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Erector Spinae Plane Block: Review Article

Ahmed Mahmoud Azmy*, Abdelrahman Hassan Abdelrahman, Fawzy Abbas Badwy, Wael Alham Mahmoud, Al Haitham Mohamed Taha
Anesthesia, Intensive Care and Pain Management, Faculty of Medicine, Sohag University, Egypt
***Corresponding author:** Ahmed Mahmoud Azmy, **Mobile:** (+20) 01004793896, **E-Mail:** ahmedazmy19692@yahoo.com

ABSTRACT

Background: Erector Spinae Plane Block (ESPB) belongs to the family of fascial plane blocks in which local anesthetic is injected into a plane between two layers of fascia and subsequently spreads to nerves located within that plane or within adjacent tissue compartments. ESPB has been used in pain management, cervical, thoracic and cardiovascular surgeries.

Objective: The goal of this narrative review article is to go through the pertinent anatomy, explain how the injectant spreads, show several ways to erector spinae plane block, and summarise case studies and clinical trials.

Conclusion: Because the craniocaudal and vertical spread of local anesthetics and sensory block are not well understood or predicted, it appears that, unlike other blocks, the mechanism of erector spinae plane block and spread of local anesthetics will be decided by clinical data.

Keywords: Erector Spinae Plane Block, Pain management.

INTRODUCTION

Erector Spinae Plane Block (ESPB) is one of the fascial plane blocks, in which local anesthetic is injected in plane between two fascial layers, afterwards extends to nerves situated inside that plane or neighboring tissue compartments [(1)].

It is classified as a paraspinal block due to the location of injection above the vertebral transverse processes, and the local anesthetic is administered underneath the erector spinae muscle and superficial to extremities of the transverse processes (TPs) [(2)].

Forero *et al.* [(3)] initially reported two methods for applying local anesthetic. The first is an application into the interfascial plane between the rhomboid major and erector spinae muscles, while the second is an application deep into the erector spinae muscle.

The authors stated that the first method may be inadequate and that more efficacy might be obtained by injecting the drug deep in erector spinae muscle at interfascial plane [(4)].

In a postoperative analgesic procedure with a child having surgery for the funnel chest, the rhombus major and erector spinae method was found to have experienced bilateral ESPB [(5)].

Due to a deep interfascial level with the erector spinae, bilateral ESPB was performed [(6)].

Anatomic features of erector spinae plane block:

The spinae erector is an anatomical word that describes a three-fold muscle group: iliocostalis lumborum, longissimus thoracis and spinalis thoracis. These muscles are derived from the transverse processes of ribs, thoracic and lumbar and inserted on the sacrum and ilium [(7)]. The erector spinae constitute a paraspinal muscular column that overlooks the osteoporosis laminae and transverse events, along with the more medial transversal-spinalis group of muscles next to spinal processes. The muscles lie in a complex integrated sheet of aponeuroses and fasciae (a retinaculum) that runs from the sacrum to the base of the crane, which is synonymous to the thoracolumbar fascia in the lower parts of the retinaculum [(8)]. This fascial column envelope makes it possible to distribute fluid into the deep ESP from a single injection site in cranial-caudal direction, which is one of the distinctive qualities of ESPB [(1)].

Shortly after the intervertebral foramen emerges, each thoracolumbar spinal neuron splits in dorsal and ventral ram. The rear ram goes backwards and divides the back tissue in medium and side branches. In the intercostal area between the internal and the most intercostal muscles the ventral rami T1–T12 runs down the inside side of the rib. This gives rise to different musculoskeletal branches and lateral cutaneous branches of ripple angle as shown in **Figure (1)** [(1)].

