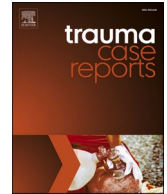




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Case Report

Single injection, ultrasound-guided planar nerve blocks: An essential skill for any clinician caring for patients with rib fractures

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ABSTRACT

In patients with acute rib fractures, regional anesthesia has the potential to reduce suffering, decrease opiate use, lower rates of in-hospital delirium, and improve pulmonary function. While many regional anesthesia techniques are complex and time consuming, two single injection nerve blocks, the serratus anterior plane block and erector spinae plane block, are particularly fast, safe, and simple methods to anesthetize the chest wall. Herein we describe two cases in which the serratus anterior plane block and erector spinae plane block were each used with great success in achieving improved pain control in trauma patients with multiple rib fractures. We believe that any provider who routinely cares for patients with rib fractures (emergency physicians and trauma surgeons alike) can and should learn to use these straightforward nerve blocks.

Introduction

Effective pain management in trauma patients with acute rib fractures is critical but also challenging. Severe pain from rib fractures can impair ventilatory function and decrease the ability to clear respiratory secretions thereby putting patients at higher risk of developing nosocomial pneumonias (as high as 31 % in the elderly patients) [1]. Systemic analgesia (acetaminophen, NSAIDs, opioids, etc.) is frequently inadequate to fully control pain from rib fractures and comes with a host of possible adverse effects [2]. Regional analgesia (RA), including epidural anesthesia and nerve blocks, is strongly recommended by trauma guidelines, but, in practice, is woefully underutilized [3]. A 2019 review of the U.S. National Trauma Data Bank showed that of patients with more than 3 rib fractures only 3 % received epidural analgesia and fewer still (1.1 %) were treated with other RA modalities [4]. The under-utilization of RA is likely multifactorial but is no doubt exacerbated by the fact that many RA techniques are difficult to perform, time intensive, and are often felt to lie within the exclusive purview of specialized anesthesia or pain management teams [5]. However, two single injection, ultrasound-guided planar nerve blocks, the serratus anterior plane block (SAPB) and erector spinae plane block (ESPB), are fast, safe, and simple methods to anesthetize the chest wall [6,7]. With long-acting local anesthetics (i.e., bupivacaine and ropivacaine), a single nerve block can provide more than 12 h of sensory blockade [8]. Furthermore, principles of preventive analgesia

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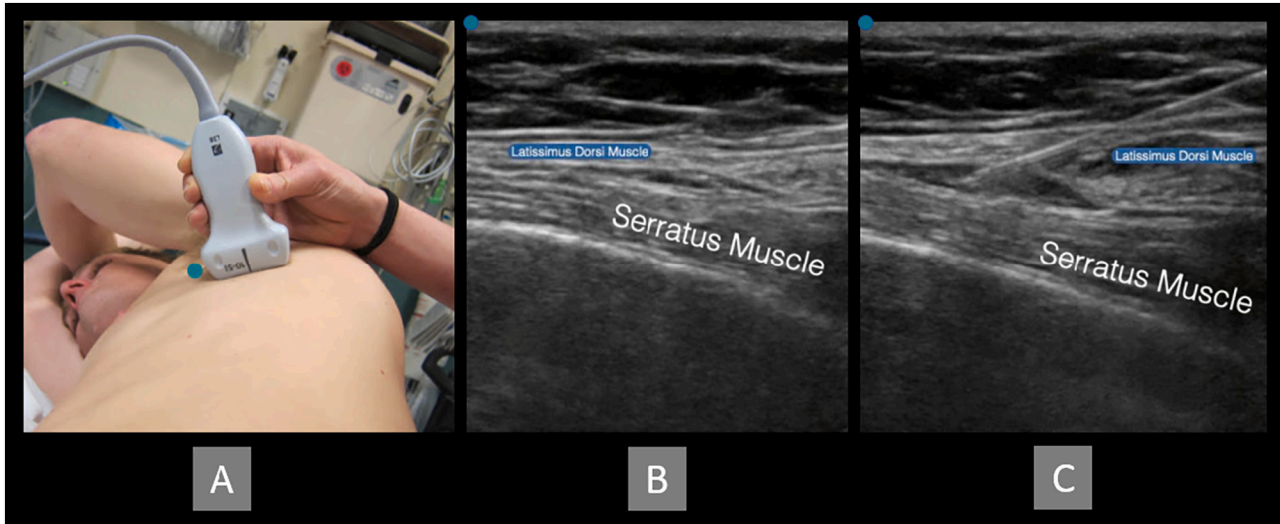


Fig. 1. Serratus anterior plan block.

