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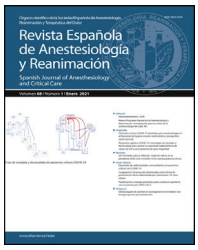

CASE REPORT

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

We describe a series of cases involving parascapular sub-iliocostalis plane (PSIP) block - an alternative analgesic technique for patients with posterior rib fracture.

The PSIP block has hitherto only been described in a single case report.[1] This is the first case series describing its use in patients with posterior rib fracture. The PSIP largely spares the anterior spinal nerves and carries less risk of inadvertent neuraxial involvement, and may therefore be a good alternative in patients contraindicated for erector spinae plane block (ESPB) or paravertebral block (PVB).[1]

No clinical or cadaveric studies have yet described the mechanism of action and local anaesthetic (LA) spread of the PSIP block.

Materials and methods

Patient demographics, clinical details, comorbidities, analgesia approach, clinical setting, progression, and outcomes are described in Table 1.

Results

The PSIP block was performed with the patient in lateral decubitus under American Society of Anesthesiologists standard monitoring. Under sterile technique, a high-frequency linear ultrasound probe (Acuson 300; Siemens, Munich, Germany) was placed in a parasagittal plane 2 cm from the medial border of the scapular at the level of the scapula spine (between either the 4th or 6th rib, depending on the location of the posterior rib fracture) (Fig. 1). The trapezius, rhomboid major, iliocostal, and intercostal muscles were visualized from superficial to deep above the 5th rib; distal to the 5th rib only the trapezius and iliocostalis muscles were observed (Fig. 1). A sonovisible 100 mm 18 G needle (Contiplex S ultra; B. Braun, Melsungen, Germany) was inserted in-plane and advanced in a cranial to caudal direction in the iliocostal-intercostal myofascial plane in the vicinity of the rib (Fig. 1). 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 tunnelled under the skin. None of the patients presented sensory alterations.

During this period, all patients received conventional intravenous analgesia, and their vital signs were monitored continuously in an intermediate care unit.

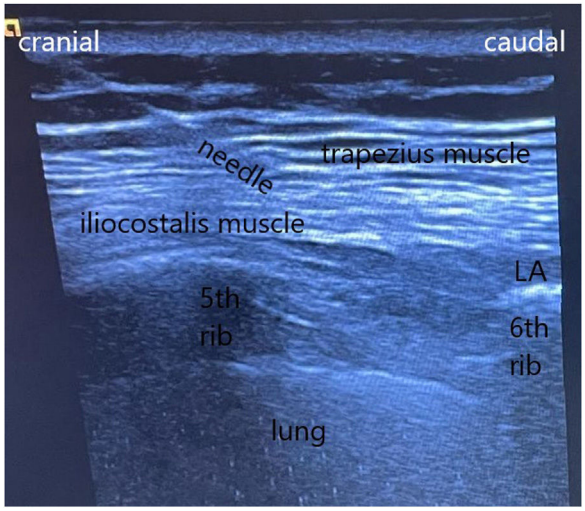

Figure 1 Description of the parascapular sub-iliocostalis plane block performed in patient 3.
With the patient in a lateral position, with both arms along the body, a high-frequency linear ultrasound probe was placed with a parasagittal orientation, immediately adjacent to the medial scapular border 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 msucles at upper levels.
Abbreviations: LA, local anesthetic spreading.

Discussion

The PVB and ESPB may cause central sympathetic blockade, which can lead to significant hypotension and bradycardia, and can affect ventricular function and reduce cardiac output. All this can increase the risk of pulmonary oedema and worsen dyspnoea. These techniques can also give rise to significant chest wall weakness that can reduce thoracic expansion and, indirectly, venous return.[1–5]

These side effects may aggravate pre-existing cardiovascular disease, as in patient 1, or respiratory distress caused by concomitant pulmonary contusion, post-traumatic atelectasis, undrained pneumothorax, diaphragmatic paralysis or rupture. The neuromuscular blockade that may accompany the ESPB or PVB may also aggravate pre-

Table 1 Patients receiving PSIP block.