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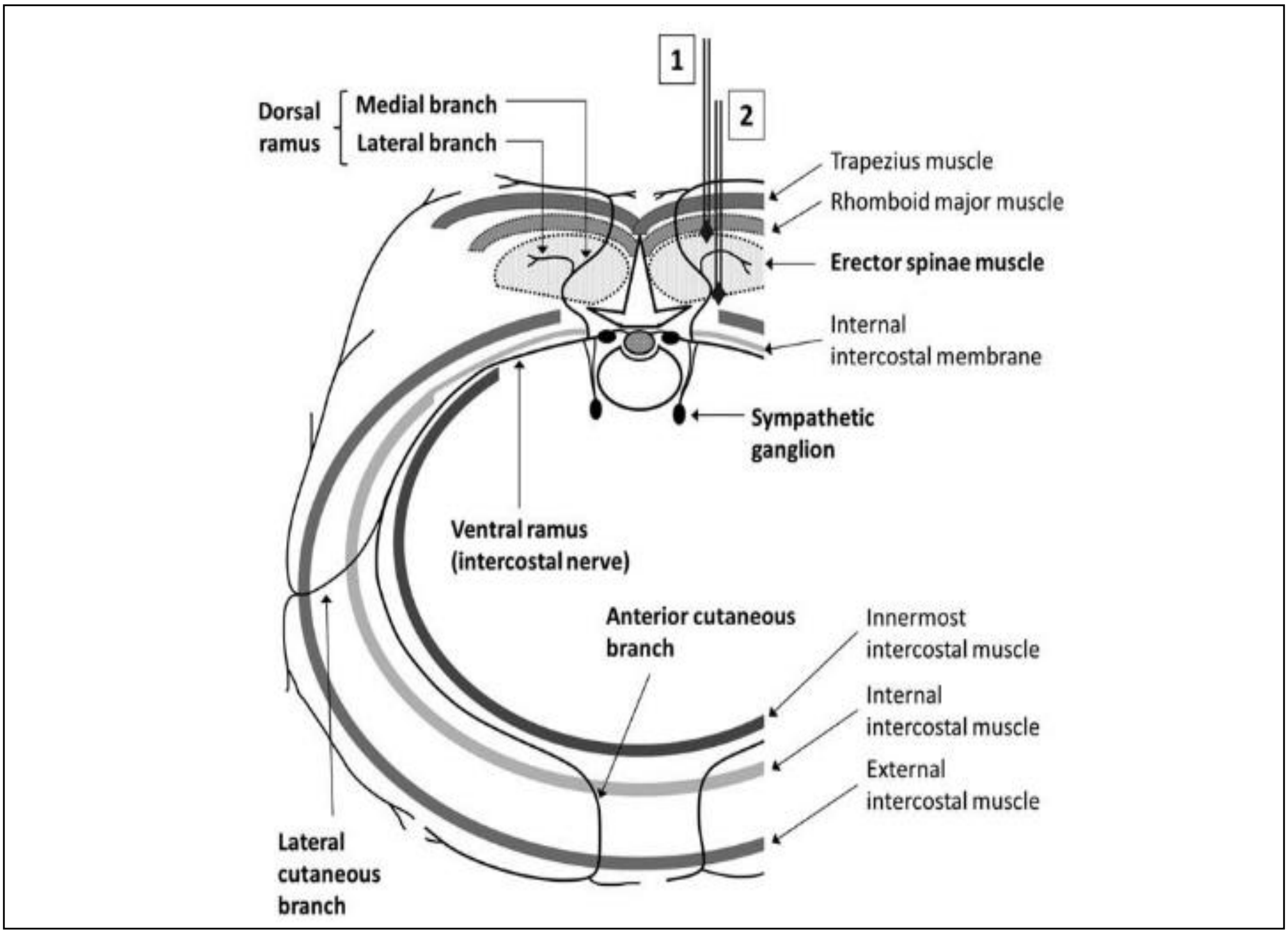

Figure (1): Anatomy of erector spinae plane [1]

Mechanism of action of erector spinae plane block:

There are now three probable mechanisms in place to induce analgesic ESP injection of local anesthesia [1].

The first is that local anesthetics enter in advance via fenestrations of the connective tissues that cover neighbouring transverse processes and ribs into the PV and epidural areas that contain vertebral nerves and dorsal and ventral rams.

This "intertransverse tissue complex" consists of numerous components, involving not just superior cost-transverse ligament, but also the intertransverse ligaments as well as the cost-arum levator and rotator muscles. The dorsal ram and the accompanying ships cross the barrier and offer at least one route of injecting the injectate into the photovoltaic space from whence it may laterally expand to the intercostal and medial space. This is seen in both fresh and living individuals in magnetic resonance imaging [5]. The second, the dorsal rami are blocked as they ascend through the lake of local anesthetic deposited in the ESP [6].

