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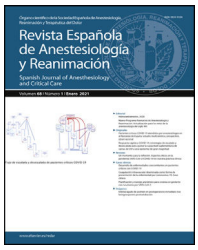

CASE REPORT

The ultimate technique for posterior rib fractures: The parascapular sub-iliocostalis plane block – A series of cases

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KEYWORDS
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Abstract We report retrospectively a series of four cases involving the successful use of the recently described parascapular sub-iliocostalis plane block (PSIP), for lateral-posterior rib fractures.

The efficacy of the PSIP block may potentially depend on different mechanisms of action: (1) direct action in the fracture site by craniocaudal myofascial spread underneath the erector spinae muscle (ESM); (2) spread to deep layers through tissue disruption caused by trauma, to reach the proximal intercostal nerves; (3) medial spread below the ESM, to reach the posterior spinal nerves; and (4) lateral spread in the sub-serratus (SS) plane to reach the lateral cutaneous branches of the intercostal nerves; while avoiding significant negative hemodynamic effects and other possible complications associated to other techniques leading that the PSIP may be considered an alternative in some clinical scenarios to the erector spinae plane block or the paravertebral block.

PALABRAS CLAVE
Fracturas de costillas;
Bloqueo nervioso;
Ecografía;
Bloqueo PSIP

Una técnica fundamental para las fracturas costales posteriores: el bloqueo paraescapular del plano subiliocostal. Una serie de casos

Resumen Presentamos retrospectivamente una serie de 4 casos en los que se utilizó con éxito el bloqueo paraescapular del plano subiliocostal (PSIP), descrito recientemente, para fracturas costales laterales-posteriores.

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La eficacia del bloqueo PSIP puede depender potencialmente de diferentes mecanismos de acción: (1) acción directa en las fractura por la extensión miofascial craneocaudal por debajo del músculo erector de la columna, (2) diseminación a capas profundas a través de la disrupción tisular causada por el traumatismo, para alcanzar los nervios intercostales proximales, (3) extensión medial por debajo del músculo erector de la columna, para alcanzar los nervios espinales posteriores y (4) extensión lateral en el plano subserrato para alcanzar las ramas cutáneas laterales de los nervios intercostales, evitando al mismo tiempo efectos hemodinámicos negativos y otras posibles complicaciones asociados a otras técnicas, lo que hace que el bloqueo PSIP pueda considerarse en algunos escenarios clínicos una alternativa al bloqueo del plano erector de la columna vertebral o al bloqueo paravertebral.

Introduction

Herein, we describe a series of cases involving an alternative analgesic technique, the parascapular sub-iliocostalis plane (PSIP) block for patients suffering from posterior rib fractures.

The PSIP block was previously described only as single case report[1] being this report the first case series in posterior rib fracture patients. The PSIP block may be an alternative whenever contraindications for erector spinae plane (ESP) block or paravertebral block (PVB) are present, due to its less action in the anterior spinal nerves or to its less risk of inadvertent neuraxial involvement.[1]

To date there are no studies, neither cadaveric nor clinical, related to mechanism of action and local anesthetic (LA) spread of the PSIP block.

Materials and methods

Details about the patients and about patients' condition, comorbidities, analgesia approach, clinical scenario, progression of the case and outcome are described in Table 1.

Results

The PSIP blocks were performed with the patient lateral decubitus under American Society of Anesthesiologists standard monitoring. A high-frequency linear ultrasound probe (Acuson 300; Siemens, Munich, Germany) was placed in a parasagittal plane orientation to 2 cm from the medial scapular border at the level of the edge of the scapula spine under sterile conditions (between the fourth rib level and sixth rib level depending on the location of the posterior rib fractures) (Fig. 1). The trapezius, rhomboid major, iliocostal, and intercostal muscles were visualized from the superficial to deep muscular layers cranial to 5th rib; distal to 5th rib only trapezius and iliocostalis muscles are observed (Fig. 1). A sonovisible 100 mm 18 G needle (Contiplex S ultra; B. Braun, Melsungen, Germany) was inserted with a cranial to caudal orientation using an in-plane technique and advanced in the iliocostal-intercostal myofascial plane in the vicinity of the rib (Fig. 1). The needle location was confirmed with a 2 mL saline solution, after which ropivacaine (Fresenius Kabi Pharma, Santiago de Besteiros, Portugal) was administered (Table 1). A catheter was then inserted 6 cm beyond the needle tip and tunneled under the skin. No sensitive alterations were noted in all the patients.