Patients	Trauma	Technique	Duration of non-conventional analgesia	Conventional analgesia	Evolution/ complications
Patient 1 Male 63 years old No comorbidities or usual medication	**Fracture of 4th to 11th** costal arches (posterior) Pneumothorax and pulmonary contusion Brain Trauma **Hypoxaemia** requiring O_2 with 35%inspiratory fraction of oxygen	Day 4 of hospitalization → **PSIP block** PSIP block at the fifth rib performed with initial 20 ml bolus of ropivacaine 0.5% **Initial NPRS 8—9** under systemic analgesia with - IV metamizole 2 g twice daily - Perfusion of tramadol 300 mg/24 h - IV ketorolac 30 mg twice daily - IV meperidine 30 mg for rescue as required, up to 4 times a day **After PSIP** block → **NPRS 4—5**	Mandatory bolus ropivacaine 0.2% 4 times a day (20 ml) until day 5 of PSIP block **Day 4 of PSIP block → no need for supplemental O_2** 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 removed**	Day 1 - day 5 PSIP block: - IV Paracetamol 1 g 3 times daily perfusion of tramadol 300 mg/24 h - IV ketorolac 30 mg twice daily - IV metamizole 1 g twice daily Day 6–7 of PSIP block: - IV paracetamol 1 g 3 times a day - IV metamizole 1 g twice daily -No need for rescue medication Day 8 of PSIP block: - IV paracetamol 1 g 3 times daily 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, dyslipidaemia, heart failure (NYHA II), and atrial fibrillation.	**Third to seventh left posterolateral rib fracture** after a fall 5 days earlier. At hospital admission, blood gas analysis showed **hypoxaemic respiratory insufficiency** (PaO_2/FiO_2 < 150).	Day 1 hospitalization → **PSIP block** PSIP block performed with initial bolus of 30 ml ropivacaine 0.375% at fourth rib. **Initial NPRS 9** under systemic analgesia with: - IV metamizole 2 g twice daily - perfusion of tramadol 300 mg/24 h - rescue IV meperidine 30 mg as required, up to 4 times daily **After PSIP** block → **NPRS 2** After PSIP block, the patient reported discrete left thoracic thermal sensory changes.	Elastomeric **infusion** pump (*B. Braun*) 10 ml**/h ropivacaine 0.25%** started through PSIP catheter and maintained for **5 days** (15 ml *bolus every* 6 h) The patient maintained **significant pain relief** at rest and on movement during this period. During this period, the patient required no rescue analgesia or PSIP block bolus.	Day 1 – day 5: only **infusion** pump 10 ml**/h ropivacaine 0.25%** started through the PSIP catheter	**Ambulation** after PSIP block. No further respiratory distress or aggravation of the cardiac pathology observed during ward stay.

Table 1 (*Continued*)

Patients	Trauma	Technique	Duration of non-conventional analgesia	Conventional analgesia	Evolution/ complications
Patient 3 **Female** 75 years old Comorbidities: varicose veins	**Fracture of 6th costal arch (posterior)** Pneumothorax Brain Trauma Hypoxaemia requiring O_2, nasal cannula 2 l/min	Day 1 of hospitalization → **PSIP block** PSIP block performed with initial bolus of 20 ml ropivacaine 0.75% at the sixth rib **Initial NPRS 9−10** Under systemic analgesia with - IV metamizole 2 g twice daily - perfusion of tramadol 300 mg/24 h - IV ketorolac 30 mg twice daily - rescue IV meperidine 30 mg as required, up to 4 times daily **After PSIP** block → **NPRS 2−3**	Mandatory bolus ropivacaine 0.2% 4 times daily (20 ml) **Day 5 of PSIP block** → No need for rescue medication. **Catheter removed**	Day 1 − day 5 of PSIP block: -Paracetamol 1 g IV 3 times daily -Perfusion of tramadol 300 mg/24 h - IV metamizole 1 g twice daily No need for rescue medication	**Ambulation** after PSIP block **Respiratory kinesiotherapy** after PSIP block No adverse effects or epidural-like symptoms.
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%	Day 2 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 - IV metamizole 2 g twice daily - perfusion of IV tramadol 300 mg/24 h - IV ketorolac 30 mg twice daily - rescue meperidine 30 mg IV as required, 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 15 ml rescue bolus of ropivacaine 0.2% as required **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 supplemental O_2 on day 7; no need for rescue bolus **Day 8 of PSIP block** → 1 15 ml rescue bolus of ropivacaine 0.2% **Day 9 of PSIP block** → Catheter removed	Day 1 − day 2 of PSIP block: IV Paracetamol 1 g 3 times a day IV metamizole 1 g 3 times a day Perfusion of tramadol 300 mg/24 h Day 3 of PSIP block: IV paracetamol 1 g 3 times a day IV metamizole 1 g twice daily Perfusion of tramadol 200 mg/24 h Day 4 of PSIP block: IV paracetamol 1 g 3 times a day IV parecoxib 40 mg twice daily IV metamizole 1 g twice daily No need opioids	**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 home on day 10

PSIP, Parascapular Sub-Iliocostalis Plane; NPRS, Numeric Pain Rating Scale; IV, Intravenously; NYHA, New York Heart Association; COPD, Chronic Obstrutive Pulmonary Disease; CAI, Community Acquired Infection; HCAI, Healthcare-associated Infection.

existing lung disease, as in the case of patients 1–4. The PSIP block, in contrast, is less likely to affect chest expansion due to the reduced risk of bilateral block and the limited action of the block on the spinal nerves.[1,10]

The ESPB and PVB may be hazardous in patients with concomitant brain trauma, as in the case of patients 1 and 3. The presence of sepsis or haemostatic alterations may

require the catheter to be placed distant from the neuraxial region.[10]

Some studies have failed to demonstrate that the ESPB spreads to the paravertebral space,[6] whereas others concluded that analgesia is mainly due to epidural spread beyond the paravertebral compartment.[4]

Circumferential epidural spread of LA after ESPB has been reported, a phenomenon that can worsen cardiac conditions in high-risk patients.[2]

The PSIP block would probably cause less epidural-like effects compared with the ESPB due to a lateral injection site, which reduces the risk of massive epidural/paravertebral spread or bilateral block.[1,10] Epidural spread of LA, inadvertent dural puncture, or direct epidural injection may affect intracranial pressure when ESPB or PVB are performed.[10]

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

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

This block, therefore, may have limited effect at fracture sites medial to the lateral border of the iliocostalis muscle (ICM), which may prevent the LA present in the subrhomboid plane or lateral to the ICM from spreading to the fractured rib below the ESM.

This novel technique could hypothetically be criticised for its name. Nevertheless an expert consensus in 2021 (ASRA-ESRA Delphi Consensus)[8] established the retrolaminar (RL) block as an independent entity from the ESPB. In the RL block, LA is injected between the laminae and the ESM; in the ESPB, it is injected between the transverse process and the ESM; in the PSIP block, LA is injected between the most lateral component of the ESM and the ribs, giving this block a different pattern of spread and mode of action, and also different contraindications, benefits, and complications compared to the RL and ESPB. In addition, the PSIP block, unlike the RL and ESPB, does not use the vertebrae as a sono-anatomical reference – another factor that makes it a truly novel technique.[1,10]

A recent report by Almeida et al.[9] showed the potential benefit of PSIP block in thoracic spine surgery or trauma due to its action on the posterior rami of the spinal nerves and less direct action on the anterior spinal nerves. In patients with concomitant thoracic spine fractures, therefore, the PSIP block may be beneficial because it limits neuraxial LA spread, thus sparing damaged meningeal membranes or dura-mater. Spread of LA to these structures can be hazardous and can interfere with postoperative neurological evaluations.

In the PSIP block, the catheter is placed beneath the ICM and permits craniocaudal LA spread in the longitudinal myofascial sub-ICM plane and deeper LA spread through the disrupted tissue. The significant pain relief on movement achieved with the PSIP may be due to LA spread to deep intercostal layers at the fracture site, direct infiltration of the fractured bone, and LA spread to the proximal intercostal nerves.[1]

The LA is also likely to spread to deep intercostal layers, although it would not easily reach the paravertebral space, and could also spread medially below the ESM to block the posterior spinal nerves. Indeed, Almeida et al.[9] describe the use of PSIP for postoperative analgesia after thoracic spine fixation surgery. However, it is important to bear in mind that PSIP is not a reliable alternative to ESPB and PVB in patients with concomitant anterior-lateral fractures. The clinical scenarios in which PSIP block would be preferable to ESPB or PVB in posterior rib fractures, even though it does not anaesthetise the ventral rami of the spinal nerves, are shown in Table 2.

Table 2 Circumstances in which the PSIP block could be less hazardous than ESPB or PVB for posterior rib fractures analgesia.

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

Conclusions

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

Conflict of interest

The authors declare that they have no conflicts of interest

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