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Erector Spinae Plane Block: A Newer Regional Anesthetic Technique in Spine Surgery

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Abstract:

The erector spinae plane (ESP) block is a relatively new regional anesthetic technique that has gained increasing attention in spine surgery. It involves the injection of local anesthetic deep to the erector spinae muscle, targeting the dorsal and ventral rami of the spinal nerves. This approach provides effective analgesia, reduces perioperative opioid consumption, and improves postoperative recovery. Compared with traditional neuraxial blocks, ESP block is technically simpler, safer, and associated with fewer complications.

Keywords: Erector spinae plane block; regional anesthesia; spine surgery; analgesia; postoperative pain.

Introduction:

The management of perioperative pain in spine surgery remains a major challenge due to the extensive surgical exposure and significant postoperative pain experienced by patients. Inadequate pain control can delay mobilization, increase opioid requirements, and prolong hospital stay. Therefore, the introduction of safer and more effective regional anesthetic techniques is of high clinical importance **(1).**

The erector spinae plane (ESP) block, first described by **Forero et al. (2),** has emerged as a novel interfascial plane block technique. It involves injection of local anesthetic deep to the erector spinae muscle at the transverse process level, producing both dorsal and ventral rami blockade. This technique provides effective analgesia for thoracic, abdominal, and spine surgeries with a relatively simple and safe approach.

Several studies have demonstrated that ESP block reduces perioperative opioid consumption, improves postoperative pain scores, and facilitates early mobilization in spine surgery. Furthermore, it has been associated with fewer complications compared to traditional neuraxial or epidural blocks, making it a valuable alternative in multimodal analgesia strategies**(3).**

Despite its growing popularity, the use of ESP block in spine surgery is still evolving, with ongoing research needed to establish standardized protocols regarding drug volume, concentration, and level of injection. Nevertheless, current evidence suggests that ESP block is a promising technique that enhances postoperative recovery and patient satisfaction **(4).**

The Erector Spinae Plane (ESP) block is a newer regional anesthetic technique that can be used to provide analgesia for a variety of surgical procedures or to manage acute or chronic pain. The technique is relatively easy to perform on patients, and it is performable with minimal or no sedation in the pre-operative holding area. The ESP block can is possible either using a single-injection technique or via catheter placement for continuous infusion. The first report of the successful use of this procedure was in 2016; the block was used to manage thoracic neuropathic pain in a patient with metastatic disease of the ribs and rib fractures **(2).** Since then, the block has been reported to have been used successfully in a multitude of procedures including Nuss procedure, thoracotomies, percutaneous nephrolithotomies, ventral hernia repairs, and even lumbar fusions **(5).**

Indications and Choice of Level:

The use of ESP blocks for upper and lower thoracic surgeries have decreased the use of epidural and Paravertebral blocks. The rationale is augmented in less severe complications associated with the interfacial blocks, giving the potential to achieve greater patient access to regional analgesia. For major abdominal surgery, epidural analgesia continues to be highly used, but with enhanced recovery protocols, the practices are moving away from epidurals, so the use of interfacial plane blocks may represent an alternative. The ESP block can be used to deliver regional analgesia (with a multimodal analgesic approach) for a wide variety of surgical procedures in the anterior, posterior, and lateral thoracic and abdominal areas, as well as for management of acute and chronic pain syndromes (**Table 1**) **(6).**

Table (1): Level selection for erector spinae plane block, according to painful condition **(7)**

Spinal level	Pain condition		Volume
	Acute	Chronic	
High thoracic T2 or T3	Postsurgical shoulder pain	Chronic shoulder pain syndrome	20–30 mL
		CRPS upper extremity	
Mid-thoracic T4 to T6	Rib fracture (midpoint of the level of rib fracture)	Chronic post herpetic neuralgia (level of segment involved)	20–30 mL
	Open thoracotomy and VATS lobectomy(T5)	Chronic post-thoracotomy pain (level of segments involved)	
	Rescue after thoracic epidural for thoracic surgery(T5)	Metastatic rib cancer (level of segments involved)	
	Cardiac surgery sternotomy (T5)		
	Breast surgery with axillary lymph node dissections (T3)		
Low thoracic T7 to T12	Nephrectomies (T8) Hysterectomies (T10) Laparoscopic ventral hernia repair with mesh (T7) Laparotomies (T7)	Chronic post herpetic neuralgia (level of segment involved)	20–30 mL
		Chronic abdominal pain syndrome (T7 to T10)	
		Chronic pelvic pain syndrome (T10)	
Lumbar (L4)	Vertebral surgery (midpoint of levels involved)	Postsurgical hip replacement pain management (L4)	20–30 mL