Thirdly, since the ESP is sideways to the earth and is superficial to both ribs and intercostal muscles and deep to the serratus anterior muscular plane, it may perhaps reach and treat lateral skin nerve branches laterally inside this plane [9-11]. Moreover, the ESP is also adjacent to the plane between quadratus lumborum and the erector spinae muscles at low thoracic and lumbar levels, and thus it may have a similar mechanism of action with posterior quadratus lumborum block [7].

Approaches, sonography and technical features:

The first description of the ESPB was that the US probe should be placed at a lateral 2.5–3 cm in the spinal process, at 4th and 5th thoracic vertebral level, into a parasagittal plane (**Figure**) [8].

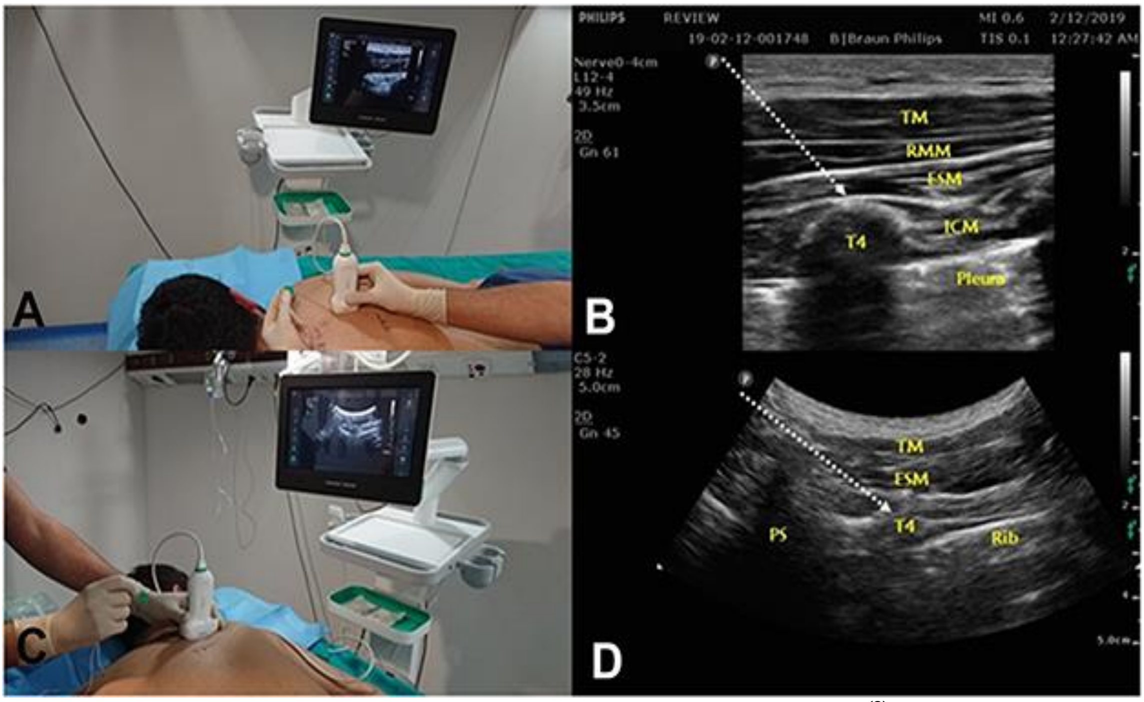

Figure (2): Approach of erector spinae plane block [8]

(A): The ultrasonic transducers location and orientation during an upper thoracic parasagittal scan with the patient in the prone position. **(B)** Parasagittal ultrasound image of upper thoracic ESPB. **(C)** The location and direction of the ultrasound transducer with the patient in prone position during a transverse analysis of upper thoracic area. **(D)** Upper thoracic ESPB transverse ultrasonic imaging. Indicates needle in white arrow. T4, thoracic 4 vertebrae transverse process; TM, trapezius muscle; RMM, rhomboid major muscle; ESM, erector spinae muscle; ICM, intercostal muscle.

