Review Article

Analgesic efficacy of ultrasound-guided retrolaminar block in truncal surgeries: A narrative review

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Abstract

Postoperative pain management in patients undergoing thoracoabdominal surgery always remains challenging for the anesthesiologist. As a method of pain management, multimodal analgesia is commonly used. In recent years, interfascial plane blocks like erector spine plane block (ESPB), retrolaminar block (RLB), transverse thoracic plane block, and pectointercostal plane block have been increasingly utilized as important components of acute postoperative pain management in truncal surgeries. Here, we reviewed the analgesic efficacy of ultrasound (US)-guided retrolaminar block in patients undergoing truncal surgeries. The primary objective of this review was total opioid consumption within 24 hours of the postoperative period. The secondary objectives were postoperative pain score, time to first analgesic requirement, and adverse effects. All articles relevant to the retrolaminar block were searched in six major databases (PubMed, Embase, Medline, Ovid, PMC, and Google Scholar). A total of 706 records were identified, out of which only 11 kinds of literature were included in this review article, based on our inclusion criteria. The published literature suggests that retrolaminar (RLB) provides more effective analgesia in comparison to the erector spinae block (ESP), is associated with reduced opioid consumption and numeric rating scale (NRS) score, and is not inferior to paravertebral (PVB). There is an evidence that a retrolaminar block can effectively relieve pain during truncal surgery. RLB had a lower rate of complications, was simpler to perform, and required shorter hospital stays.

Keywords: Opioid, postoperative analgesia, retrolaminar

Introduction

Postoperative pain management in patients undergoing thoracoabdominal surgery always remains challenging for anesthesiologist. The multimodal perioperative analgesic technique has been recommended as an intervention to decrease the prevalence of long-term opioid use following surgery. Traditional regional analgesia techniques during truncal procedures, paravertebral block (PVB), and thoracic epidural anesthesia (TEA) are frequently employed. However, TEA can be technically challenging in some circumstances and carries a high risk of life-threatening consequences that include epidural hematoma, nerve damage, and hypotension. Complication associated with PVB includes pneumothorax, hypotension, or nerve damage. In recent years, interfascial plane blocks have been increasingly utilized as important components of acute postoperative pain management in truncal surgeries.[1] US-guided retrolaminar block is one of the newer and technically simpler alternatives to the traditional PV block. Pfeiffer *et al.*[2] described landmark technique of RLB for post-mastectomy pain relief in eleven patients. They injected the local anesthetic between the thoracic laminae and the deep paraspinal muscles. In 2013, Zeballos *et al.* suggested that improving the lamina technique by mandating

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the US guidance RLB and defining the site of drug injection and real-time monitoring of needle tip and injected drug spread over lamina thus minimizes the risk of epidural injection associated with the blind technique.[3] This was immediately followed by a report by the same group describing their first experiences with the retrolaminar technique in patients with multiple rib fractures.[4] Retrolaminar block also used in breast surgery.[5] The aim of this narrative review is to explore the analgesic efficacy of US-guided retrolaminar block in truncal surgeries. The primary objective of this review was total opioid consumption within 24-hours of postoperative period. The secondary objectives were postoperative pain score, time to first analgesic requirement, and adverse effects.

Material and Methods

All articles relevant to the retrolaminar block were searched in six major databases (PubMed, Embase, Medline, Ovid, PMC, and Google Scholar). From May 22 to May 26, 2023, a total of 706 records were identified, and 668 were excluded because they were not relevant to the study design. A total of 38 records were included, and 27 were excluded due to non-English literature. Different surgery populations did not match out of which only 11 kinds of literature were included in this review article based on our inclusion criteria Figure 1. PICO (Populations of interest, intervention, comparator, and outcomes) model for this narrative review were as follows: (1) adult or pediatric patient, (2) regional analgesia, (3) comparative intervention such as other blockade or systemic analgesia or no blockade, and (4) various clinical outcome including pain score and analgesic consumption. Exclusion criteria: (1) duplicate or irrelevant article and (2) non-English article. Keywords used to search the articles included in this narrative review were "retrolaminar, postoperative analgesia, and opioid." Types of articles included in this narrative review were case reports, randomized clinical trials, and reviews.