Also, the ESP block placed at the most upper thoracic segments (T1–T2) could provide coverage up to cervical nerve roots giving analgesia for shoulder pain. Usually, the level chosen for thoracic indications is between T2 and T5 and for abdominal or pelvic indications is between T7 and T10. Despite its extensive spread, it is recommended to perform an ESP block at a vertebral level congruent to the thoracic or abdominal surgical incision, rather than relying on adequate spread of the local anesthesia **(8).**

Contraindications:

Infection at the site of injection in the paraspinal region or patient refusal, are absolute contraindications for performing an ESP block. Also, Anticoagulation may be a relative contraindication to ESP block, although there are no specific guidelines. The most recent 2018 ASRA consensus statement does not specifically address paraspinal blocks and anticoagulation **(9).**

Mechanism of Action of the ESP Block:

At present, there are three likely mechanisms by which ESP injection of local anesthetic may produce analgesia. The first is that local anesthetic penetrates anteriorly into the Paravertebral and epidural space containing spinal nerves and dorsal and ventral rami, through fenestrations in the connective tissues that span

adjacent transverse processes and ribs. There are several structures that constitute this "Intertransverse tissue complex," including not only the superior costotransverse ligament (usually singled out as the layer that must be pierced to enter the Paravertebral space when performing a thoracic Paravertebral block) but also Intertransverse and costotransverse ligaments, as well as levatorcostarum and rotator costarum muscles.

The dorsal rami and accompanying vessels traverse this barrier and provide at least one pathway for injectate to flow anteriorly into the Paravertebral space, from where it can spread laterally into the intercostal space and medially into the epidural space. This has been demonstrated in magnetic resonance imaging of both fresh cadavers and live subjects **(10).**

Second, the dorsal rami are blocked as they ascend through the lake of local anesthetic deposited in the ESP. Third, because the ESP is contiguous laterally with the plane deep to serratus anterior muscle and superficial to the ribs and intercostal muscles, local anesthetic spreading laterally within this plane can potentially reach and anesthetize lateral cutaneous nerve branches. It should be further noted that at low thoracic and lumbar levels, the ESP is also contiguous with the plane between Quadratus lumborum and erector spinae muscle, and thus it may share a common mechanism of action with the posterior Quadratus lumborum block **(11, 12).**

The current cadaveric evidence clearly indicates that local anesthetic can reach the Paravertebral space from the ESP. The question that remains is to what extent and how consistently this occurs. This is best answered by studies of clinical effect. It is logical to expect that only a fraction of the injected dose of local anesthetic will enter the Paravertebral and epidural space, yet this may still be sufficient for analgesia. This hypothesis is supported by clinical evidence for the ESP block that points to action on the ventral rami and intercostal nerves, rather than merely the lateral cutaneous branches. The extent of sensory blockade exceeds the physically detectable extent of injectate spread even in thoracic Paravertebral blockade, and this likely reflects the fact that smaller or unmyelinated nociceptive nerve fibers may be blocked by relatively small amounts of local anesthetic **(13).**

Technique:

- **Preparation:**

The ESP block can be performed using a single-injection technique or via catheter placement for continuous infusion. After informed consent and peri-procedural "time-out," standard patient monitoring should be placed. Intravenous access should be obtained, and resuscitation equipment, including vasopressors and medications for local anesthetic toxicity, should be available. The procedure is performed with standard prep, the use of sterile gloves, surgical cap, mask, and sterile ultrasound probe cover for imaging. Linear probe (7–12 MHz) is usually sufficient. For high BMI, a curvilinear (2–6 MHz) is recommended. The typical needle is 22-gauge 50–100 mm needle (depending on body habitus). When catheter insertion is considered, perineural (catheter through needle or needle over catheter) or regular epidural catheter can be considered **(14).**

- **Procedure:**

Position the patient in sitting or prone position, depending on the operator and patient's comfort. A lateral decubitus could be an alternative when performing the block after general anesthetic induction or when the patient is unable to tolerate sitting or prone position. The ultrasound probe is placed at the selected level of the spine using a longitudinal parasagittal approach, approximately 3 cm lateral to the spinous process. The level is identified by counting from cephalad to caudad, starting from the first rib and descending caudally to the desired level (**Fig.** 1). This level is followed medially to identify the corresponding transverse process. The location could be established using the transverse process counting cephalad from the 12th rib **(15).**