It must be borne in mind that transverse process across T2 and T6 levels is three layers of muscle, while the lower the layers are two because of the absence of rhomboid muscle [8]. The cross approach method was then defined as putting the United States son on the cross plane as well as inserting needle using in-plane method from the lateral direction to the medium **(Figure**) [9].

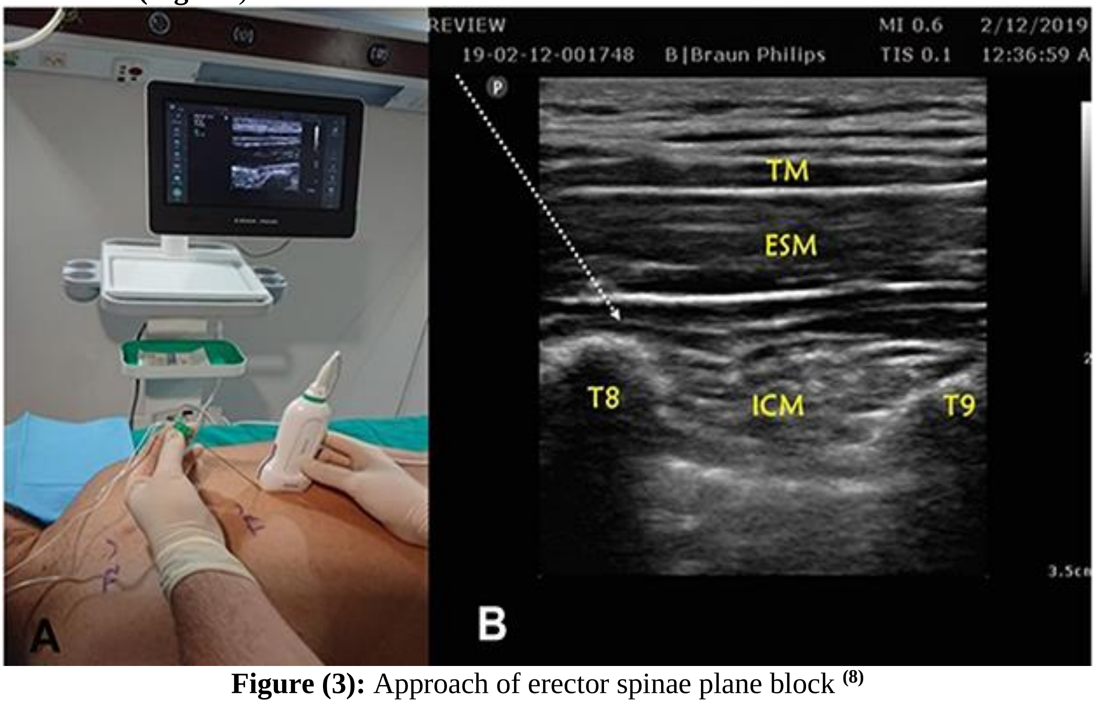

Figure (3): Approach of erector spinae plane block [8]

(A**):** Posture and positioning of the ultrasonic transducer with the patient in its prone position during the parachute scan of the mid-thorax area. (B**):** Mid-thoracic erector spinae block ultrasonography parasagittal picture. Indicates needle with white arrow. T, transverse process; TM, trapezius muscle; ESM, erector spinae muscle; ICM, intercostal muscle.

Yörükoğlu ***et al.*** **[10] (Figure 3)** presented a method that's safe and simple for conducting the bilateral ESPB utilizing one needles insertion over spinous process, progressed medium and sideways on both sides (**Figure**).

