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Case Report

Bilateral Continuous Serratus Anterior Blockade for Postoperative Analgesia After Bilateral Sequential Lung Transplantation

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ACUTE PAIN FROM bilateral transverse anterolateral thoracotomy can be severe, with pain arising from skin incision, muscle splitting, rib retraction and dislocation, pleural irritation, and intercostal nerve manipulation.^{1,2} Current evidence-based, first-line regional analgesic strategies for postoperative thoracotomy pain include thoracic epidural analgesia (TEA) and paravertebral block (PVB).^{3,4} Both techniques are associated with complications, including failure rates (TEA 14%-30%⁵ v PVB 10%⁶), and can be technically challenging to perform.

The serratus anterior plane (SAP) block, first described by Blanco et al., is a novel interfascial field block for the anterior thoracic wall that can provide analgesia involving the T2 to T9 levels.⁷ In this case report, the authors discuss the role of postoperative continuous bilateral serratus anterior blocks for analgesia in the setting of technical difficulties and relative contraindications for thoracic and paravertebral analgesia in a patient who underwent bilateral sequential lung transplantation. Written, informed consent was obtained from the patient.

Case Presentation

A 61-year-old man (weight 53 kg) with severe end-stage chronic obstructive pulmonary disease, congenital deafness, mild coronary artery disease, and benign prostate hyperplasia

was scheduled to undergo bilateral sequential lung transplantation. His medication included 5 mg of sustained-release morphine twice daily for chronic musculoskeletal pain, fluticasone, salbutamol, and calcium carbonate.

Before induction of general anesthesia, 2 senior anesthesiologists each attempted placement of a thoracic epidural catheter at multiple levels (T4-T7). After unsuccessful attempts at 3 separate levels and urgency to commence surgery because of time constraints on the ischemic downtime of the harvested donor lungs, additional attempts were abandoned and general anesthesia was induced. The surgical procedure consisted of a bilateral transverse anterolateral thoracotomy (with sparing of the sternum). The patient remained intubated and ventilated and was transferred to the intensive care unit postoperatively.

On the morning of postoperative day (POD) 1, the acute pain service (APS) was consulted to recommend an analgesic regimen that would facilitate weaning from the ventilator and expedite extubation in line with routine postoperative protocols for recipients of lung transplantation. When assessed by the APS approximately 15 hours postoperatively on POD 1, the patient was sedated on a propofol infusion at 15 mg/h and a morphine infusion of 2 mg/h. Supplementary analgesics included 1g of intravenous paracetamol 3 times daily. Nonsteroidal agents were contraindicated in accordance with the transplantation team's preference.

Attempts at weaning the patient from sedation resulted in confusion and agitation, which were believed to be influenced partially by severe pain. A congenital hearing impairment complicated patient assessment, meaning that nursing staff

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had to assess pain and other information through nonverbal cues. Use of the critical care pain observation tool, a validated nonverbal pain score that consists of 4 different items (ventilator compliance, facial expression, body movements, and muscle tension), yielded a baseline score of 3 at rest and activity, indicative of severe pain, and corroborated the likelihood of severe pain contributing to the patient's agitation.⁸

A full blood count revealed a low platelet count and the international normalized ratio was 1.4, both of which posed relative contraindications to an epidural catheter insertion.⁹ In addition, the previous failed attempts at epidural catheter insertion by 2 senior anesthesiologists, an abnormal clotting profile, and the inability to assess for neurologic complications in an intubated and sedated patient posed absolute contraindications per American Society of Regional Anesthesia guidelines.^{9,10}

Bilateral paravertebral catheters as an alternative were believed to be contraindicated because of the aforementioned variables, including an increased bleeding risk, especially in light of the fact that it has been shown that use of the bilateral paravertebral technique approximately doubles the likelihood of inadvertent vascular puncture (9% v 5%).¹¹

Taking into consideration these factors and after obtaining informed consent from the next of kin, a decision was made to insert bilateral serratus anterior block catheters as a relatively safe and reliable novel regional analgesic technique, as previously described by Blanco et al.⁷ (Fig 1). The serratus plane block is a technically easy and superficial block technique with relatively few absolute contraindications.¹² The authors deemed the benefit-risk analysis in favor of performing this novel block compared with a thoracic epidural or paravertebral block.

The procedure was performed at the patient's bedside in the intensive care unit with full monitoring in place (pulse oximetry, electrocardiogram, invasive arterial, and pulmonary arterial blood pressure monitoring) approximately 18 hours postoperatively on POD 1. The patient remained sedated and

intubated for the procedure, and the block procedure was carried out with the patient in a supine position.

A high-frequency linear ultrasound transducer (SonoSite SII; Fujifilm SonoSite Inc, Bothell, WA) was placed in a sagittal plane and the ribs were counted inferiorly and laterally, until the fifth rib was identified in the midaxillary line and the latissimus dorsi and serratus muscles were identified overlying the fifth rib.

In addition to the original technique described by Blanco et al., the probe then was rotated 90 degrees to obtain a transverse view of the sonoanatomy as previously described. An 18-gauge, 80 mm Tuohy needle (Portex; Smiths Medical, Minneapolis, MN) was inserted in plane from anteromedial to posterolateral, and the final needle end point was the connective tissue plane between the serratus muscle and the fifth rib. A single injection of 30 mL of 0.375% ropivacaine was performed, and an epidural catheter (closed end multiport [Portex]; Smith Medical) was threaded 3 cm past the tip of the Tuohy needle. The same procedure was performed on the contralateral side with the same dose of local anesthetic 30 minutes after the first procedure. The total amount of local anesthetic was calculated, and the patient was given nurse-administered bolus doses of 15 mL of 0.125% bupivacaine simultaneously on both sides on a strict every 4-hour basis with a background infusion of 2 mL/h.

The patient was reassessed 2 hours later, at which time the critical care pain observation tool score had decreased to 0. A sensory examination was not performed because it would have breached the extensive sterile wound dressings in the surgical field in both anterior hemithoraces. On POD 2, approximately 24 hours after the block was performed, the patient's intravenous opioid consumption had decreased approximately 50%, the propofol infusion was ceased, and the patient's airway was extubated successfully. Despite an episode of agitation and confusion on POD 3 (catheter day 2), the patient progressed well with regard to analgesia, deep breathing, and coughing. He was transitioned to an oral pain regimen consisting of 5 to 10 mg of oxycodone every 3 hours as needed, 1 g of paracetamol every 6 hours, and 75 mg of pregabalin twice daily. His baseline sustained-release oral morphine was increased from 5 mg twice daily to 15 mg (maximum) twice daily until POD 8 (catheter day 7) when the serratus plane catheters and chest drains were removed and the patient was discharged from the APS. He was weaned from the sustained-release oral morphine dose to his usual baseline dose of 5 mg twice daily approaching hospital discharge, and he did not require any more breakthrough opioid. The mean morphine equivalent dose for the aforementioned period was 27 mg daily (Table 1).

Discussion

Even though TEA and PVB are considered the preferred regional anesthetic modalities for thoracic wall surgery,¹³ their usage is limited in certain scenarios. In the patient described here, the TEA and PVB techniques were contraindicated because of postoperative thrombocytopenia and coagulopathy and the inability to safely assess for possible neurologic injury

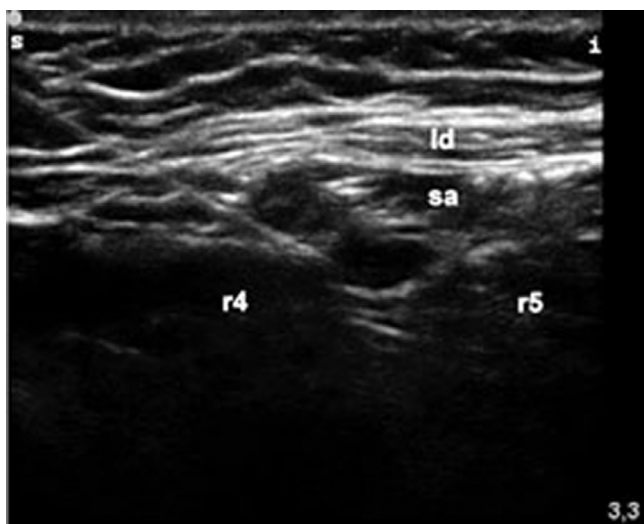


Fig 1. In plane view of needle with injection of local anesthetic into the deep plane of the serratus muscle. ld = latissimus dorsi muscle; R 4 = rib 4; R5 = rib 5, sa = serratus anterior muscle.

Table 1
Postoperative Opioid Consumption

	POD 0	POD 1	POD2/POC1	POD3/POC2	POD4/POC3	POD5/POC4	POD6/POC5	POD7/POC6	POD8/POC7	POD9/POC8
Morphine (IV, mg)	24	74	29	0	0	0	0	0	0	0
Controlled-release morphine (mg)	0	0	10	10	20	20	20	20	30	15
Oxycodone (mg)	0	0	15	0	20	0	0	10	0	0
MED (oral)	72	222	119.5	40	50	20	20	35	30	15

Abbreviations: IV, intravenous; MED, morphine equivalent dose; POC, postoperative catheter day; POD, postoperative day.

during block performance per American Society of Regional Anesthesia guidelines^{9,10}

The serratus anterior block is a novel interfascial plane block, targeting the lateral cutaneous branches of the intercostal nerves from the T2 to T9 dermatomes. It has very few contraindications, with patient refusal and allergy to local anesthetics being the only absolute contraindications.¹²

Despite standard complications such as pneumothorax, vascular puncture, and local anesthetic toxicity as possibilities, a potential advantage of ultrasound is to mitigate some of these risks.¹⁴

The injection can be performed either superficially or deep to the serratus muscle plane, as per the Blanco et al. landmark study.⁷ The authors of the present case report chose to inject into the deep plane because there is some evidence suggesting that doing so leads to a more reliable and denser clinical block.¹⁵ In addition, the deep plane is easier to detect on ultrasound imaging¹⁵ and possibly more stable for catheter anchoring. The superficial injection is believed to last longer compared with the deep injection.⁷ However, the area of sensory loss to pinprick in the Blanco et al. study was similar, irrespective of whether the injection was superficial or deep to the serratus muscle.⁷ The clinical observation of the authors of this case report was that the patient became symptomatic toward the end of each 4-hour bolus interval, which supports the shorter duration of action with a deep approach, possibly because of a higher clearance rate of local anesthetics from a compartment of high vascularity.

Advantages of an injection superficial to the SAP may include an improved analgesic coverage of thoracostomy-related pain mediated by the long thoracic nerve and the thoracodorsal nerve, both of which traverse the superficial SAP.¹⁶ However, the presence of the extensive network between the different branches of the intercostal nerves across multiple dermatome levels, ranging from the superficial extrathoracic space to the innermost intercostal muscle plane,¹⁷ may facilitate diffusion of local anesthetics and be responsible for serratus plane block efficacy. Furthermore, a block of the long thoracic nerve owing to impairment of serratus anterior muscle is undesirable because it may cause winged scapula syndrome.¹⁵ This novel interfascial block therefore may be useful in providing hemithoracic anesthesia for nociceptive somatic and neuropathic primary afferents that are affected by bilateral transverse thoracotomy incisions. The principal mode of antinociception seems to be blockade of the afferent input to the lateral cutaneous branches of the intercostal nerves before they divide into anterior and posterior branches.^{7,18} In theory, the posterior branches of the intercostal nerves may not be blocked; however, this has not been shown to reduce the efficacy of this novel technique,¹⁹ nor would this potentially spared nerve territory have mattered because this type of incision is anterior lateral. In the present case report, the anterior cutaneous branches of the intercostal nerves potentially may have been missed, which did not seem to have any clinical relevance in this case because of the sternum-sparing approach.

In unilateral thoracic surgery, the serratus plane block has been shown to be effective and safe, resulting in improved

pain scores and reduced opioid consumption in patients undergoing anterior-lateral thoracotomies,²⁰ posterior-lateral incisions,¹⁹ and mini-thoracotomies along the T5 dermatome for transcatheter aortic valve replacement surgery.²¹

The authors of the present case report chose a bolus-based regimen with a minimal background infusion based on the concept that the bolus injection would deliver a suitable amount of local anesthetics to the interfascial plane and create an adequate spread of the local anesthetics in accordance with the initial Blanco et al. study.⁷ In addition, the volume of local anesthetics (15 mL 0.125% bupivacaine every 4 hours) had to be adjusted to less than that used in the Blanco et al. study (the lowest volume used in their study was 19 mL in 1 patient) because simultaneous anesthesia had to be provided to both hemithoraces, and the authors needed to consider a combined dose of local anesthetics that was unlikely to produce toxicity. Conceptually, providing entire coverage of the T2 to T9 dermatome levels was not required; restricting nociceptive block between the T4 to T5 and T6 to T7 dermatome levels to cover the surgical incision and chest drains and therefore a bolus volume of 15 mL was deemed sufficient.

A recent randomized controlled trial showed that SAP block performed with a single bolus of 40 mL of 0.375% ropivacaine provides a wider dermatome spread compared with 20 mL ($p=0.002$; 6 [5-7] v 4 [3-4] dermatomes). As previously stated, in the patient described here, 4 dermatome levels seemed adequate to cover the incision and chest drains so that a bolus volume of 15 mL seemed to approximate the 20 mL used in the study by Kunigo et al.²²

In another recent randomized controlled trial, a bolus injection of 0.4 mL/kg of 0.375% ropivacaine in patients undergoing video-assisted thoracic surgery demonstrated a significant improvement in the quality of recovery, significantly lower pain scores at rest, and less opioid consumption up to 6 hours compared with a control group. In addition, the cumulative opioid consumption remained significantly lower in the first 24 hours after surgery in the serratus plane block group.²³

It remains to be seen whether bolus dosing versus continuous background infusion is clinically superior; additional studies hopefully will clarify the safety and efficacy and optimal technique for this promising novel block technique.

Conclusion

The serratus plane block may be a safe and effective regional anesthetic alternative for acute post-thoracotomy pain after bilateral sequential lung transplantation when paravertebral and thoracic analgesia are contraindicated or technically difficult to perform.

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