During this period, all the patients maintained intravenous conventional analgesia. The patient remained under

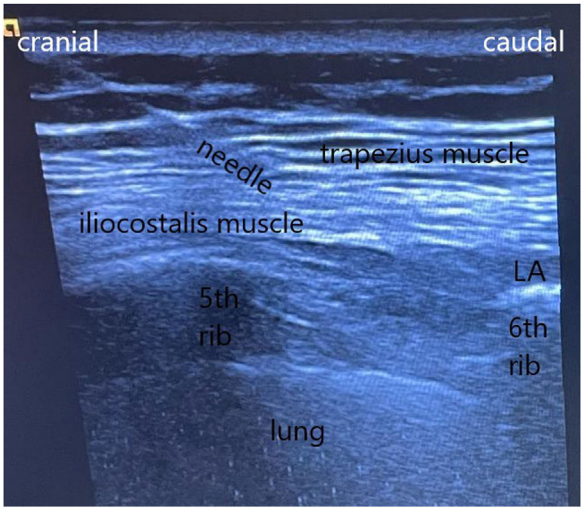

Figure 1 Description of the parascapular sub-iliocostalis plane block performed in patient 3.
With the patient in a lateral position, with both arms along the body, a high-frequency linear ultrasound probe was placed with a parasagittal orientation, immediately adjacent to the medial scapular border at the level of the edge of the sixth rib level. Identification of the lateral border of the iliocostalis muscle and performance of the parascapular sub-iliocostalis plane block. The tendinous insertion of the ILCM at the rib is in the superolateral direction (it should not be confounded with the insertion of the levatore costarum muscles whose insertion is in the inferior-lateral direction). The rhomboid major or minor muscle and the posterior superior serratus muscles are observed between the trapezius muscle and the iliocostalis muscles at upper levels. Abbreviation: LA, local anesthetic spreading.

Table 1 Serie of cases of PSIP block.

Patients	Trauma	Technique	Duration of no conventional analgesia	Conventional analgesia	Evolution/ complications
Patient 1 Male 63 years old No comorbidities or usual medication	Fracture of the 4th to 11th costal arches (posterior) Pneumotorax and pulmonary contusion Brain trauma Hypoxemia requiring O_2 needing inspiratory fraction of oxygen of 35%	4th day of hospitalization → PSIP block PSIP block at the fifth rib level performed with initial bolus of 20 mL of ropivacaine 0.5% Initial NPRS 8–9 Under systemic analgesia with: - Metamizole 2 g IV 2 times a day - Perfusion of tramadol 300 mg/24 h IV - Ketorolac 30 mg IV 2 times a day - Meperidine 30 mg IV at rescue, as deemed necessary up to 4 times a day After PSIP block → NPRS 4–5	Mandatory bolus 4 times a day ropivacaine 0.2% (20 mL) until Day 5 of PSIP block Day 4 of PSIP block → no need for O_2 supplementation and NPRS 1–2 with forced inspiration Day 6 of PSIP block → no need for SOS bolus of ropivacaine → NPRS 0 Day 8 of PSIP block → No need for rescue medication. Catheter removal	Day 1–Day 5 of PSIP block: -Paracetamol 1 g IV 3 times a day -Perfusion of tramadol 300 mg/24 h IV -Ketorolac 30 mg IV 2 times a day -Metamizole 1 g IV 2 times a day Day 6–Day 7 of PSIP block: -Paracetamol 1 g IV 3 times a day -Metamizole 1 g IV 2 times a day -No need for rescue medication Day 8 of PSIP block: -Paracetamol 1 g IV 3 times a day No need for rescue medication	Ambulation after PSIP block Respiratory kinesiotherapy after PSIP block No adverse effects or epidural-like symptoms.
Patient 2 Male 64 years old Hypertension, dyslipidemia, heart failure (NYHA II), and atrial fibrillation	Third to seventh left posterolateral rib fractures, after a fall 5 days earlier. At hospital admission, the blood gas analysis showed hypoxemic respiratory insufficiency (PaO_2/FiO_2 < 150)	1th day of hospitalization → PSIP block PSIP block performed with initial bolus of 30 mL of ropivacaine 0.375% at the fourth rib region. Initial NPRS 9 Under systemic analgesia with: - Metamizole 2 g IV 2 times a day - Perfusion of tramadol 300 mg/24 h IV - Meperidine 30 mg IV at rescue, as deemed necessary up to 4 times a day After PSIP block → NPRS 2 After PSIP block, the patient reported discrete left thoracic thermal sensitive changes.	An elastomeric infusion 10 mL/h pump (*B. Braun*) of 0.25% ropivacaine was initiated through the PSIP catheter and maintained for 5 days. (*bolus 15 mL every 6 h*) The patient maintained significant pain relief at rest and with active mobilization during this period. During this period, the patient required no rescue analgesia, including PSIP block bolus.	Day 1–Day 5: only infusion 10 mL/h pump of 0.25% ropivacaine was initiated through the PSIP catheter	Ambulation after PSIP block. No further respiratory distress or aggravation of the cardiac condition was observed during her presence in the ward.

