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Case Report

Ultrasound-guided serratus plane block for ED rib fracture pain control☆,☆☆

Abstract

Rib fractures are common and painful; providing effective pain relief promotes optimal pulmonary function, thereby preventing complications such as pneumonia and respiratory failure. Opioids, long considered the criterion standard analgesic, have significant drawbacks including respiratory depression, suppression of the cough reflex, and delirium. Regional anesthetic techniques such as intercostal and paravertebral blocks or epidurals can be time-consuming with significant risks and remain uncommon in the typical emergency department. The serratus anterior plane block (SAPB) holds promise to be a technically simple, relatively safe, and effective intervention for emergency treatment of rib fracture pain. The technical skill required is on par with an ultrasound-guided femoral nerve block for hip fracture. At its most simple, the block involves using ultrasound to inject a 20- to 40-mL bolus of local anesthetic into the space between the surface of the ribs (external intercostal) and the overlying muscle (serratus anterior) centered over the rib fractures. Once injected, the local first anesthetizes the lateral cutaneous branches of the intercostal nerves, then as the bellowing motion of the thoracic wall promotes dispersal, it soaks into the intercostal space to anesthetize the root intercostal nerves and spread up and down several thoracic levels to achieve multilevel analgesia. Further research will clarify questions about the optimal location of SAPB for various rib fracture patterns, the volume and concentration of local anesthetic, the role of injected adjuncts, and expected duration of analgesia. Herein we present the first description of a SAPB successfully used for rib fracture analgesia in the emergency department.

The efficacy of a serratus anterior plane block (SAPB) for rib fracture analgesia is based on the unique anatomy of the intercostal nerves that supply the chest wall from the parietal pleura to the skin [1-4]. The intercostal nerves emerge from the anterior rami of the spinal thoracic nerves to form a branching network of interconnected nerves that communicate across multiple dermatomal levels. There is also communication from the superficial extrathoracic space to the innermost intercostal muscle plane (origin of intercostal nerves) (Fig. 1). Because of this communication between muscular planes, the SAPB can be performed with injection either below or beneath the serratus anterior muscle. The SAPB is in the same family as the PECS, transabdominus plane, and rectus sheath blocks that exploit this unique anatomy to produce large areas of thoracic anesthesia with targeted thoracic muscular plane injections [2]. These blocks are simple, relatively low risk, and easy to learn for emergency providers already familiar with ultrasound-guided procedures.

Patient 1. An 82-year-old man fell onto a table fracturing right ribs 4-9. He reported severe pain despite intravenous (IV) morphine.

Patient 2. A 65-year-old woman struck by a car while riding a bicycle, resulting in left 5-7 rib fractures. On hospital day 3, she complained of severe pain despite around-the-clock IV hydromorphone. The emergency department (ED) team was consulted by trauma to assist with pain management.

Serratus anterior plane block technique

Informed consent. We explained that the block would last 6 to 8 hours, with the possibility of severe rebound pain, block failure, and local anesthetic toxicity (LAST).

Equipment. Cardiac monitoring, an IV line, and access to Intralipid was confirmed. A 3.5-in. 20-gauge Touhy needle, extension tubing, and a 30-mL syringe loaded with 0.5% ropivacaine and 3 mL of 1% lidocaine loaded in a 5-mL syringe with a 27-gauge needle were prepared. An adhesive sterile probe cover, sterile gloves, and sterile drape were assembled.

Positioning. Both patients were placed in the lateral decubitus position (the block can also be performed in the supine position). The injection was targeted toward the posterior axillary line at the level of T5 (Fig. 2).

Injection. The needle was advanced in-plane, under ultrasound guidance to the plane deep to the serratus anterior muscle (case 1, Fig. 3) and to the plane just superficial to the serratus muscle (case 2, Fig. 4). After negative aspiration, a test dose of 3 mL confirmed proper needle tip placement with opening of the intramuscular layer. Injection continued under ultrasound guidance with aliquots of 3 to 5 mL after negative aspiration until 30 mL of 0.5% ropivacaine was administered. Neither patient experienced untoward cardiac events or had signs of LAST; both had appropriate lung sliding on ultrasound postprocedure. At 30 minutes after the block, patient 1 was able to cough and laugh without pain (dynamic pain 8/10 to 0/10) and did not request analgesics until the following morning (>12 hours after the block). She was discharged the following day. Patient 2 had resting pain of 9/10 in severity. Thirty minutes after SAPB, he spontaneously dressed himself and requested to be discharged home complaining of only minimal pain. He was convinced to accept admission and reported excellent analgesia throughout the night. The next morning (10 hours after the block), his pain returned and epidural was placed by the anesthesia service (who are unfamiliar with the SAPB).