(A) Patient and transducer positioning.

(B) Basic anatomy showing latissimus dorsi overlying serratus anterior with rib below.

(C) Infiltration of local anesthetic within the fascial plane between the latissimus dorsi and serratus anterior muscles.

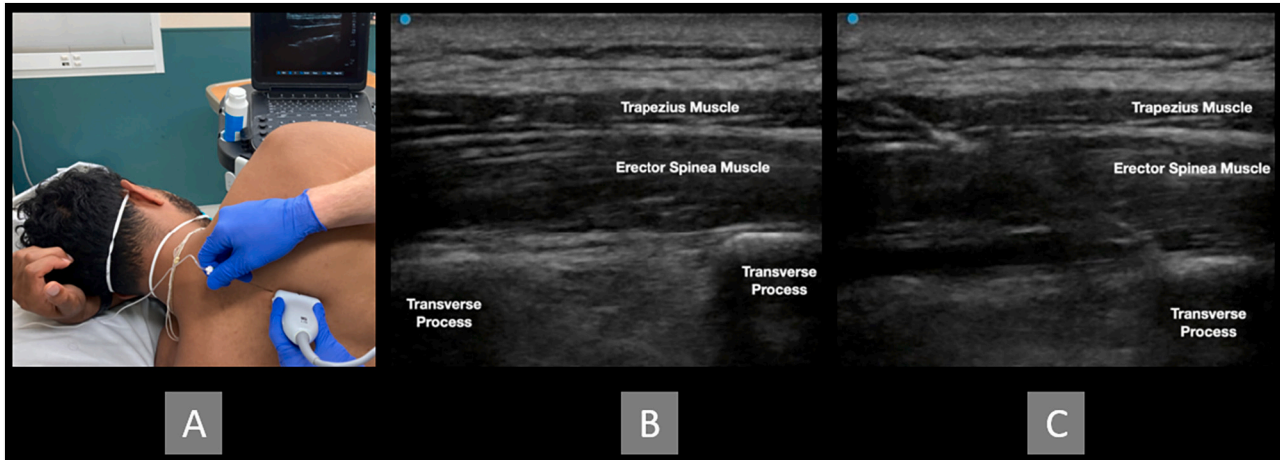


Fig. 2. Erector spinae plane block.

(A) Patient and transducer positioning.

(B) Basic anatomy showing erector spinae overlying the 4th transverse process.

(C) Infiltration of local anesthetic within the fascial plane between the 4th transverse process and erector spinae muscle.

suggest that the benefits of the nerve blocks can also extend far beyond the actual duration of the local anesthetic. Early attenuation of severe pain is believed to prevent central pain sensitization and pain wind-up phenomena thereby reducing the risk of more severe sub-acute and chronic pain syndromes [9]. Once the patient's initial severe pain is addressed (with RA), systemic analgesia may be sufficient for ongoing pain control beyond the initial 12 h, however, repeat nerve blocks may be performed safely and easily as needed. The SAPB and ESPB are well within the scope of practice of trauma surgeons and emergency physicians alike. When armed with these nerve blocks, we believe that trauma surgeons and emergency physicians are uniquely positioned to surmount the current shortfall in RA use for acute rib fractures.

In 2019, our level 1 trauma center implemented an interdepartmental pain management protocol for rib fractures. To date, through this collaborative effort between the departments of trauma surgery and emergency medicine, we have performed more than 100 single injection, ultrasound-guided planar nerve blocks for acute rib fractures. In the first year, 48 nerve blocks were performed with initial (unpublished) data demonstrating a significant mean pain score reduction of 3.5. Herein we present two cases in which single injection, ultrasound-guided planar nerve blocks, as part of a larger multimodal pain control strategy, allowed for highly effective pain management in two acutely injured trauma patients with multiple rib fractures. We believe that these cases are illustrative of the ease, speed, and efficacy with which these nerve blocks may be performed. Of note, based on anecdotal data and literature review, we believe that the SAPB is most efficacious for anterior and lateral rib fractures, whereas the ESPB is ideal for posterior rib fractures [10]. The cases that follow highlight the use of each of these respective planar nerve blocks for distinct fracture patterns.