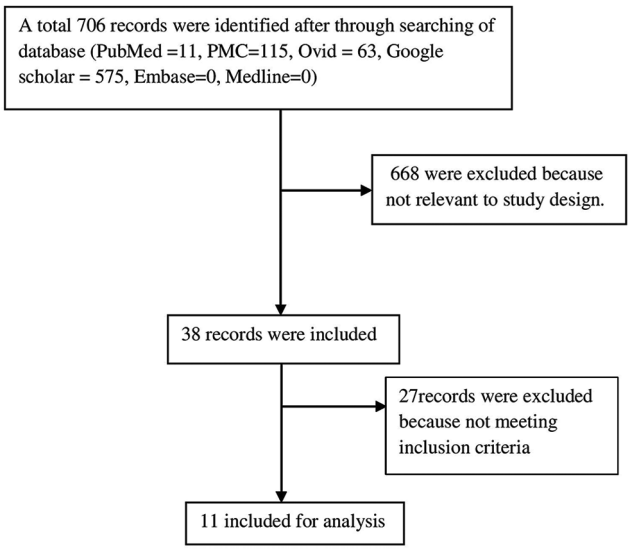

Figure 1: Flow diagram for patient selection

Mechanism of Action of RLB

The exact anatomical mechanisms of retrolaminar (RLB) remain unclear. However, several studies supported the spread of local anesthetic into the intervertebral foramina, epidural space, and paravertebral space.[6-8] In RLB, the dermatomal distribution of block areas varied between different investigations. Dye-injected studies show staining of the posterior lamina vertical in RLB. Table 1 provides a summary of anatomical investigations. Due to the differences in tissue quality between a cadaver and a living person, these anatomical investigations were constrained. However, it was not completely excluded that tissue movement during dissection could have caused the dye to diffuse into deeper areas such as the epidural space and paravertebral space.

Block techniques

RLB can be performed by using a landmark approach or US-guided technique. Landmark technique: RLB is carried out using either the landmark approach or US imaging. In the landmark technique, the target spinous process is palpated first. A technique comparable to the paramedian approach for thoracic epidural puncture is used to introduce the needle 1-1.5 cm laterally to the target spinous process. The needle is then moved caudally or cranially until it makes contact with the lamina. Following negative aspiration for blood and CSF 20–30 cc doses of local anesthetics are administered on to the lamina.

In the US-guided RLB, a linear US probe was placed longitudinally in the midline to identify the spinous process of the vertebra. Following this, the US probe was slid slightly laterally (1–1.5 cm lateral to the target spinous process) toward the operating side to identify the following structures the lamina (horse head sign of hyperechoic structure) and erector spinae muscle. The needle was inserted in-plane to the probe in caudal to the cranial direction toward the lamina and the needle tip was contacted with the lamina [Figure 2]. After negative aspiration 20 ml of local anesthetic was injected.

Erector Spinae Plane Block (ESPB), Paravertebral (PVB), and Thoracic Epidural (TEA) are Compared to Retrolaminar (RLB)

Table 1 describes the technique of RLB, ESPB, PVB, and TEA and their associated complications. The most popular method is TEA, which provides analgesia for the somatic and visceral systems. TEA requires a high level of expertise, knowledge, and has a failure rate of around 14–30%.[9] In TEA, the volume of drug per segment is 1–2 ml and

Table 1: The feature of RLB, ESPB, PVB, and TEA

	RLB	ESPB	PVB	TEA
Difficulty	Probably simple	Probably simple	More difficult	More difficult
Method	Landmark technique or US guided	US guided	US guided	Landmark technique
Needle position and Site of drug deposition	Lamina	Transverse process	Paravertebral region	Epidural space
Volume of drug per dermatomal	3–5 ml	3.4 ml	3–5 ml	1–2 ml
Laterality of effects	Unilateral	Unilateral	Unilateral	Bilateral
Complications	Pneumothorax, nerve damage	Pneumothorax, nerve damage	Hypotension (less than TEA) Pneumothorax Epidural injection hematoma	Epidural hematoma Epidural abscess Paralysis Nerve injury Hypotension Dural puncture

RLB: retrolaminar block, ESPB: erector spinae plane block, PVB: Paravertebral block, TEA: thoracic epidural anesthesia

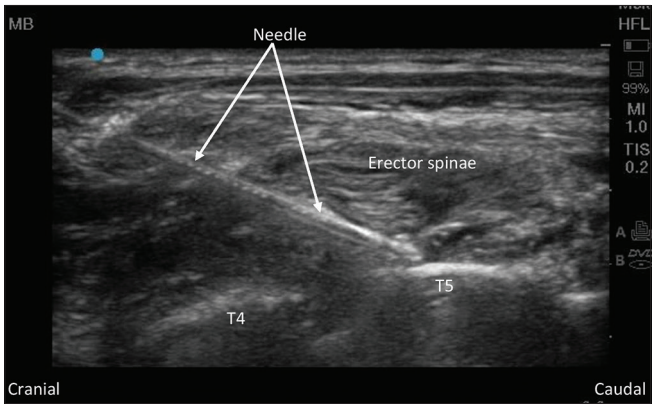

Figure 2: Ultrasound-guided continuous retrolaminar block. The figure shows the entry of a needle, coming into contact with the T5 lamina