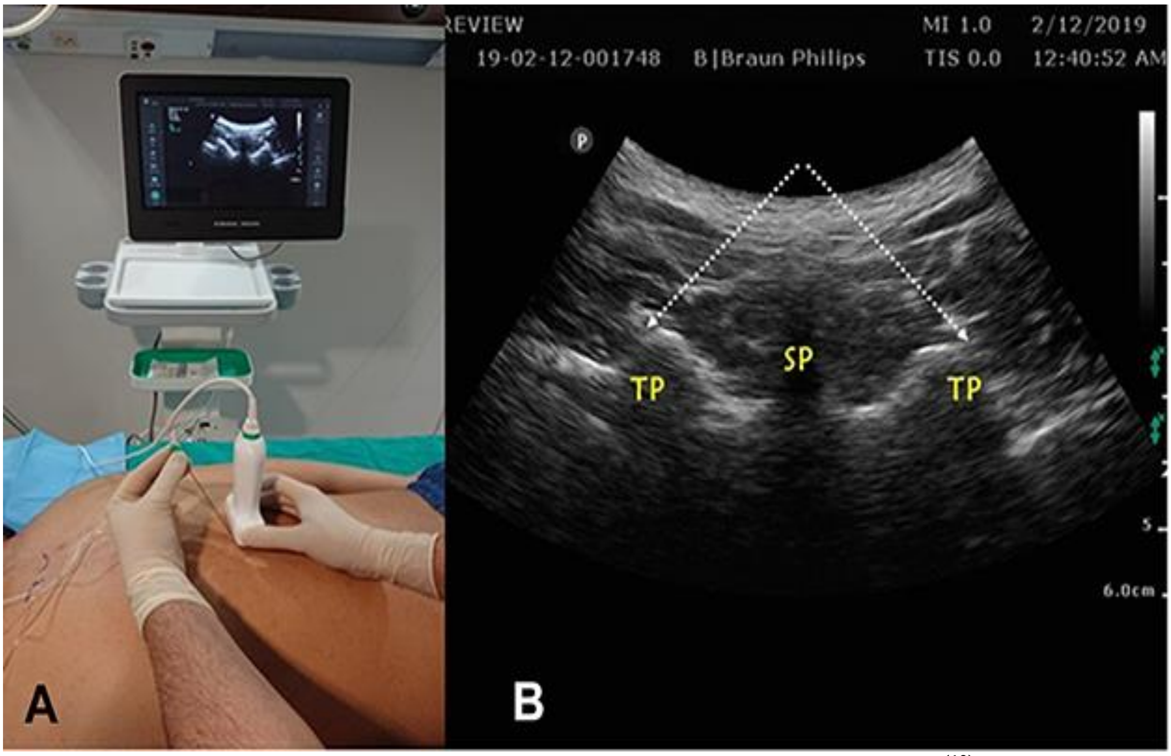

Figure (4): Yörükoğlu approach of erector spinae plane block [10]

(A): Position and orientation of an ultrasonic transducer at the level of the spinal process via **Yörükoğlu** method through a mid-thoracic transverse scan. **(B):** The mid-thoracic, bilateral erector spinae block's transverse ultrasound picture. Indicates needle with white arrow. TP, transverse process; SP, spinous process.

The ESPB was initially reported in the lateral hip-operation for the lumbar area, utilising the in-plane method, to advance the needle craniocaudally. The out-plane method subsequently became a common technique for the ESPB in the parasagittal plane [11].

Given that lumbar ESPB needs more insertion of the needle in comparison with chest ESPB, several methods are inevitable. A change to the Shamrock lumbar ESPB method under US supervision on the lateral position was presented as an easily executed alternative in lumbar ESPB (Aksu technique) (**Figure**) [9].