All nerve blocks were performed under ultrasound-guidance. The patient was placed on a cardiac monitor, and either 1 % ropivacaine or 0.5 % bupivacaine is injected into the target fascial plane under ultrasound guidance. Anesthetic dosing was calculated based on accepted weight-based guidelines [11]. Cardiac monitoring was continued for a minimum of 30 min after the ultrasound-guided nerve block. Additional intravenous pain medications were also administered as needed.

Cases

Case 1

A 46-year-old male was brought in by EMS after a moderate speed motor vehicle collision. The patient's vital signs at triage were a heart rate of 124 bpm, a blood pressure of 156/70 mm Hg, a respiratory rate 22, and pulse oximetry reading of 99 % on room air. After stabilization in the trauma bay and administration of 50 micrograms of fentanyl intravenously, computed tomography was performed which showed four nondisplaced, left anterior rib fractures. There was no evidence of hemothorax/pneumothorax. The patient continued to complain of 8/10 pain (NRS scale) despite aforementioned fentanyl administration. The trauma team resident in consultation with the emergency medicine attending performed an ultrasound-guided left SAPB. After patient consent, 24 ml of 0.5 % bupivacaine (with 20 ml of normal saline) was injected into the fascial plane between the latissimus dorsi and serratus anterior muscle under ultrasound-guidance (Fig. 1). Total procedure time was 12 min. The patient's pain level went from 8/10 to 2/10 at 20 min post-injection. Duration of pain control was 11 h.

Case 2

A 65-year-old female was brought in by EMS after a fall down stairs. The patient's vital signs at triage were heart rate of 118 bpm, blood pressure 168/84 mm Hg, respiratory rate of 26 and pulse oximetry reading 98 % on room air. After stabilization in the trauma bay and administration of 100 micrograms of fentanyl intravenously, computed tomography imaging indicated five nondisplaced right posterior rib fractures. Imaging also revealed a small right-sided hemothorax without associated pneumothorax. The patient continued to complain of 10/10 pain (NRS scale), with difficulty breathing despite the aforementioned fentanyl administration. The trauma team resident in consultation with the emergency medicine attending performed an ultrasound-guided right ESPB. After patient consent, 20 ml of 1 % ropivacaine was injected into the fascial plane between the lateral fourth transverse process and overlying erector spinae muscle (with 20 ml normal saline) (Fig. 2). Total procedure duration was 10 min. The patient's pain level went from 10/10 to 4/10 at 30 min post-injection. The patient required no additional opioid analgesia during her hospital stay.

Discussion

In recent years there has been increased attention paid to the role of ultrasound guided nerve blocks as a fundamental component of early and effective pain management in patients with acute traumatic injuries. In particular, the femoral nerve and fascia iliaca compartment blocks have gained popularity as they have been associated with improved outcomes when administered early to patients with acute hip fractures [12]. This has resulted in a widespread call for the implementation of streamlined, comprehensive pain protocols that integrate regional nerve blocks into the standard treatment of acute hip fracture [13–15]. We believe that the treatment of acute rib fractures should follow suite. Specifically, it is our opinion that the SAPB and ESPB should be incorporated into the day-to-day practice of trauma surgeons and emergency physicians with equal urgency. The SAPB and ESPB rely on relatively simple sonographic anatomy and are therefore safe, quick to perform, and straightforward to learn. Furthermore, there are numerous published and online resources that provide clear and simple instruction on how to perform these nerve blocks (i.e. NYSORA, Duke Regional Anesthesia and Acute Pain Medicine, etc.). Simply put, in the hands of trauma surgeons and emergency physicians, the SAPB and ESPB have the potential to reduce suffering, decrease opiate use, lower rates of in-hospital delirium, and improve pulmonary function in patients with acute rib fractures [16,17]. Widespread use of these nerve blocks could radically improve the quality of care provided to

acutely injured patients with rib fractures. This potential benefit is even greater in austere, rural, or under-resourced health systems.

