

# Erector Spinae Plane Block for Perioperative Analgesia in Percutaneous Nephrolithotomy

Manar Atef Abdellatif, Ahmed Mohamed Salama, Kamelia Ahmed Abaza, Reham Mohamed Mohamed Aamer

Anesthesia & Surgical Intensive Care Department, Faculty of Medicine, Zagazig University, Egypt

Corresponding author: Manar Atef Abdellatif

E-mail: [manaratef1718@gmail.com](mailto:manaratef1718@gmail.com), [MAHasan@medicine.zu.edu.eg](mailto:MAHasan@medicine.zu.edu.eg)

**Conflict of interest:** None declared

**Funding:** No funding sources

## Abstract

The erector spinae (ES) is a large and superficial muscle that lies just deep to the thoracolumbar fascia and arises from the erector spinae aponeurosis (ESA). The erector spinae plane block (ESPB) is a novel technique in which local anesthetic (LA) is deposited in the fascial plane deep to the erector spinae muscle and superficial to the tip of the transverse process. ESP was recently introduced as an alternative to postoperative analgesia in surgical procedures including thoracoscopies and mastectomies. The ESP block is a novel ultrasound-guided interfascial technique serendipitously discovered while treating thoracic neuropathic pain in an adult patient. Percutaneous nephrolithotomy (PCNL) is the standard urologic procedure used to disintegrate and remove large kidney stones. There are few clinical trials regarding erector spinae plane block in percutaneous nephrolithotomy. The aim of our study was to review the role of ESP as perioperative analgesia for patients who undergoing to PCNL.

**Keywords:** Perioperative Analgesia; Erector Spinae Plane Block; Percutaneous nephrolithotomy

**Tob Regul Sci.™ 2023;9(1): 3202-3208**

**DOI: [doi.org/10.18001/TRS.9.1.224](https://doi.org/10.18001/TRS.9.1.224)**

## Introduction

The muscles of the back categorize into three groups. The intrinsic or deep muscles are those muscles that fuse with the vertebral column. The second group is the superficial muscles, which help with shoulder and neck movements. The final group is the intermediate muscles, which help with the movement of the thoracic cage. Only the intrinsic muscles are considered true back muscles [1].

The two muscles in the superficial layer include the splenius cervicis and splenius capitis. They help with movements of the shoulder and neck [2].

The intermediate muscles are the erector spinae. They include the longissimus, iliocostalis, and spinalis muscles. Their attachments subdivide these muscles, and they all have a common tendinous origin. They play a role in the movement of the thoracic cage and flexion of the upper vertebral column and head [3]

The intrinsic/deep muscles are well developed and extend from the skull base to the sacrum. These deep muscles are enclosed by fascia. The deep back muscles are posterior to the erector spinae. They are short muscles associated with the spinous and transverse processes of the vertebrae. The three deep muscles of the back include the semispinalis, multifidus, and rotatores. These muscles stabilize the vertebral column and play a role in proprioception and balance. Moreover, these muscles help with the movements of the vertebral column and maintain posture [4].

As the muscles of the back develop, they extend caudally. The origins and insertions are described as though the fibers run caudocranially. In this manner, origins are inferior to their insertions [5].

The ESA is a common aponeurosis that blends with the thoracolumbar fascia, with a proximal attachment on the sacrum and the spinous processes of the lumbar vertebrae [6].

The ES is formed of 3 muscles with its fibres run more or less vertically throughout the lumbar, thoracic and cervical regions. It lies in the groove to the side of the vertebral column [7]. Its muscle mass is poorly differentiated, but divides into three sections in the upper lumbar area named iliocostalis which present in laterally; longissimus which is the intermediate column, and Spinalis which present in medial aspect [8].

### **Post percutaneous nephrolithotomy analgesia**

Percutaneous nephrolithotomy (PCNL) is today the gold standard for the management of patients with renal calculi as it is less invasive than the open surgery, less time consuming, and is associated with less chances of infection. It is also associated with lower morbidity and faster recovery. [9].

There are multiple methods to diminish the intensity of postoperative pain. It may be lowered after tubeless and totally tubeless procedures or applying a smallbore nephrostomy tube . Scientific findings support using paravertebral block or epidural anesthesia before PCNL to minimize the postoperative pain .Local injection of analgesic drugs is also effective for this treatment. Preventive preoperative intravenous or subarachnoid spinal analgesia was also described [10].

Skin infiltration with local anesthetic has not proven very effective after PCNL; however, infiltration of renal capsule has shown to facilitate painless insertion of nephrostomy tube [9].

Epidural anesthesia and paravertebral blocks are considered effective pain treatment that lowers postoperative opioid consumption and the rate of complications caused by these drugs .However, they require well-trained medical personnel as there is a risk of significant complications .To maintain the benefits of regional anesthesia while diminishing the possible complications, fascial plane blocks were evaluated and proved effective [11].

Analgesics such as non-steroidal anti-inflammatory drugs and opioids have side effects that limiting their use in patients with potential renal problems.[ [11].

### **Erector Spinae Plane Block**

The ESP block is a novel ultrasound-guided interfascial technique serendipitously discovered while treating thoracic neuropathic pain in an adult patient [12].

Erector spinae plane block (ESPB) was recently introduced as an alternative to postoperative analgesia in many surgeries including ventral hernia, thoracoscopy and thoracic vertebra surgery, cholecystectomy, and mastectomy [12].

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 [13]. This interfascial block is hypothesised to target the ventral - and dorsal rami of spinal nerves, as the block is performed in a tissue plane deep to the erector spinae muscle [14].

Local anaesthetic is deposited deep to the erector spinae muscle, yet superficial and lateral to the tips of the transverse processes [15].

The therapeutic effect of the ESP block is attributed to the craniocaudal spread of anaesthetic over multiple vertebral levels within the tissue plane [16].

Absorption and diffusion of anaesthetic across intersecting tissue planes also play a role in the extent and quality of the block. Furthermore, the block has been reported to successfully manage acute and chronic pain for truncal procedures as it blocks both visceral and somatic pain [17].

There is a hypothesis that the multi-dermatomal sensory block is due to the cranial and caudal spread of the injected local anesthetic. This spread is aided by the thoracolumbar fascia, which extends across the posterior thoracic wall and abdomen [17].

The local anesthetic spread extended 3 or 4 levels cranially and caudally from the site of injection. The reported mechanism of action is the diffusion of the injected local anesthetic through the connective tissues and towards the spinal nerve roots [18].

A more recent study described the transforaminal and epidural spread of the local anesthetic during ESP block using MRI. The authors noted that ESP block might be advantageous to other thoracic interfascial plane blocks because of this spread and the resultant abdominal visceral analgesia [19].

### **Indications of ESP:**

The ESP block can be used to deliver regional analgesia for a wide variety of surgical procedures in the anterior, posterior, and lateral thoracic and abdominal areas, as well as for the management of acute and chronic pain syndromes. The vast majority of indications for ESP block have their basis in case reports and anecdotal clinical experience [20].

### **Contraindications of ESP:**

Infection at the site of injection in the paraspinal region or patient refusal, are absolute contraindications for performing an ESP block. 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 [20].

### **Technique of ESP:**

The ESP block is most often performed between the T5-T7 paraspinal levels, but it can be performed at lower levels as well. The curvilinear ultrasound transducer should be placed in a cephalocaudal orientation over the midline of the back at the desired level. The probe should then slowly be moved laterally until the transverse process is visible. The transverse process requires differentiation from the rib at that level. The transverse process will be more superficial and wider, while the rib will be deeper and thinner. Upon verification of the transverse process, the trapezius muscle, rhomboid major muscle (if performing at T5 level or higher), and erector spinae muscle should be identified superficial to the transverse process. The Tuohy needle should be inserted superior to the ultrasound probe using an in-plane approach in the cephalad to caudal direction. The bevel of the Tuohy needle should point posteriorly and inferiorly, and advance under ultrasound guidance through the trapezius muscle, rhomboid major muscle, and erector spinae muscle and towards the transverse process; once the needle tip is below the erector spinae muscle, a small bolus of local anesthetic should be given through the Tuohy needle. The erector spinae muscle should be visualized, separating from the transverse process. This separation from the transverse process confirms the proper needle position. The local anesthetic should then be injected in 5 ml increments, with aspiration after every 5 ml to prevent intravascular injection. Between 20 and 30 ml of 0.25% bupivacaine or 0.5%, ropivacaine should be used [21].

### **Complications of ESP:**

Complications are very rare because the site of injection is far from the pleura, major blood vessels, and the spinal cord. Infection at the needle insertion site, local anesthetic toxicity/allergy, vascular puncture, pleural puncture, pneumothorax, and failed block are the primary complications. Because of the few published data, more investigations (e.g., randomized controlled trials, RCTs) are needed to verify the safety, complications rates, and efficacy of this strategy. A recent evidence-based study, indeed, identified only four RCTs and their endpoints were heterogeneous [22].

### **Advantages and disadvantages of ESP:**

The main appeal of the ESP block is the ease of application. With the aid of ultrasound guidance, bony landmarks and anatomical structures are easily identifiable [23].

The ease of identification reduces procedure time, as well as the potential for failed blocks. Furthermore, the entire course of the needle and eventual endpoint can be constantly viewed, allowing the practitioner to avoid important anatomical structures in the area [24].

The ESP block carries a lower risk of clinical complications as the needle is inserted into a tissue plane that is a safe distance from that of the parietal pleura, neuroaxis and major neurovascular structures [25].

Additionally, by allowing the tip of the needle to make contact with the transverse process, it acts as a natural barrier and further provides a guide to the appropriate depth of insertion in children of different sizes, contributing to the safety of the block [26].

Since the block has the ability to cover multiple dermatomal levels from a single injection, the block can be performed at a different vertebral level than the level of the surgical site, thereby avoiding wound dressing or surgical incision [26]. This block also allows for the use of catheter insertion for intermittent boluses and continuous infusion of regional anaesthesia [27].

The ESP block is linked to reduced opioid requirement, as there is ongoing analgesic coverage into the post-operative period. Another advantage is that the patient can be positioned in various ways, including prone, lateral decubitus or leaning forward in a seated position and the recently described dry leaf technique (semi-lateral position) [27].

However, as with most regional blocks, there is a risk of systemic toxicity, for which authors suggest routinely adding epinephrine when introducing large doses of anaesthesia for this block [28].

Although there haven't been any reported incidences, put forward a theoretical possibility that the ESP block may negatively affect the spinal biomechanics and further impact stable, non-displaced vertebral fractures brought about by muscular relaxation from the block. Furthermore, the ESP block is not contraindicated for anti-coagulated patients, unlike the epidural block [29].

### **Conclusion:**

Spine plane block (ESP) block holds promise as a simpler, safer alternative to thoracic epidural or paravertebral block because the sonographic target is easily visualized, and the site of injection is distant from the neuroaxis.

In addition, ESP block is an effective pain treatment after percutaneous nephrolithotomy but only for a short postoperative period.

### **No Conflict of interest.**

### **References:**

- [1] Frank H. and Netter MD (2006). Atlas of Human Anatomy; 4(6):140-166.
- [2] Dieterich, A. V., Andrade, R. J., Le Sant, G., Falla, D., Petzke, F., Hug, F., & Nordez, A. (2017). Shear wave elastography reveals different degrees of passive and active stiffness of the neck extensor muscles. *European journal of applied physiology*, 117, 171-178.

- [3] Hansen, L., De Zee, M., Rasmussen, J., Andersen, T. B., Wong, C., & Simonsen, E. B. (2006). Anatomy and biomechanics of the back muscles in the lumbar spine with reference to biomechanical modeling. *Spine*, 31(17), 1888-1899.
- [4] Bakkum, B. W., & Cramer, G. D. (2014). Muscles that influence the spine. *Clinical Anatomy of the Spine, Spinal Cord, and Ans*, 98-134.
- [5] Creze M, Soubeyrand M, Gagey O. 2019; The paraspinal muscle-tendon system: Its paradoxical anatomy. *PLoS One*. 14(4):e0214812
- [6] Schlesinger, S. M., Fankhauser, H., & De Tribolet, N. (1992). Microsurgical anatomy and operative technique for extreme lateral lumbar disc herniations. *Acta neurochirurgica*, 118, 117-129.
- [7] Willard, F. H., Vleeming, A., Schuenke, M. D., Danneels, L., & Schleip, R. (2012). The thoracolumbar fascia: anatomy, function and clinical considerations. *Journal of anatomy*, 221(6), 507-536.
- [8] Mekonen, H. K., Hikspoors, J. P., Mommen, G., Eleonore KÖhler, S., & Lamers, W. H. (2016). Development of the epaxial muscles in the human embryo. *Clinical Anatomy*, 29(8), 1031-1045.
- [9] Geeta P Parikh, Veena R Shah, Manisha P Modi, and Nikhil C Chauhan (2011) The analgesic efficacy of peritubal infiltration of 0.25% bupivacaine in percutaneous nephrolithotomy *J Anaesthesiol Clin Pharmacol*. Oct-Dec; 27(4): 481–484.
- [10] Piotr Bryniarski, Szymon Bialka , Michal Kepinski, Anna Szelka-Urbanczyk(2021) : Erector Spinae Plane Block for Perioperative Analgesia after Percutaneous Nephrolithotomy *International Journal of Environmental Research and Public Health* 18, 3625
- [11] McCartney, C.J.L.; Mariano, E.R (2016): Education in Ultrasound-Guided Regional Anesthesia: Lots of Learning Left to Do. *Reg. Anesth. Pain Med*. 41, 663–664.
- [12] Govender, S., Mohr, D., Bosenberg, A., & Van Schoor, A. N. (2020). A cadaveric study of the erector spinae plane block in a neonatal sample. *Regional Anesthesia & Pain Medicine*, 45(5), 386-388.
- [13] Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ 2016. The Erector Spinae Plane Block: A Novel Analgesic Technique in Thoracic Neuropathic Pain. *Reg Anesth Pain Med*. Sep-Oct; 41(5):621-7
- [14] Chin KJ, El-Boghdadly K 2021. Mechanisms of action of the erector spinae plane (ESP) block: a narrative review. *Can J Anaesth*. Mar; 68(3):387-408.
- [15] Muñoz, F., Cubillos, J., Bonilla, A. J., & Chin, K. J. (2017). Erector spinae plane block for postoperative analgesia in pediatric oncological thoracic surgery. *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*, 64, 880-882.
- [16] López, M. B., Cadórniga, Á. G., González, J. M. L., Suárez, E. D., Carballo, C. L., & Sobrino, F. P. (2018). Erector spinae block. A narrative review. *Cent Eur J Clin Res*, 1(1), 28-39.