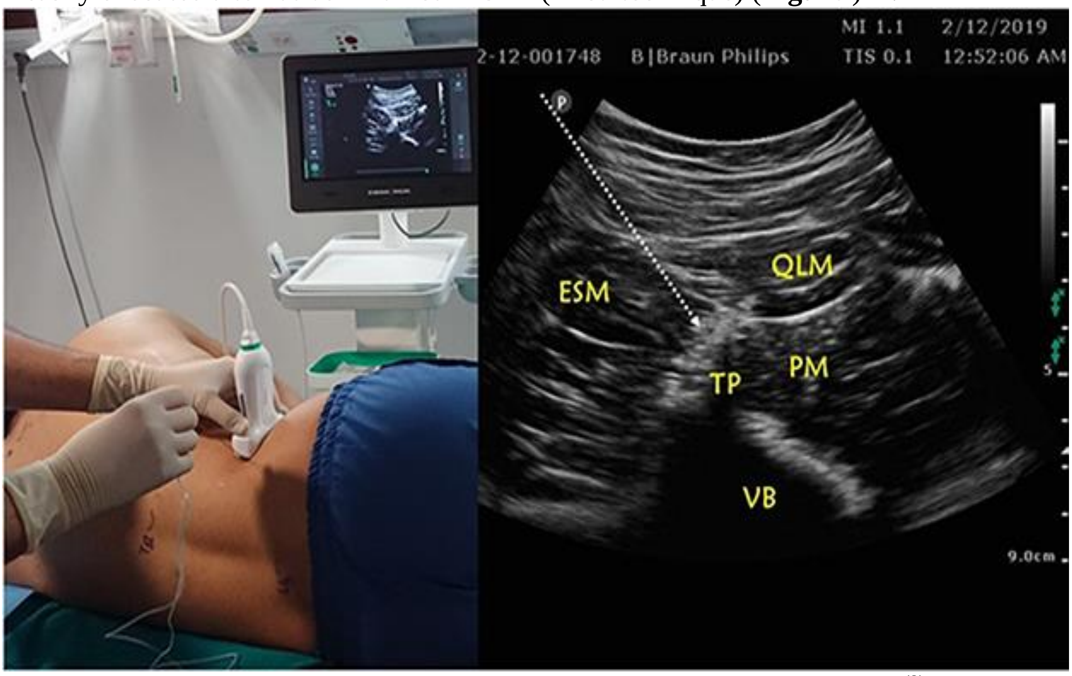

Figure (5): Aksu/Cassai approach of erector spinae plane block [9]

(A): The curvilinear ultrasound transducer is positioned and oriented throughout a transverse scan of the lumbar area above the iliac crest with the patient in the lateral decubitus posture. **(B):** Images of the shamrock sign and the Aksu methods for ESPB in posterior axillary line over iliac crest on ultrasound. The needle is indicated with a white arrow [9]. TP, transverse process; QLM, quadratus lumborum muscle; ESM, erector spinae muscle; PM, psoas muscle; VB, vertebral body.

The Tulgar method is another modification/approach for lumbar ESPB, in which local anesthetic is given to posterior and anterior of lumbar transverse process, that enjoys greater probability of ensuring block distribution (**Figure**) [11].

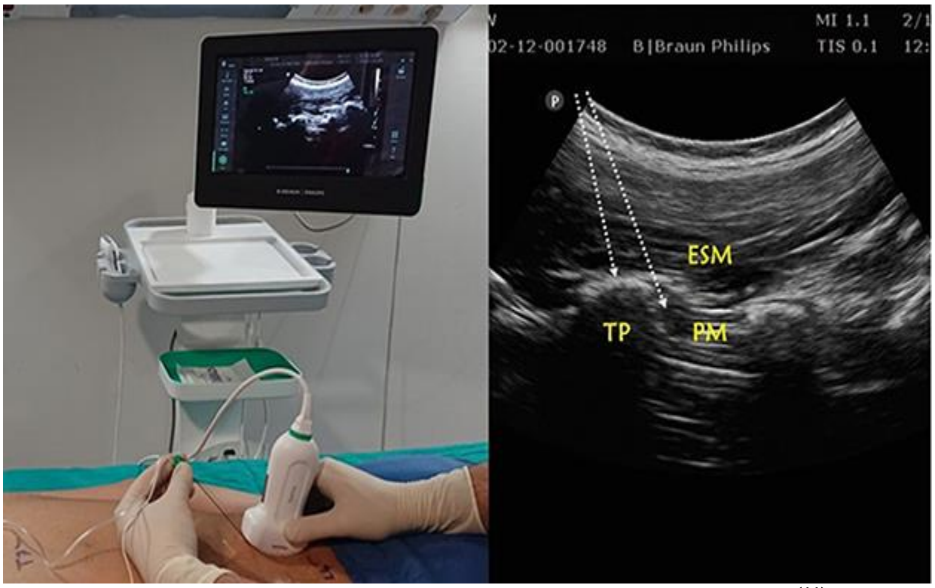

Figure (6): Tulgar approach of erector spinae plane block [11]
(A) Position and direction of the ultrasonic transducer at prone parasagittal scan of lumbar region. **(B)** Tulgar approach ultrasound pictures for lumbar ESPB. The white arrow denotes a needle with an in-plane approach. TP, transverse process; ESM, erector spinae muscle; PM, psoas muscle.