Our cases suggest a major role for the SAP in the ED treatment of rib fracture pain. Rib fractures are both common (10%-38% of ED blunt trauma patients) and painful. Enhancing analgesia with SAP may help improve pulmonary function, avoid adverse outcomes, and reduce mortality [1,3-8]. Current evidence on rib fracture analgesia suggests improved outcomes with an opioid-sparing multimodal approach that integrates regional anesthesia [8]. Further study is needed to determine if improved long-term outcomes can be achieved with early initiation of SAPBs for rib fractures in the ED.

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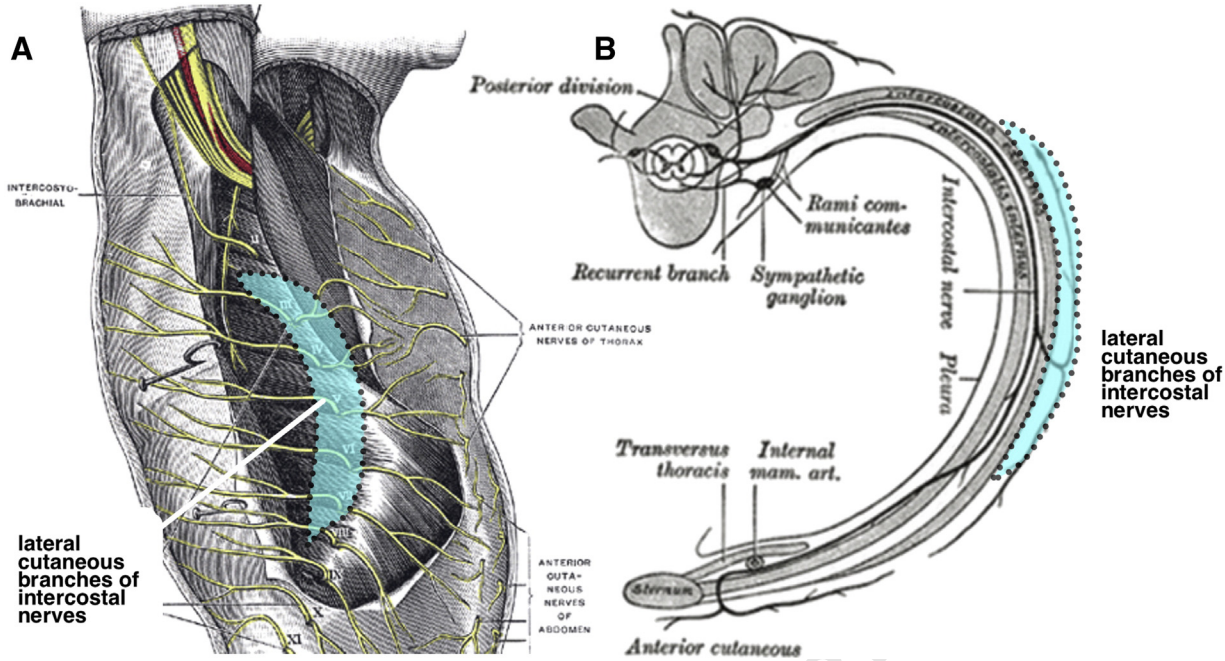

Fig. 1. Innervation of the thorax by the intercostal nerves. A, The intercostal nerves originate from anterior rami of the thoracic spinal nerves and travel adjacent to intercostal artery within the intercostal muscles. The lateral cutaneous branches pierce the internal and external intercostal muscles at the midaxillary line to innervate the muscles and skin of the lateral trunk. When the SAPB is performed, local anesthetic (blue highlight) is deposited directly in contact with the lateral cutaneous branches. The significant relief from fracture pain with the SAPB implies that the local anesthetic soaks into the intercostal space to reach the root intercostal nerves that supply the rib periosteum and parietal pleura. B, Cross-sectional anatomy of the intercostal nerve as it travels from the anterior ramus of the spinal thoracic nerve toward the sternum. Approximate location of local anesthetic (blue highlight) in SAPB is shown. Henry Gray, *Anatomy of the Human Body*, 1918.

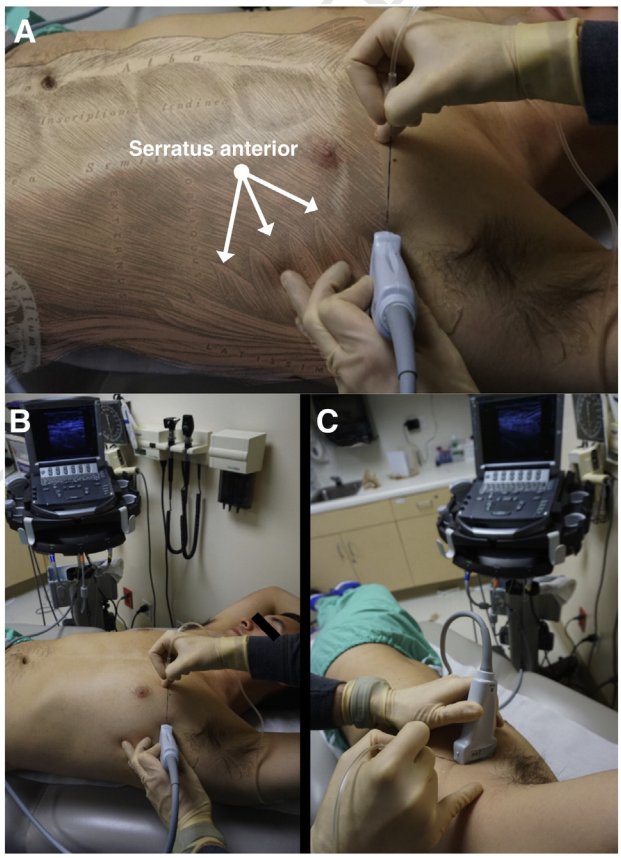

Fig. 2. Surface anatomy and patient positioning for the SAPB. A, The serratus anterior muscle originates as muscle branches from the first to ninth ribs (giving the muscle its saw tooth appearance) and inserts onto the medial border of the scapula. In the superficial axillary region, the serratus is found lateral to the pectoralis muscle and medial to the latissimus dorsi muscle. B, Anterior approach. The patient is placed in a supine position with the ultrasound machine positioned for easy line-of-site with an in-plane injection centered over the rib fracture level. C, Posterior approach. The patient is placed in a lateral decubitus position.

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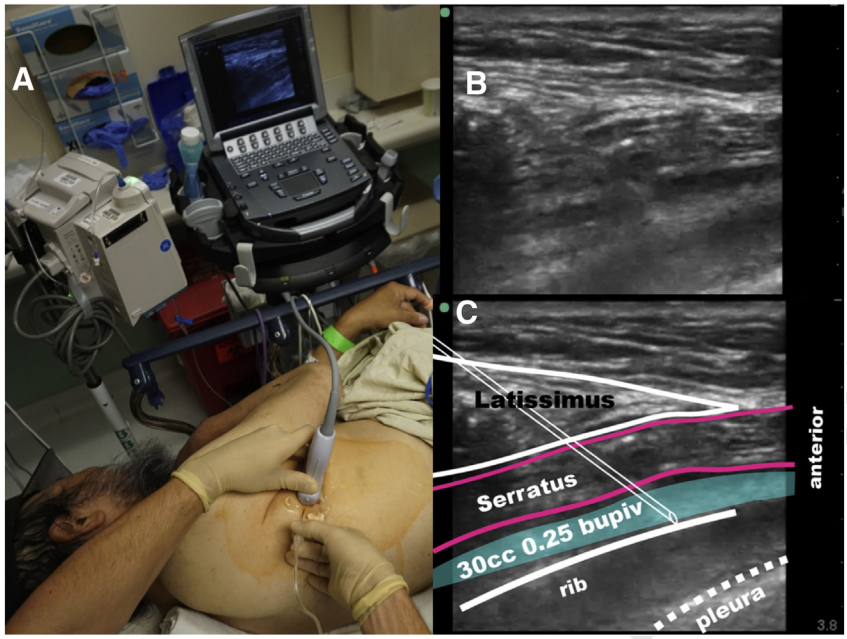

Fig. 3. Case 1: injection deep to the anterior serratus muscle. A, The patient in left lateral decubitus position for an in-plane, posterior approach SAPB. B and C, Ultrasound still image showing the space deep to the serratus anterior muscle with bolus local anesthetic injection.

We applied the SAPB to emergency rib fracture patients based on the initial description by Blanco et al [2] and several additional case reports describing the successful use of the SAPB for breast surgery [9-13], after thoracotomy pain [14-16], and rib fractures [17]. The major risk is LAST and can be avoided by using dilute anesthetic (eg, 30 mL of 0.25 bupivacaine) and standard precautions. Pneumothorax would require a major operator error because the block target is *superficial* to the rib. Nerve injury is unlikely. Further study is needed to modify the technique for specific fracture patterns, such as, posterior vs anterior ribs. Injecting in the cephalad-cadual plane or multiple injections at different thoracic levels may promote better spread to multiple thoracic levels. Use of catheters and or adjuvants such as dexamethasone may play a future role in achieving prolonged analgesia. In summary, our preliminary experience suggests the SAPB is technically easy and superior to IV opioids for ED treatment of rib fracture pain.

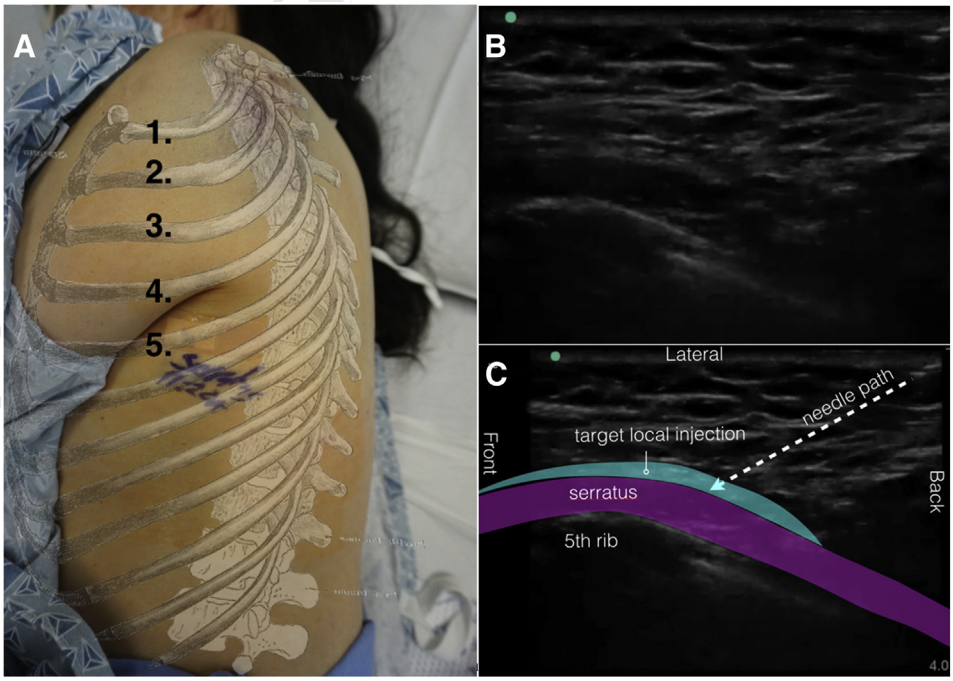

Fig. 4. Case 2: injection superficial to the anterior serratus muscle. A, The patient in left lateral decubitus position for an in-plane, posterior approach SAPB with approximate location of ribs shown (Henry Gray,*Anatomy of the Human Body*, 1918). B and C, Ultrasound still image showing the space superficial to the serratus anterior muscle with bolus local anesthetic injection.

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