craniocaudal distribution is 2:1.[10] Epidural hematoma, hypotension, spinal injection, nerve injury, and inadvertent dural puncture are all frequent TEA side effects. US-guided thoracic paravertebral block local anesthetic was administered inside the thoracic paravertebral space, in PVB the volume of the drug is 3–5 ml per segment.[11] According to reports, US-guided PVB poses fewer difficulties.[12] However, due to the close proximity of spinal nerve roots and pleura, there are chances of nerve damage and pneumothorax.[13] In RLB and ESPB the needle tip was not in close proximity to the pleura and spinal nerve roots in comparison to TEA and PVB. Additionally, the needle tip and the injected drug spread can be seen when using the US. In ESP, the volume of drug per segment is 3.4 ml.[14] In retrolaminar, the volume of drug per segment is around 3–5 ml.[8] The amount of information that is now known about these blocks, however, is still insufficient; more research is needed to determine the best local anesthetic dosage, the area of sensory block, and the distinctions between single injection and continual injection.

Clinical reports

Few studies and case reports have been published on the single shot and continuous catheter techniques of retrolaminar block. It is simple to carry out and offers efficient analgesia, making it a good substitute for indirect methods of the PVB Table 2. For patients with multiple rib fractures, Zhao *et al.*[15] investigates the effects of retrolaminar and ESPB on intraoperative and postoperative analgesia. Intraoperative remifentanil and morphine dosage as well as pain assessment were the primary objective. They found that RLB was a more effective analgesic in comparison to an erector spinae plane block. In their study, they have not calculated block onset times, or dermatomal distribution of sensory block as the block was performed after general anesthesia. They have given only 20 ml of local anesthetics which could not provide sufficient bilateral analgesia. Liu *et al.*[16] investigated for patients who underwent retroperitoneal laparoscopic surgery, and determined how the RLB and the ESPB will differ in terms of postoperative analgesia. The primary objective was the visual analog scale (VAS) score. They came to the conclusion that single-point ESPB and three-point RLB with US guidance can be used to safely and effectively manage pain after retroperitoneal laparoscopic surgery. Comparison of a single-high volume injection with multiple injections may still be inappropriate, given that the injection areas are very close in RLB and ESPB, and the volume which is administered greatly affects the drug spread. In their study, they used a weak opioid analgesic (tramadol) as rescue analgesia in both groups. It will be investigated further how RLB and ESPB's analgesic processes differ from one another, in terms of 24-hour postoperative fentanyl consumption and pain scores. Abdelbaser *et al.*[17] studied the postoperative analgesic effects of single-shot bilateral thoracic retrolaminar block (TRLB) in pediatric open cardiac surgery. In their study they have taken total fentanyl consumption within 24 hours after the extubation as the primary outcome, postoperative pain scores, the duration of the first rescue analgesia, the duration of extubation, and the frequency of complications were the secondary outcomes. They concluded that effective postoperative analgesia was achieved with US-guided bilateral TRLB performed at the level of the

Table 2: Evidence summary of retrolaminar block

Study	Intervention control	No of patients	Level	Local anesthetics	Type of surgery	Primary outcome	Outcome
Zhao *et al.*[15]	RLB ESP	33 34	Rib fracture segment location Rib fracture segment location	0.5% Ropivacaine 20 ml in both groups	Multiple rib fractures	Intraoperative remifentanil consumption and morphine requirement and pain score	In comparison to an ESPB, RLB provides a more effective analgesic
Liu *et al.*[16]	RLB ESP	44 44	T8-T10 T9	0.4% Ropivacaine 30 ml in both groups	Retroperitoneal laparoscopic surgery	VAS score	Single-point ESPB and three-point RLB effectively manage pain after retroperitoneal surgery
Abdelbaser *et al.*[17]	RLB control	33 33	T4 T4	Bupivacaine0.4 ml/kg 0.9% normal saline 0.4 ml/kg	Open cardiac surgery	Fentanyl consumption within 24 hours after extubation	Effective postoperative analgesia with US-guided bilateral TRLB in terms of opioid consumption and postoperative pain scores
Wang *et al.*[18]	RLB Paravertebral	30 30	T3 and T5 T3 and T5	0.5% Ropivacaine given in both groups	UVATS	Mean NRS score	US-guided PVB appears to be a more effective analgesic approach than US-guided RLB
Hwang *et al.*[19]	RLB Sham block	22 24	T3 T3	0.75% Ropivacaine 20 ml+2% lidocaine 10 ml None	Breast surgery	Cumulative morphine consumption within 24-hour postoperative period	Single injection of US-guided RLB reduced postoperative morphine consumption but did not have the benefit of lowering pain levels immediately after surgery
Nobukuni *et al.*[20]	RLB Epidural	47 47	T4 or T5 T4 or T5	0.2% Ropivacaine, 8–12 ml/hr continuous infusion 0.2% Ropivacaine 3–6 ml/hr continuous infusion	Video-assisted thoracic surgery	Median differences in NRS scores	Analgesic effects of continuous US-guided RLB were non-inferior to TEA
Kamel *et al.*[21]	RLB T Epidural	26 26	T7 T7	20 ml of bupivacaine 0.25% plus 5 μg/ml (1:200,000) adrenaline 20 ml of Bupivacaine 0.25% plus 5 μg/ml adrenaline (1:200,000)	Laparoscopic cholecystectomy	Postoperative pain by Numeric Rating Scale	Retrolaminar block considerably reduced pain levels compared to thoracic epidural analgesia that lasted up to 6 hours postoperatively, both groups were satisfied with their analgesia
Murouchi *et al.*[22]	RLB Paravertebral	15 15	T4 T4	Continuous infusion 4 ml/hour 0.25% levobupivacaine Given in both groups	Mastectomy	Determine the analgesic efficacy	Continuous RLB was not inferior to PVB except for the first 24 h, and was satisfactory
Sotome *et al.*[23]	RLB ESP	23 22	T4 T4	0.375% Levobupivacaine 20 ml in both groups	Breast surgery	Analgesic efficacy in terms of time to first postoperative rescue analgesia	RLB was more effective than ESP
Karaca *et al.*[24]	RLB IV (control)	30 30	At the level in the dorsal root corresponding to the dermatome	0.25% of 10 ml on each side	Lumber spine surgery	Difference in postoperative pain (NRS)	Bilateral RLB provides effective postoperative pain relief
Sandeep *et al.*[25]	Different regional technique	2224	Depend on the block technique	Depend on the block technique	Meta-analysis different regional analgesia techniques VATS	Opioids consumed in the first 24 hours	TPVB outstanding analgesic effects

fourth thoracic vertebra in terms of opioid consumption and postoperative pain scores. Additionally, it was also discovered early ICU discharge and early tracheal extubation. However, they have not calculated the minimum effective volume of local