Technique:

A. Positioning:

The bilateral ESPB positioning varies depending on the location and method used, however for thoracic and lumbar ESPB, the sitting, side, or pronated positions are usually used. The lateral decubitus posture is utilized in Aksu [9], Tulgar [11] methods. It is conceivable that the patient's posture during ESPB may influence the distribution of local anesthetic and therefore the efficiency and reliability of the procedure. There have been no research that have looked into this impact [8].

B. Transducer selection and needle orientation:

The most regularly used technique with the thoracic region is the high-frequency linear probe, but obese individuals may need a curvilinear (2–5 MHz) probe. A curvilinear (2–5 MHz) probe is recommended when using Aksu [9], Yörükoğlu [10]**, or** Tulgar [11], methods. When inserting the needle for thoracic or lumbar applications, the in-plane or out-of-plane method should be utilized based on the physician's expertise.

Needle length and gauge:

Although the needle length may vary according to application locations and patient characteristics, usually, for chest applications a needle of 22 G measure 50, 80 or 100 mm is utilized, while for lumbar or other applications a needle of 22 G measurement of 80–100 mm is used [8-12].

Catheterization:

The literature documented the catheter usage in bilateral thoracic ESPB. In individuals having heart operations, catheterization studies have been recorded with bilateral ESPB [13-16]. There have been reports of case series of catheters in bilateral ESPB applications in children with the programmed application of intermittent bolus, as well as of continuous or intermittent use of local anesthesia via thoracotomy catheter, laparoscopic gastric operation, abdominal operation, radical prostatectomy or lumbosacral surgery leading to an effective post-operation analgesia [17-18]. There have been reports of single faces of lumbar catheterization [19].

The authors' own experiences are the basis for reports and related characteristics of catheterization (e.g., local anesthetic concentration, infusion or duration between boluses and the first dose). No research comparing two different modalities were carried out [8].

Local anesthetic volume and concentration:

The most essential variables for ESPB, like other plane blocks, are local volume anesthetic and concentration. Flat blocks rely on volume, hence dermatomal coverage rises as volume increases. ESPB applications with 10-40 mL quantities have been conducted. The volume has been calculated based on the weight of the kid when pediatric cases are examined. In general, this dose is 0.5 mL/kg without exceeding the local anesthesia limit. Ropivacaine, levobupivacaine, bupivacaine (at 0.5%, 0.25%, or 0.375%) and lidocaine (at 0.5%) were found to be local anesthesia agents (1 percent or 2 percent concentration) [8].

When a local anesthetic agent is selected, a suitable single-shot agent should be selected that would remain below the maximum daily dose. For surgical anesthetic, higher levels may be needed, whereas for after-operative analgesia lower amounts are necessary. The addition of dexamethasone to the peripheral nerve blocks has been shown to enhance the blocking time, including the use of dexamethasone in chronic, neuropathic, myofascial and lower back pains for ESPB. In the early 12 hours with a numerical rating scale (NRS) scoring < 3 in the first 24 hours, ESPB with dexamethasone was reported as substantially increased analgesia without the need for analgesics [(14)].

Indications:

I. Pain management:

Lower cervical in addition to interscapular myofascial pain and chronic back pain have been used with bilateral ESPB. In a patient with lumbar vertebra transverse fracture [(13, 21)], bilateral ESPB was also utilized for efficient and lengthy analgesics. For effective hyperalgesia analgesia induced by acute pancreatitis, bilateral ESPB was reported [(15)].

II. Cervical surgeries [(16)]:

III. Thoracic and cardiovascular surgeries:

For usage in thoracic and cardiovascular operations, bilateral ESPB has been most frequently documented. It was initially described for the postoperative analysis of chest wall deformation needs, such as funnel chest as well as pectus carinatum, and then in more complex operations, such as video-assisted thoracotomy, thoracostomy and esophagectomy thoracotomy [(17)].

The bilateral ESPBs utilized in cardiovascular surgery have been case reports as well as clinical trials. For the first 9 hours after the aortic valve replacement operation, bilateral ESPB resulted in no analgesia required [(18)].