Conclusion

In managing the pain of patients with acute rib fractures, we cannot rely exclusively on systemic analgesics nor should the burden of providing RA fall solely on the shoulders of anesthesiologists. The SAPB and ESPB are safe, simple, and can easily be incorporated into the therapeutic armamentarium of any provider who routinely cares for trauma patients. As more providers become capable and confident with the use of these nerve blocks, we will begin to rectify the current dismal shortfall in RA use for patients with acute rib fractures.

References

- [1] E.M. Bulger, M.A. Arneson, C.N. Mock, G.J. Jurkovich, Rib fractures in the elderly, *J. Trauma* 48 (6) (2000 Jun) 1040–1046, <https://doi.org/10.1097/00005373-200006000-00007>, discussion 1046–7. PMID: 10866248.
- [2] A.M. Ho, M.K. Karmakar, L.A. Critchley, Acute pain management of patients with multiple fractured ribs: a focus on regional techniques, *Curr. Opin. Crit. Care* 17 (4) (2011 Aug) 323–327, <https://doi.org/10.1097/MCC.0b013e328348bf6f>. PMID: 21716105.
- [3] S.M. Galvagno Jr., C.E. Smith, A.J. Varon, E.A. Hasenboehler, S. Sultan, G. Shaefer, K.B. To, A.D. Fox, D.E. Alley, M. Ditillo, B.A. Joseph, B.R. Robinson, E. R. Haut, Pain management for blunt thoracic trauma: a joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society, *J. Trauma Acute Care Surg.* 81 (5) (2016 Nov) 936–951, <https://doi.org/10.1097/TA.0000000000001209>. PMID: 27533913.
- [4] F.A. Cheema, E. Chao, J. Buchsbaum, et al., State of rib fracture care: a NTDB review of analgesic management and surgical stabilization, *Am. Surg.* 85 (5) (2019) 474–478.
- [5] V. Thiruvengadarajan, H. Cruz Eng, S.D. Adhikary, An update on regional analgesia for rib fractures, *Curr. Opin. Anaesthesiol.* 31 (5) (2018 Oct) 601–607, <https://doi.org/10.1097/ACO.0000000000000637>. PMID: 30020155.
- [6] E. Durant, B. Dixon, J. Luftig, D. Mantuani, A. Herring, Ultrasound-guided serratus plane block for ED rib fracture pain control, *Am. J. Emerg. Med.* 35 (1) (2017 Jan) 197.e3–197.e6, <https://doi.org/10.1016/j.ajem.2016.07.021>. Epub 2016 Jul 19. PMID: 27595172.
- [7] J. Luftig, D. Mantuani, A.A. Herring, B. Dixon, E. Clattenburg, A. Nagdev, Successful emergency pain control for posterior rib fractures with ultrasound-guided erector spinae plane block, *Am. J. Emerg. Med.* 36 (8) (2018 Aug) 1391–1396, <https://doi.org/10.1016/j.ajem.2017.12.060>. Epub 2017 Dec 28 PMID: 29301653.
- [8] R. Blanco, T. Parras, J.G. McDonnell, A. Prats-Galino, Serratus plane block: a novel ultrasound-guided thoracic wall nerve block, *Anaesthesia* 68 (11) (2013) 1107–1113.
- [9] C.M. Spofford, R.W. Hurley, Preventive analgesia, in: *Essentials of Pain Medicine*, Elsevier, 2018.
- [10] K.J. Chin, Thoracic wall blocks: from paravertebral to retrolaminar to serratus to erector spinae and back again - a review of evidence, *Best Pract. Res. Clin. Anaesthesiol.* 33 (1) (2019 Mar) 67–77, <https://doi.org/10.1016/j.bpa.2019.02.003>. Epub 2019 Apr 5 PMID: 31272655.
- [11] D.J. Williams, J.D. Walker, A nomogram for calculating the maximum dose of local anaesthetic, *Anaesthesia* 69 (8) (2014 Aug) 847–853, <https://doi.org/10.1111/anae.12679>. Epub 2014 May 12 PMID: 24820093.
- [12] R. Sean Morrison, Eitan Dickman, Ula Hwang, Saadia Akhtar, Taja Ferguson, Jennifer Huang, Christina L. Jeng, Bret P. Nelson, Meg A. Rosenblatt, Jeffrey H. