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Stranger things: the erector spinae block, extra sensory perception, or paranormal block by proxy?

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Abstract

The erector spinae plane block remains a divisive regional technique which has split the regional anesthesia community into believers and non-believers. Its main mechanism of action remains controversial and this has been pivotal in the controversy. We explore our current understanding of fascial plane blocks and erector spinae blocks as well as explore the gaps in knowledge. This opinion paper is meant to give a balanced view of the current state of this block in regard to guidelines, research and future. The viewpoint of the authors may not necessarily align with current ideas, however, hopefully will guide subsequent trials to more robust evidence.

Keywords Erector Spinae Plane block, Locoregional anesthesia, Pain management

"The task is…not so much to see what no one has yet seen; but to think what nobody has yet thought, about that which everybody sees" Erwin Schrodinger 1933 Nobel prize for Physics

1 Introduction

Surgical (r)evolution from open techniques to laparoscopic and robotic interventions have forced us to radically innovate our postoperative pain management strategies. Neuraxial techniques, once the flagships of acute pain therapy, have been largely replaced by fascial plane blocks. The focus on faster mobilisation, reduced complication rate and easy to learn regional anaesthetic techniques has fuelled this (still) ongoing quest. Following the initial development of thoracic and abdominal wall blocks a myriad of new approaches were published refining and perfecting the original ideas. Anatomical dye studies investigating the working mechanisms accompanied this groundwork. Randomized control trials (RCT) soon followed, examining efficacy and safety. The erector spinae plane block (ESPB) is currently one of the most used techniques; however, it is also highly controversial due to severe shortcomings in our understanding of its exact mechanism of action. In this opinion paper we investigate current understanding, the benefits and shortfalls and the future of this divisive technique.

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2 Discussion

2.1 Fascial plane blocks

Despite ongoing research of ESPB, like some other fascial plane blocks (e.g., quadratus lumborum blocks (QLB), it has not been linked to a consistent and reliable paravertebral spread covering visceral pain. Acute postoperative pain consists of somatic, visceral, and referred pain. Early visceral pain is associated with an increased risk of developing chronic pain, and so, its control in the acute postoperative phase is of utmost importance [1]. The extent of somatic analgesia of most fascial plane blocks (FPBs) depends largely on the exact anatomical point of injection, the volume of local anesthetic used and the spread

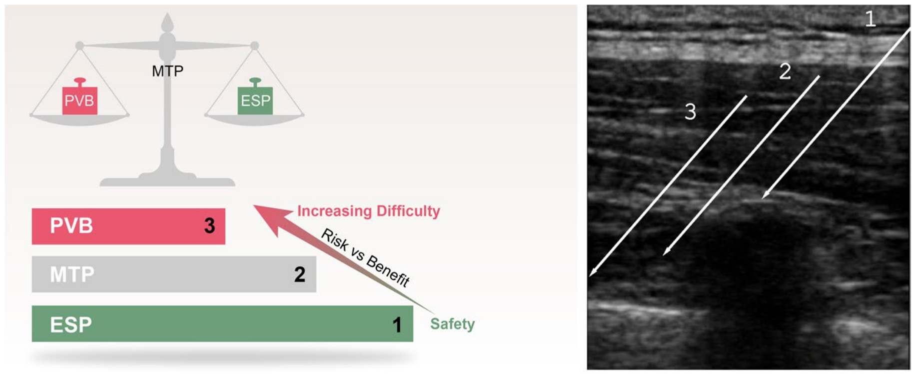

Fig. 1 Steppingstone theory, figure adapted by the UZ Leuven local group. With permission and special thanks to Amit Pawa and Ki Jinn Chin

of the injectate [2]. The development of high-resolution ultrasound machines has allowed us to better quantify and measure this spread, however, fascial microstructures are complex and variable. This may lead to the huge variance in efficacy seen in ESPB.