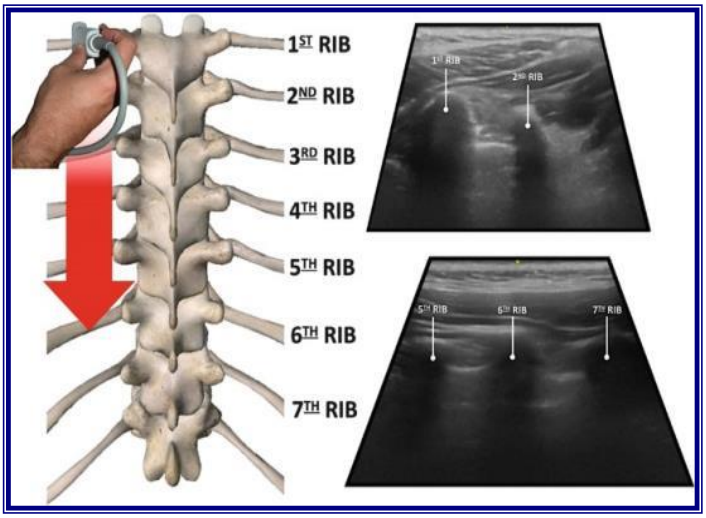

Figure (1): Process for the recognition of the level before the realization of the erector spinae plane block **(16).**

The transverse process requires differentiation from the rib at that level. The transverse process will be more superficial, wider, and square-shaped, while the rib will be thinner and semicircular-shaped (**Fig.2** a, b). Alternatively, the transverse process can be visualized by a transverse approach over the spinous process in the midline, and the lamina, transverse process, and rib are seen laterally (**Fig. 3**). After all the structures are seen, the probe is rotated in a parasagittal orientation with the tip of the transverse process as the target **(15).**

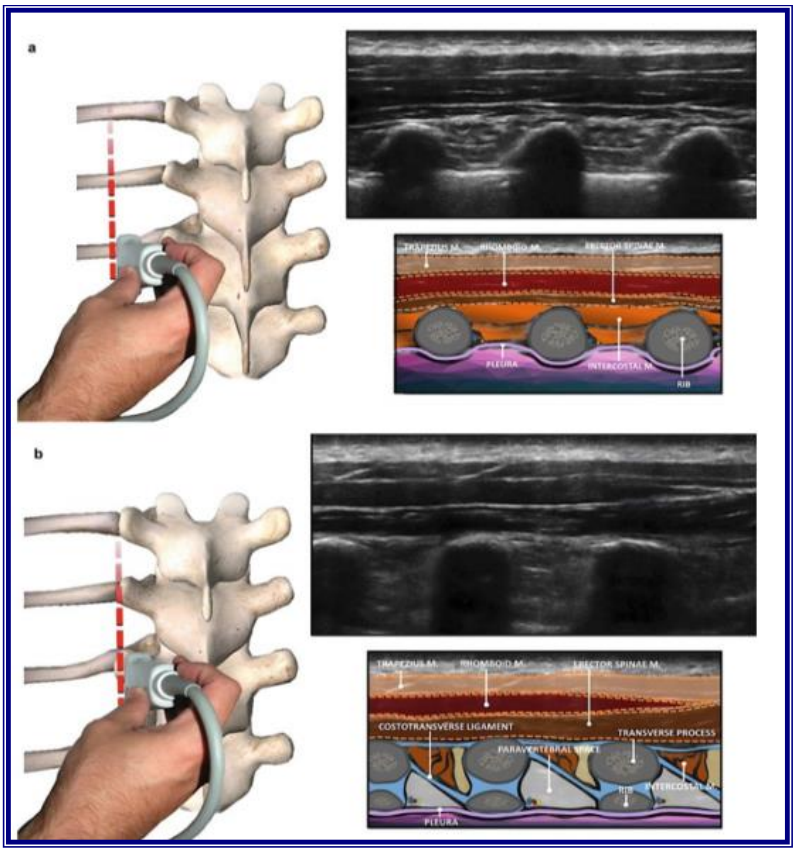

Figure (2): (a) Sonographic appearance of the rib. The rib is smaller, thinner, and semicircular in shape and deepens toward the posteromedial planes. (b) The transverse process is more superficial, wider, and square-shaped. The structures in the sonogram are indicated in the schematic diagram **(17).**