anesthetic and suggested future studies. Wang *et al.*[18] compared the analgesic effects of the US-guided PVB with retrolaminar block in uniportal video-assisted thoracoscopic surgery (UVATS). Their primary outcome was postoperative pain score. They found that US-guided PVB appears to be a more effective analgesic approach than US-guided RLB. However, small sample size, the use of specific local anesthetic type, concentration, and volume preclude its applicability. An inconsistent conclusion can be made if the surgical procedure is altered to three-port thoracoscopic surgery or open thoracotomy. They have suggested further studies with large sample sizes with multiple ports for video-assisted thoracoscopic surgery (VATS).[18] Hwang *et al.*[19] assessed the analgesic efficacy of a single injection of US-guided RLB in a patient who underwent breast surgery. Their primary outcome was morphine consumption within 24 hours of the postoperative period. Their secondary outcomes included the total amount of morphine used after 48 hours of surgery, the VAS score during resting and coughing, and the occurrence of adverse events. They concluded that intraoperative remifentanil requirements and postoperative total morphine consumption were less in the RLB group than in the control group. However, they have not to study about the variation of local anesthetic spread in either vertical or paravertebral space due to anatomical anomalies in the pleural space or due to vertebral trauma. They have not studied the ideal timing and delivery method of local anesthetics for RLB require further investigation. Nobukuni *et al.*[20] examined the effectiveness of US-guided RLB and TEA in VATS. Their Primary objective was the median differences in pain score (NRS) between the TEA and RLB groups when they were resting on postoperative day 1 morning. In their study secondary outcomes were NRS scores at rest and when coughing, postoperative initial narcotic rescue usage, rescue analgesia, and adverse effects. They recommended that the analgesic effects of continuous US-guided RLB were non-inferior to those of TEA for minor VATS procedures. Limitations of their study included a small sample size and a lack of assessment of the dermatomal distribution of sensory block in both groups. Kamel *et al.*[21] compared US-guided bilateral retrolaminar block with US-guided thoracic epidural analgesia in order to reduce discomfort following laparoscopic cholecystectomy. Their primary objective was to compare postoperative pain by NRS. Secondary objectives were to compare the time for the first call of nalbuphine, the total amount of nalbuphine consumption in the first 12-hour postoperatively, patient satisfaction, and side effects. They concluded that retrolaminar block considerably reduces postoperative pain compared to thoracic epidural analgesia. Patients of both groups were satisfied with their analgesia. The limitation of their study is the lack of assessment of dermatomal distribution. Murouchi *et al.*[22] evaluated the analgesic efficacy and safety of retrolaminar block. Their Primary objective was postoperative analgesic consumption in the form of nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids. They concluded that continuous RLB was non-inferior to paravertebral (PVB) and provided satisfactory analgesia after mastectomy. RLB was safe as low peak serum levobupivacaine concentrations. The limitation of their study was the lack of measurement of dermatomal coverage of either block. They have suggested further research on continuous RLB for unilateral thoracic or abdominal surgery. Sotome *et al.*[23] compared the ESPB with the retrolaminar block for breast surgery. Their primary outcome was analgesic efficacy in terms of time to first postoperative rescue analgesic requirement. Their secondary outcomes were consumption of remifentanil during anesthesia, pain intensity at rest for 24 hours of the postoperative period, and occurrence of postoperative nausea and vomiting (PONV). They concluded that the RLB provided more effective analgesia than ESP. The limitation of their study included a lack of measurement of dermatomal coverage in both blocks. They suggested further clinical studies are needed to confirm the anatomical mechanisms of action of both blocks as well as the appropriate concentration and volume of local anesthetics required for adequate ESPB and RLB. Karaca *et al.*[24] studied retrolaminar block in lumber herniotomy. Their primary outcome was to evaluate the difference in the pain score (NRS) between groups in a postoperative period of 24 hours. Secondary outcomes measured in their study were the cumulative opioid consumption and requirement of tenoxicam as NSAIDs in postoperative period of 48 hours in a patient who underwent lumber spine surgeries. According to them, bilateral RLB provides effective postoperative pain relief for patients undergoing lumbar spinal surgery. The limitation of their study were the small sample size and lack of measurement of injected drug spread. Sandeep *et al.*[25] in a network meta-analysis compared different regional analgesia techniques in patients undergoing video-assisted thoracic surgery (VATS). Their primary objective was the number of opioids consumed in the first 24 hours of the postoperative period. They found that TPVB had outstanding analgesic effects and it ranked the highest in decreasing pain scores and lessening opioid consumption in the early postoperative period in comparison to intercostal nerve block (ICNB), retrolaminar block (RLB), and ESPB. However, their study has some limitations, they included only those RCTs that were conducted in VATS and provided inappropriate information about the technique of block and medication use.[25]

Future investigations and clinical indications

Anatomical studies have revealed lesser analgesic efficacy in comparison to PVB and TEA. This is because of the restricted dispersion of dyes in the paravertebral area. The

optimal volume and dose of local anesthetic for RLB have still not well established. Recently, it was discovered through the anatomical examination of RLB in pig cadavers that the dye seems to be distributed to the paravertebral area in a volume-dependent manner. The number of local anesthetics used will play a significant role in deciding the dermatomal coverage of RLB. Further investigation is needed to determine the appropriate volume of local anesthetic requirement for appropriate dermatomal coverage by RLB. Many more research are also required for the effectiveness of RLB in targeted populations like the elderly and pediatric age groups. The role of RLB in the intensive care unit and in truncal trauma have been poorly studied. RLB will be suitable for patients who are ambulatory or who have back pain; however, there is no evidence for chronic pain management further investigation is required.

Clinical application

1. The blockade's coverage should match the intended surgical site.
2. Various things could affect the blockade's consistency. The amount of paravertebral distribution of the injectate can have an impact on the effectiveness of paravertebral by proxies. In addition, improper injectate dispersion into the target plane due to a lack of sensitive control during needle tip insertion can compromise block consistency.
3. In order to maximize the effectiveness of multimodal analgesia, the somatic blockade may be combined with other analgesics since it does not ensure total analgesia for truncal surgery.
4. Functional or long-term clinical outcomes are limited, despite the fact that the research included in this review demonstrated excellent results for various truncal procedures. The results of RLB for truncal surgery demonstrate efficient analgesia and low procedure-related hazards. As a result, truncal surgery benefits from the application of RLB.

Conclusion

There is evidence that a retrolaminar block can effectively relieve pain during truncal surgery. RLB had a lower rate of complications, was simpler to perform, and required shorter hospital stays.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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