The proposed mechanism of action of fascial plane blocks are through local effects on nociceptors and neurons within the fascial plane itself, or within adjacent tissue compartments [3]. The extent of spread, analgesia, and cutaneous sensory loss is variable. These variations may be due to anatomical variations, factors governing fluid dispersion, and local anaesthetic pharmacodynamics. Another proposed mechanism of action is of vascular absorption of local anaesthetic providing systemic analgesia. Robust evidence is unavailable but early investigations may suggest that FPBs can produce transient elevations in plasma concentrations, similar to intravenous infusion of local anaesthetics [4]. The exact contribution of local versus systemic actions to the total analgesic effect is uncertain and a topic of robust debate.

Paravertebral blocks (PVB) were first documented in 1905 and had varying levels of popularity over the next century [5]. The thoracic paravertebral space begins at T1 and extends caudally to T12. There is no direct communication between adjacent levels in the cervical and lumbar paravertebral regions and therefore most PVBs are performed in the thoracic region. Indications for PVB are numerous and include analgesia for acute postoperative pain, trauma or relief of chronic pain of the trunk. Advantages include delivering analgesia comparable with thoracic epidural while minimising risks associated with neuraxial techniques [6]. In spite of these advantages, widespread clinical implementation of the PVB has been hampered by a manifold of roadblocks. Ultrasound guided needle visualisation, steep angle approach and adjacency of the pleura are but a few of the common issues. Although hypotension and motor block occurrence are much less pronounced than following thoracic epidural placement, these can still occur. The ESPB and mid-point transverse process to pleura block (MTP) were recently described as "paravertebral blocks-by proxy" and should be evaluated in this light [7]. However ingenious this steppingstone theory might sound, the authors have yet to see any proof of ESPB and MTP training leading to progressive quality and skill level of PVB placements (Fig. 1).

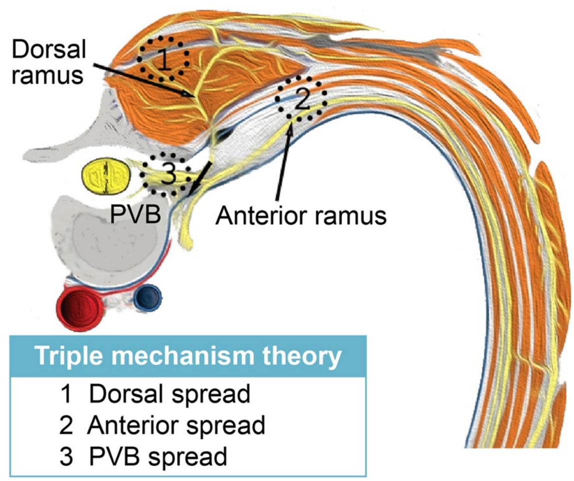

Fig. 2 Triple action of the ESPB, figure copyright by the UZ Leuven local group

2.2 Erector spinae plane block

The ESPB originally published in 2016 by Forero et al. described its use for post thoracotomy neuropathic pain [8]. ESPB follows a triple theory model (ventral, dorsal rami and paravertebral spread, Fig. 2). By targeting the space between the erector spinae muscle sheath and the transverse process of a vertebra, the injected agent spreads craniocaudally, resulting in the blockade of multiple vertebral levels. Injectate spreads anteriorly into the paravertebral space where it can theoretically block not only the dorsal and ventral rami, but also the rami communicantes. This pattern of spread suggests the potential to confer both somatic and visceral analgesic effects [9].