In a randomised controlled study, bilateral ESPB was assessed in patients having emergency cardiac operations, and it was discovered that during the first 12 hours the total rescue analysis, opium and NRS ratings were decreased and also intubated [(19)].

IV. Breast [(20)] and thoracic [(8)] surgeries.

V. Open abdominal surgeries and cesarean sections [(21)].

VI. Laparoscopic abdominal surgeries [(8)].

VII. Spinal surgeries [(22)].

VIII. Pediatric surgeries:

In the majority of instances, the abdominal methods were used with some ESPB findings on thoracic, cardiac and urological operations, reporting effective postoperative analgesia and reducing needs for rescue analgesia [(23)].

IX. Renal surgery:

Visceral pain originating in kidneys, ureters, as well as somatic pain from incision site are the primary causes of acute pain following percutaneous nephrolithotomy (PCNL). Renal pain takes place in the vertebral nerves of T10–L1 and the ureter pain in T10–L2 takes place in the spine. In addition, cutaneous innervation of incision site is mostly provided via T10–T11 (T8–T12) because of its typical usage at 10^{th}–11^{th} intercostal region or subcostal zone in the incision site and tract for PCNL [(24)].

X. Rib Fractures:

The analgesic results and impact on breathing volumes for patients with traumatic border fractures were investigated in a retro-local cohorts research at the level 1 trauma hospital in Pennsylvania. Statistically substantial reduction of the maximum NRS pain values and a 12 hour reduction in opiate use in patients receiving ongoing technology (yet this wasn't statistical significance). The mean blood pressure in any patients hasn't changed. Those with one-injection ESPB had less persuasive overall findings. The authors found that ESPB is the main regional intervention at their hospital for rib fracture patients. The advantages were also proposed for the safety profile of individuals with neuraxial and peri-neuraxial contraindications (i.e. anticoagulated patients) [(25)].

XI. Lower Limb Surgery:

The analgesic effectiveness of lumbar ESPBs for patients having hip and femur operations was investigated in a randomized, controlled, double-blind trial. The authors discovered that patients who received ESPBs had substantially lower pain ratings at first 6 hours and consumed significantly less tramadol over the course of a 24-hour period than those who received conventional intravenous analgesia. The ESPB was compared to quadratus lumborum blocks, which had comparable outcomes. The findings indicate that lumbar ESPBs, as part of multimodal analgesic approach, may offer effective analgesia during hip and femur surgery. Given the possibility of local anesthetic spreading into the epidural region, lumbar techniques to ESPB may result in lower limb paralysis [(26)]. **Selvi and Tulgar** [(27)] reported the transitory biological lower limb weaknesses case report after a T11 ESPB.

XII. Novel Uses:

There are many case reports and short series with favorable results in the literature. Patients having upper limb and spine surgery were examined by clinicians for the efficacy of the ESPB [(28)]. There is also a case report that suggests that method is effective in the refractory stress headache [(29)]. It could be used for upper arm surgery [(30)]. It may also be utilized in chronic pain treatment (refractory neuropathic thorax pain) [(31)], chronic shoulder pain [(32)] and PHN [(33)]).

Complications:

The bilateral ESPB hasn't been specifically complicated. Pneumothorax is the first documented ESPB consequence. Bilateral engine weakening in lower-extremity patients who have had a caesarean section following bilateral ESPB has been documented, however it is debated whether this can be termed a consequence of ESPB [(27)]. ESPB administered at lower or lumbar thoracic concentrations has been found to have comparable effects to lumbar plexus block [(34)]. While motor weakness is usually not seen as a problem, it's undesirable occurrence. Thus, patients undergoing lower chest or lumbar ESPB should be carefully assessed for motor weakness. One confirmed and two suspected smaller instances of CNS toxicity to local anesthetic are described in a single-center study of 182 patients with ESPB [(8)]. After a single-sided ESPB from 4th lumbar level an instance of priapism has been recorded [(35)].

CONCLUSION

Because the craniocaudal and vertical spread of local anesthetics and sensory block are not well understood or predicted, it appears that, unlike other blocks, the mechanism of erector spinae plane block and spread of local anesthetics will be decided by clinical data.

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