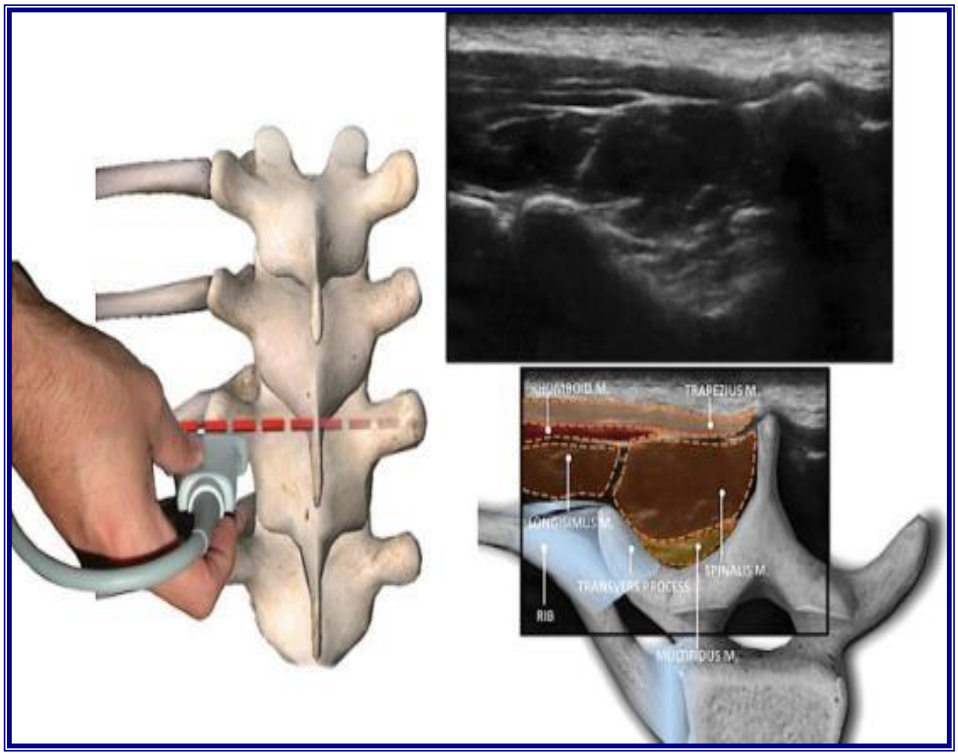

Figure (3): Transverse view of the spine. This approach can help to better characterize the structures and differentiate the transverse process from adjacent structures, such as the lamina and rib **(16).**

The trapezius, rhomboid major, and erector spinae muscles are identified superficial to the tip of the transverse process in the upper/mid-thoracic area. Following skin infiltration with lidocaine, insert the needle using an in-plane superior-to-inferior approach to place the tip into the fascial plane on the deep (anterior) aspect of erector spinae muscle. The location of the needle tip is confirmed by visible fluid lifting the erector spinae muscle off the bony shadow of the transverse process (**Fig. 4**). The injection superficial to this fascial layer, inside the muscle fibers, produces an erroneous image similar to that seen with an interfacial injection, known as lamination (**Fig. 5**) **(18).**

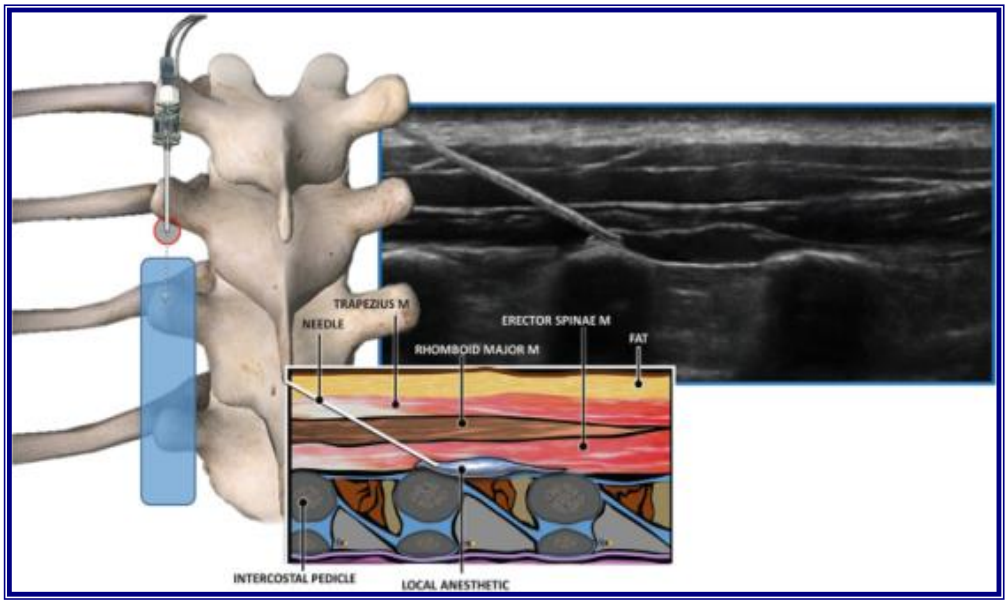

Figure (4): Needle insertion in ESP block **(7).**

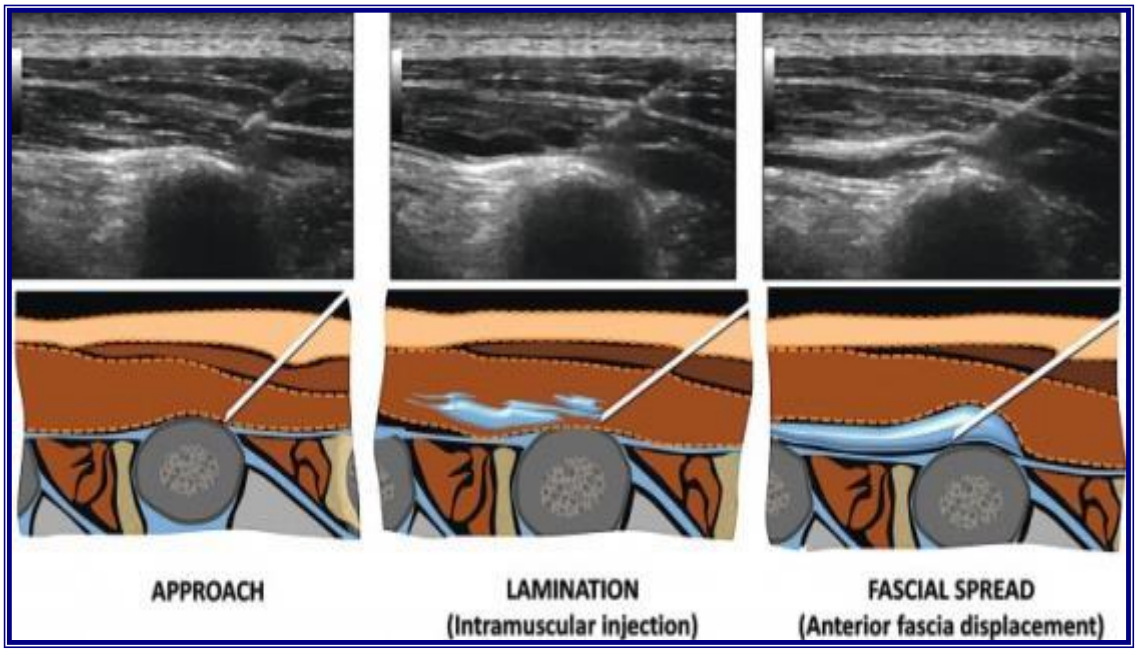

Figure (5): In a parasagittal approach, lamination mimics an interfacial spread, but the injectate is inside the muscle and needs needle repositioning. With a transverse approach, the needle placed intramuscularly results in circumferential spread, which is less likely to be confused with interfacial spread, but need needle repositioning **(16).**

A total of 20 to 30 mL of local anesthesia is injected in 5-mL aliquots through the needle with frequent aspiration to prevent intravascular injection. If a continuous technique is desired, insert the catheter trough the needle under direct vision 3 to maximum 5 cm beyond the needle tip keeping always in mind to leave the tip of the catheter at the surgical indicated level (**Fig. 6**). After the catheter is secured in place, a patient-controlled local anesthetic infusion regimen is started with a background infusion of at least 8 mL/h of 0.2% Ropivacaine and 5 mL bolus with a lockout interval of 30 to 60 minutes **(7).**