There is considerable debate surrounding the ability of the ESPB to reliably block the ventral rami. In fact, several cadaveric studies revealed less than 50% coverage [9–11]. The variability in ventral spread may be explained by numerous factors, including anatomical factors, (variance, exact point of injection), microscopic fascial plane factors, and even physiological factors (e.g., the impact of negative pressure and respiration on spread of local anaesthetic) [3]. Future research should focus on several of these key issues. Dynamics of local anaesthetic spread in the clinical setting should also be considered. For example, where ESPB catheters are placed for continuous analgesia, the method of delivery in terms of continuous infusion as compared to intermittent bolus delivery may contribute to variability in spread. Programmed intermittent bolus of local anaesthetic via the epidural space has become the preferred method of drug delivery for labour analgesia [12]. The theory being that intermittent bolus administration of larger drug volumes leads to a larger spread, thus conferring the potential to anaesthetise nerve roots which are more distal to the catheter tip than via slow continuous infusion. The benefits of intermittent bolusing techniques should be investigated in terms of spread of FPBs including ESPB. Finally, while cadaveric studies provide the potential to dissect the ESP space and its surrounding tissues, they are limited by a number of factors including the dynamics of spread of local anaesthetic in the moving postoperative patient. Studies with magnetic resonance imaging (MRI) and computerized tomography (CT) of ESPB have revealed various patterns of spread including spread to the paravertebral and epidural spaces [13-16]. All CT and MRI studies of course rely on imaging of the supine patient and therefore may fail to reveal real world dynamic spread in the patient who is likely sitting or ambulatory during their infusion of local anaesthetic in the postoperative phase. In contrast to CT and MRI, ultrasound studies may provide dynamic measurements of the spread of local anaesthetic during the bolus administration of local anaesthetic into the ESP space.

The ventral rami innervate the ribs, skin and muscles on the lateral and anterior aspect of the trunk, while the dorsal rami innervate the dorsal ribs, skin and post-vertebral muscles. Dorsal ramus blockade via ESPB is much less contentious. Numerous cadaveric and radiological studies have proven the spread of injectate to the dorsal rami following ESPB [17-19]. Indeed, the authors are unaware of any well conducted studies which dispute these findings. It is the opinion of the authors that this reliable dorsal spread defines the best indication for the ESPB. Examples of clinical indications relating to the ventral ramus include in the treatment of posterior rib fractures and to provide analgesia for major spine surgery. The benefits of the ESPB for posterior rib fractures when neuraxial/paravertebral techniques are contraindicated have been extensively published, although there seems to be no clear advantage over other FPBs like the serratus anterior plane block (SAPB) [20] Our clinical practice is thus to favour ESPB for the treatment of posterior rib fractures, and the use of SAPB for management of anterior rib fractures. Complex spine surgery is well-known for its painful nature, requiring high dose opioids, with the potential, infrequently, to lead to chronic opioid use and dependency [21]. During major spine surgery for decompression or fusion, the paraspinal muscles are split and retracted. These muscles and the overlying skin are reliably innervated by the dorsal rami. Applying regional anaesthesia can be an attractive alternative to reduce overall opioid needs and ESPB seems a perfect fit. Several randomised control trials appear to confirm this [22, 23].

While the mechanism of action of ESPB in spine surgery seems rather robust, its success in other surgeries of the trunk seems more variable. The authors have conducted RCT's on ESPB for cardiac surgery resulting in mixed results [24]. In contrast, the authors have also conducted an RCT in thoracic patients which revealed improved quality of recovery scores using ESP blocks when compared to PVB blocks [25]. Reports of its efficacy in relieving visceral pain post laparoscopic cholecystectomy are limited due to the quality of study design [26]. Despite the lack of quality papers or current published guidelines (except for a recent PROSPECT review), the ESPB has been suggested as an appropriate analgesic modality for a vast number of clinical indications, from thoracic to cardiac, to laparoscopic and pelvic surgeries and even hip and knee surgeries [27-30].

The recent ESPB for VATS PROSPECT recommendation might have come as a surprise for some, considering the conflicting evidence surrounding anterior rami spread. PROSPECT has a robust and methodical working mechanism. However they are limited to the current literature. Publication bias where positive RCT's get published first is certainly a possibility, future updates may reflect upon this.

In our opinion the staggering number of case-series, case reports and anecdotal papers recounting the ESPB's clinical efficacy in a wide and varied number of clinical indications has been detrimental to its reputation [31, 32]. While we do believe that there is a definite value to specific case reports, the efforts should be focused now on more robust evidence, well conducted RCTs, safety evaluation and multicentre trials. As with all pain studies the primary outcome is not all that easy to determine [33]. Quality of recovery scoring, opioid consumption and long-term pain outcomes should be considered by researchers and clinicians alike. Awareness of a possible placebo effect when placing an awake block must be considered when drawing out a strategy for future research [34].

A few ESPB case-series report fast absorption and high local anaesthetic plasma concentrations (albeit never exceeding toxic levels)[35]. This seems to be contradicted by an RCT, which presented significantly lower levobupivacaine levels in ESPB versus PVB in Video-assisted thoracoscopic surgery (VATS) [36]. The question remains if this is dependent on the choice of local anesthetic or if this is influenced by surgery (spine vs VATS). Although some critics of ESPB may point to systemic absorption of local anaesthetic as its main action mechanism, the authors feel this is a plausible, albeit pessimistic take. While ultimately absorption may indeed play a role, the full scope of action of the ESPB and other FPBs are yet to be discovered.

The booming success of regional anaesthesia as a subspeciality in the era of improved ultrasound technology have led us to expect extremely high-quality results from our interventions. The use of regional anaesthesia techniques, such as upper and lower limb blocks providing surgical anaesthesia, has perhaps led us to false hope for FPBs. It is probably unreasonable to expect these wall blocks to live up to these high standards considering the lack of visualisation and injection around nerves.

Perhaps our expectations of ESPB should therefore be viewed via a different lens, as a potential component of a multimodal analgesia package. Aiming to reduce our reliance on opioids and the inevitable side effects this leads to. The addition of regional anesthesia (or local anesthetics like local infiltration analgesia) to a multimodal analgesia package has the potential to confer advantages, and the weight of evidence seems to be behind some benefit being conferred by the inclusion of FPBs in analgesia plans. Whether they should supersede the well-established neuraxial techniques is an entirely different question [37, 38].

Eventually when the dust settles and more evidence is published, the real indications of the ESPB will finally become clear. To quote Lucius Annaeus Seneca, a Roman statesman and philosopher who died in 65AD. "Time discovers truth." (Veritatem dies aperit).

What we know:

- Blocks posterior ramus quite reliably
- Broadly implemented in clinical practice
- Recommended by PROSPECT for VATS
- Highly variable sensory effects

What we do not know (yet):

- Factors impeding anterior ramus spread
- Paravertebral proportion in action mechanism (if any)
- Local anesthetic absorption models
- Ideal volume and dose of local anesthetic
- Catheter placement and mode of administration
- Effect of real-world dynamics on spread (e.g., patient mobilization, position, method of drug delivery)

3 Conclusion

ESPB is a frequently utilised but severely under investigated technique. Its implementation for spine surgery seems most logical. More data are needed to prove its value in other fields. The jury is not out yet.

Abbreviations

CT	Computerized Tomography
ESPB	Erector Spinae Plane Block
FPB	Fascial Plane Block
MRI	Magnetic Resonance Imaging
MTP	Mid-point transverse process to pleura block
PVB	Paravertebral Block
RCT	Randomized Control Trial
SAPB	Serratus Anterior Plane Block
VATS	Video Assisted Thoracoscopic Surgery
QLB	Quadratus Lumborum Block

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SC has written the initial opinion and manuscript. ANE has written and revised the manuscript. DFH has revised the manuscript. GD has revised the manuscript. The author(s) read and approved the final manuscript.

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Declarations

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Not applicable.

Consent for publication
All authors consent this opinion paper for publication.

Competing interests
Steve Coppens has received BARA (Belgian Association of Regional Anesthesia) grant and ESRA (European Society of Regional Anesthesia) grant for an RCT on anterior Quadratus Lumborum block for colorectal surgery. Steve Coppens is elected BARA board member, appointed ESRA council representative and part of the scientific committee of the ESRA. Steve Coppens is a member of the Editorial Board for Anesthesiology and Perioperative Science. The paper was handled by the other Editor and has undergone rigorous peer review process. Steve Coppens was not involved in the journal's peer review of or decisions related to, this manuscript. This has not influenced this paper.

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