study was small, single-center, had a short follow-up period (24–48 hours), and varied in method, volume, adjuvant, and comparative drugs. The fusion trial did not report any significant adverse events; nonetheless, security was not well described elsewhere. In larger blinded studies, fixed dose, functional recovery, and predetermined safety outcomes should be used to compare RLB with ESPB and TLIP block in typical multimodal analgesia.

10. Narrative reviews and 2024–2026 updates

There is just one narrative review that focuses on RLB; the others discuss fascial plane or ESPB literature. The searches were conducted in October 2026 and are not all-inclusive.

Table (2) types of the study and its out come.

Types of study	First author et al. [reference]	Type of review	Main outcome
cadaveric and human	This mini review	Narrative review of RLB	RLB behaves as a posterior fascial plane block with variable spread; evidence is low-certainty and RLB is not an established equivalent of

Types of study	First author et al. [reference]	Type of review	Main outcome
			TPVB
human	Sharma et al. [33]	Narrative review	Evidence-based block selection for thoracic, abdominal, hip, pelvic and limb surgery; tips, dosing tables and safety measures (volume, toxicity, catheters, adjuvants); lists RLB among posterior thoracic wall blocks
, cadaveric and human	Mistry et al. [34]	Narrative review	Spread is variable, sensory loss and analgesia can mismatch, and visceral coverage is inconsistent
human	Gu et al. [27]	Narrative review	ESPB, QLB, TAP and SAP blocks show promising reductions in pain intensity and better comfort in non-surgical pain
human	de Souza Makiyama Lopes et al. [21]	Systematic review and meta-analysis of RCTs (related, not narrative)	MTP block and RLB gave early postoperative analgesia comparable to PVB in breast and thoracic surgery
human	Kumari et al. [22]	Narrative review dedicated to RLB; 706 records screened, 11 included	RLB gave lower opioid use and pain scores than ESPB and was not inferior to PVB; low-certainty evidence
cadaveric and human	Yang et al. [26]	Narrative review of 2019–2024 literature	Clinical evidence for ESPB is generally low-level; calls for anatomical, imaging and histological studies
human	Admiraal et al. [28]	Narrative review with systematic search; 128 of 2,135 studies included	Indications for purely sensory blocks are growing, some techniques are declining, and anatomical correlates are missing for several
cadaveric and human	Chin et al. [11]	Narrative review	Core reference on how ESPB may act
cadaveric and human	Chin et al. [13]	Narrative review	Core reference on how fascial plane blocks may act
human	Saadawi et al. [35]	Narrative review with systematic analysis of	ESPB and TPVB comparable for

Types of study	First author et al. [reference]	Type of review	Main outcome
		registered, blinded RCTs	thoracoscopic and breast cancer surgery at similar injection numbers; more comparative trials needed
, cadaveric and human	Onishi et al. [14]	Review article comparing RLB and ESPB using clinical and anatomical reports	Describes features and differences of the two blocks; evidence on mechanism and optimal dosing is insufficient
human	Kot et al. [36]	Narrative review; 125 studies	Wide clinical applicability; more evidence needed on mechanism
, human	De Cassai et al. [37]	Systematic qualitative review (related, not narrative); 4 RCTs	ESPB equal to epidural in one trial; complications reported in two reports; more RCTs needed
human	Wu et al. [32]	Narrative review	

• In contrast to the near-equivalent finding proposed in the cadaver study provided in Section 3, a 2024 RLB review [37] found that RLB is superior to ESPB. Because it summarizes a limited number of small and diverse research, the clinical conclusion should be interpreted cautiously.
• Current primary and pooled research (2025–2026)
RLB and MTP blocks versus traditional PVB for breast and thoracic surgery: a systematic review and meta-analysis, 2025 [21].
• Cadaveric investigation (2026), 10 specimens at T9: ESPB stained more spinal nerves in earlier research [29]; RLB dye consistently diffused along the retrolaminar plane into the paraspinal region, favoring dorsal rami and medial branches.

• Unilateral RLB for shock wave lithotripsy: reduced opioid use and increased satisfaction without block-related problems in a human prospective study (2026) [23].

• Retrospective Human Cervical RLB Cohort for Radiculopathy (2026), with a two-year minimum follow-up: 71.1% of pain recurrences, 6.6% of minor incidents, and no major complications [24].

• A retrospective analysis of RLB and ESPB in people following cesarean section revealed that while discharge timings were comparable, ESPB had lower VAS scores at 6 and 12 hours [25].

• There are also narrative reviews of paravertebral procedures used in spine surgery. [32].

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