Table 1 (*Continued*)

Patients	Trauma	Technique	Duration of no conventional analgesia	Conventional analgesia	Evolution/ complications
Patient 3 Female 75 years old Comorbidities: varicose veins	Fracture of the 6th costal arch (posterior)	1st day of hospitalization → PSIP block	Mandatory bolus 4 times a day ropivacaine 0.2% (20 mL)	Day 1–Day 5 of PSIP block: -Paracetamol 1 g IV 3 times a day	Ambulation after PSIP block
	Pneumothorax	PSIP block performed with initial bolus of 20 mL of ropivacaine 0.75% at the sixth rib level	Day 5 of PSIP block → No need for rescue medication. Catheter removal	-Perfusion of tramadol 300 mg/24 h IV	Respiratory kinesiotherapy after PSIP block
	Brain trauma Hypoxemia requiring O_2, nasal cannula 2 L/min	Initial NPRS 9–10 Under systemic analgesia with: - Metamizole 2 g IV 2 times a day - Perfusion of tramadol 300 mg/24 h IV - Ketorolac 30 mg IV 2 times a day - Meperidine 30 mg IV at rescue, as deemed necessary up to 4 times a day		- Metamizole 1 g IV 2 times a day No need for rescue medication	No adverse effects or epidural-like symptoms.
		After PSIP block → NPRS 2–3			
Patient 4 Male 66 years old COPD. Diabetes. Medication: budesonide + formoterol; metformin + sitagliptin	Fracture of the right 4th to 9th costal arches (posterior) Pulmonary contusion Hypoxemia requiring O_2 for needing inspiratory fraction of oxygen of 35%	2th day of hospitalization → PSIP block (sitting position) PSIP block performed at 5th intercostal space with initial bolus of 20 mL ropivacaine 0.375% Initial NPRS: 8 Under systemic analgesia with: - Metamizole 2 g IV 2 times a day - Perfusion of tramadol 300 mg/24 h IV - Ketorolac 30 mg IV 2 times a day - Meperidine 30 mg IV at rescue, as deemed necessary up to 4 times a day 30 min after bolus → NPRS 1 (static pain); 3 (dynamic pain)	Mandatory bolus 4 times a day ropivacaine 0.2% 20 mL until Day 7 of PSIP block; plus bolus of ropivacaine 0.2% 15 mL at rescue, as deemed necessary Day 1–Day 4 of PSIP block → VAS 0–1 (static pain); VAS 2–4 (dynamic pain); 1 SOS bolus/day Day 5–Day 7 of PSIP block → VAS 0–1 (static pain); VAS 1–2 (dynamic pain); end of O_2 supplementation on D7; no need for rescue bolus Day 8 of PSIP block → 1 rescue bolus of ropivacaine 0.2% 15 mL Day 9 of PSIP block → Catheter removal	Day 1–Day 2 of PSIP block: - Paracetamol 1 g IV 3 times a day - Metamizole 1 g IV 3 times a day - Perfusion of tramadol 300 mg/24 h IV Day 3 of PSIP block: - Paracetamol 1 g IV 3 times a day - Metamizole 1 g IV 2 times a day - Perfusion of tramadol 200 mg/24 h IV Day 4 of PSIP block: - Paracetamol 1 g IV 3 times a day - Parecoxib 40 mg IV 2 times a day - Metamizole 1 g IV 2 times a day No need for opioid medication	Ambulation in Day 3 of hospitalization Good compliance with respiratory kinesiotherapy after PSIP block No adverse effects or epidural-like symptoms. No evidence of CAI or HCAI Discharge to home on 10th day

Abbreviations: PSIP: parascapular sub-iliocostalis plane; NPRS: Numeric Pain Rating Scale; IV: intravenously; NYHA: New York Heart Association; COPD: chronic obstructive pulmonary disease; CAI: community acquired infection; HCAI: healthcare-associated infection.

continuous monitoring of the vital signs in an intermediated care unit.