- [17] Chin KJ, Adhikary S, Sarwani N, Forero M. 2017 The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. *Anaesthesia*. Apr;72(4):452-460
- [18] Hamilton DL, Manickam B. 2017 Erector spinae plane block for pain relief in rib fractures. *Br J Anaesth*. Mar 01;118(3):474-475
- [19] Schwartzmann A, Peng P, Maciel MA, Forero M. 2018 Mechanism of the erector spinae plane block: insights from a magnetic resonance imaging study. *Can J Anaesth*. Oct;65(10):1165-1166
- [20] Krishnan S, Cascella M. Erector Spinae Plane Block. [Updated 2023 Jan 8]. In: StatPearls [Internet]
- [21] Chin, K.J., Adhikary, S.D. & Forero, M.( 2019) Erector Spinae Plane (ESP) Block: a New Paradigm in Regional Anesthesia and Analgesia. *Curr Anesthesiol Rep* 9, 271–280
- [22] De Cassai A, Bonvicini D, Correale C, Sandei L, Tulgar S, Tonetti T 2019. Erector spinae plane block: a systematic qualitative review. *Minerva Anesthesiol*. Mar;85(3):308-319
- [23] Jinn, C. K., & Kariem, E. B. (2021). Mechanisms of action of the erector spinae plane (ESP) block: a narrative review. *Canadian Journal of Anesthesia*, 68(3), 387-408.
- [24] El-Boghdadly K, Pawa A. 2017; The erector spinae plane block: plane and simple. *Anaesthesia* 72(4):434–8
- [25] Fusco P, DI Carlo S, Scimia P, Luciani A, Petrucci E, Marinangeli F. 2017; Could the new ultrasound-guided erector spinae plane block be a valid alternative to paravertebral block in chronic chest pain syndromes? *Minerva Anesthesiol* 83(10):1112–3
- [26] Ma, Y., Lin, L., Xiao, K., Luo, Z., & Jin, T. (2022). Efficiency and Safety of Erector Spinae Plane Block in Percutaneous Nephrolithotomy: A Meta-Analysis Based on Randomized Controlled Trials. *Urology*, 168, 64-71.
- [27] Yang HM, Choi YJ, Kwon HJ, O J, Cho TH, Kim SH. 2018 Comparison of injectate spread and nerve involvement between retrolaminar and erector spinae plane blocks in the thoracic region: a cadaveric study. *Anaesthesia*.;73:1244–50.
- [28] Restrepo-Garces CE, Chin KJ, Suarez P, Diaz A 2017;. Bilateral continuous erector spinae plane block contributes to effective postoperative analgesia after major open abdominal surgery: a case report. *A A Case Rep*. 9:319–21
- [29] Restrepo-Garces, C. E., Chin, K. J., Suarez, P., & Diaz, A. (2017). Bilateral continuous erector spinae plane block contributes to effective postoperative analgesia after major open abdominal surgery: a case report. *A & A case reports*, 9(11), 319-321.