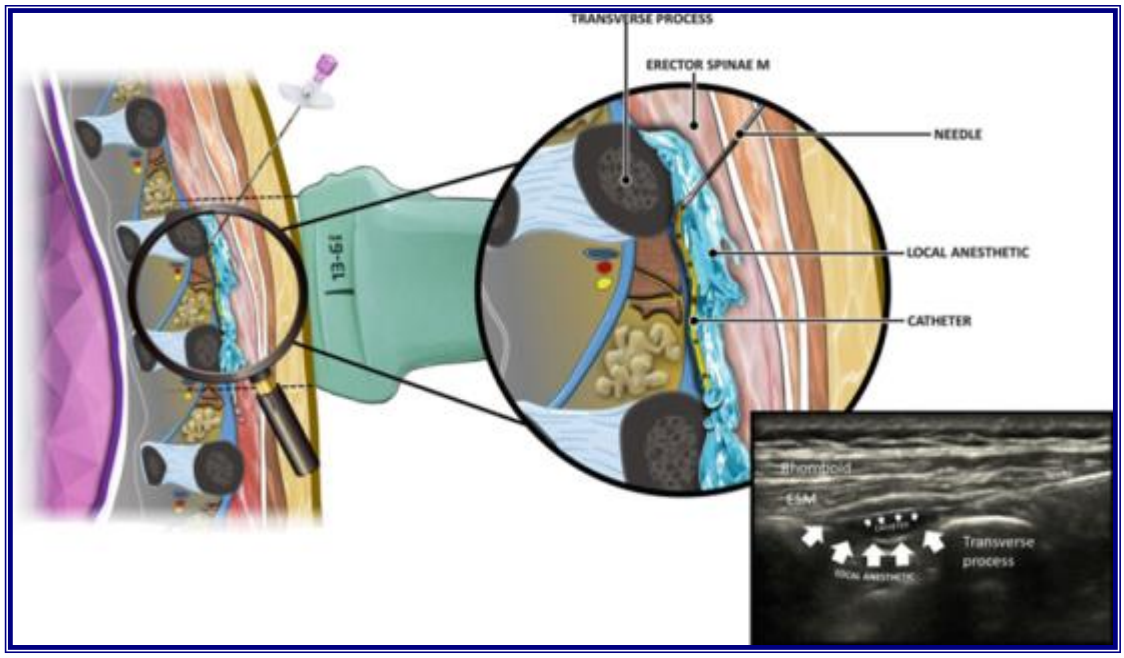

Figure (6): Catheter insertion in ESP **(7).**

Safety and Complications Associated with ESP block:

One of the reasons for the popularity of the ESP block is the large margin of safety it provides with regard to serious complications. The target for needle insertion is relatively superficial and distant from discrete nerves, major blood vessels, the epidural space, and the pleura. As mentioned above, the ESP block has been successfully performed in anticoagulated patients; in our opinion, as long as significant benefit is anticipated, its use can be justified by the low risk of hemorrhage, hematoma formation, and neural compression. Although spread to the epidural space has been reported with the ESP block, this only represents a small fraction of the total injected dose. As a result, clinically significant sympathectomy and hypotension are unlikely and have not been reported in the literature **(12, 19).**

The transverse process is an easily visualized landmark and provides a backstop to prevent inadvertently advancing the needle too far. These advantages are particularly relevant in pediatric patients, where blocks often have to be performed under general anesthesia and a high degree of skill is required to safely perform epidural or Paravertebral blocks. Nevertheless, suboptimal needle visualization and handling can still result in injury, as evidenced by one report of pneumothorax **(20).**

The most significant risk is that of local anesthetic systemic toxicity, which is a result of injecting large doses of local anesthetic into richly vascularized musculofascial tissues. Although pharmacokinetic studies have not yet been published for the ESP block, the profile is likely to be similar to other fascial plane blocks such as the Transversus Abdominis plane and rectus sheath block. Studies in these blocks have shown that peak plasma concentrations reached 30–45 min after injection and can be attenuated by the routine addition of epinephrine. The following measures should therefore always be employed when performing ESP blocks: (1) keep local anesthetic dose to maximum recommended weight-based limits, (2) add epinephrine to the local anesthetic solution, (3) monitor vital signs for at least 30 min after the block, and (4) have resources in place to manage LAST **(21).**

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