Discussion

The PVB and ESP block may promote a central sympathetic blockade that can be associated with significant hypotension and bradycardia, affect ventricular function, and decrease cardiac output, which can increase pulmonary edema and result in worsened dyspnea. Additionally, significant chest wall weakness can arise from these techniques, affecting thoracic expansion and, indirectly, venous return.[1–5]

These features may put patients at risk of aggravation of preexisting cardiovascular disease, such as in patient 1 case, or aggravate respiratory distress resulting from concomitant pulmonary contusion, post-traumatic atelectasis, undrained pneumothorax, diaphragmatic paralysis or rupture or when there is a preexisting lung disease, such as in the case of patients 1–4, due to the neuromuscular block that may arise from the ESP block or PVB (the thoracic expansion is less likely to be affected with the PSIP block mainly due to the reduced risk of bilateral block and to the limited action of the PISP block on the spinal nerves in opposition to the ESP block or PVB).[1,10]

The ESP block and the PVB may be hazardous whenever concomitant brain trauma is present, such as in the case of patient 1 and 3. The presence of sepsis or hemostasis alterations may turn out preferable the placement of a catheter away of the vicinity or the neuraxial region.[10]

Indeed, some studies failed to demonstrate that the ESP block spreads to the paravertebral space,[6] whereas others concluded that, beyond the paravertebral compartment, epidural spread is the main component of its analgesic properties.[4]

It has been reported a circumferential epidural spread of LA after an ESP block, which can worsen cardiac condition in high-risk patients.[2]

Potentially, the PSIP block would provoke less epidural-like effects compared with the ESP block due to a lateral injection point, which lowers the risk of massive epidural/paravertebral spread or bilateral block.[1,10] On the other hand, the epidural spread of LA epidurally or the inadvertent dural puncture or direct epidural injection may affect the intracranial pressure when an ESP or PVB are used.[10]

Rhomboid intercostal blocks have been successfully performed in patients with multiple lateral-posterior rib fractures and other causes of chest wall pain.[7]

However, in the study by Elsharkawy et al., the staining stopped at the lateral edge of the ESM (iliocostalis muscle) in one-third of the specimens, and in cadavers, no staining was observed to the erector spinae muscle (ESM).[7]

Therefore, this block may have limited action at the fracture sites medial to the lateral border of the iliocostalis muscle (ILCM), as this muscle may represent an obstacle for the LA present in the sub-rhomboid plane or lateral to the ILCM, preventing its spread to the fractured rib plane below the ESM.

The eventual criticism to this novel technique may be hypothetically related to its nomenclature, nevertheless an Expert Consensus in 2021 (ASRA-ESRA Delphi Consensus)[8] stablished the retrolaminar (RL) block as an independent entity from the ESP block: in the RL block the injection is done between the laminae and the ESM, in the latter the injection is done between the transverse process and the ESM; on the other hand, in the PSIP block, the injection is done between the most lateral component of the ESM and the ribs, which lead to completely different properties in terms of dispersion pattern, mode of action, contraindications, benefits and complications comparing to the RL and ESP blocks. Of note, the PSIP block is the only block of this group that does not have any component of the vertebrae as a sono-anatomical reference, which makes it a complete novel technique, as the retrolaminar block is when compared to the ESP block.[1,10]

Table 2 Patients' conditions in which the PSIP block could be less hazardous than the ESP block or the PVB for posterior rib fractures analgesia.

Post-traumatic parenchymal pulmonary pathology (atelectasis, contusion, hemorrhage)
Pre-existing lung disease
Pre-existing neurologic disease
Undrained pneumothorax
Hemostasis alterations
Diaphragmatic rupture
Sepsis
Cardiac insufficiency
Concomitant brain trauma
Previous thoracic spine surgery
Concomitant spinal trauma
Need of neurologic post-traumatic or post-surgical neurological evaluation

The PSIP block has also potential benefit for thoracic spine surgery or trauma, as it was shown in a recent report by Almeida et al.,[9] due to its action in the posterior rami of the spinal nerves, with less direct action in the anterior spinal nerves, as such, when concomitant thoracic spinal fractures are present the PSIP block can be an interesting alternative to limit neuroaxial LA spread because meningeal membranes or dura-mater can be disrupted, which can be hazardous and complicate neurological check when the ESP or PVB are used.

In the PSIP block the catheter is placed underneath the ILCM, enhancing the craniocaudal LA spread across the longitudinal myofascial sub-ILCM plane and the deeper spread of LA through the disrupted tissue. The observed significant reduction of pain with motion may be related to the LA spread to deep intercostal layers in the fracture sites, direct infiltration of the fractured bone, and action in the proximal intercostal nerves.[1]

The additional spread along the deep intercostal layers is likely, but LA would not reach easily the paravertebral space. The PSIP block could also spread medially below the ESM to block mainly the posterior spinal nerves, contributing to vertebrae analgesia as it was described by Almeida et al. in a case of thoracic spine fixation surgery.[9] It should be emphasized than if concomitant anterior-lateral fractures are present the PSIP block should not be a reliable alternative to the ESP block or the PVB. The clinical scenarios in which the PSIP block, despite lacking significant direct action in the ventral spinal rami, could be preferable to the

ESP block or PVB for posterior rib fractures, are expressed in Table 2.

Conclusions

The PSIP block has now revealed its potential in the small series of cases, further large studies are necessary to confirm our results, but we are very convinced of its merits based on our experience.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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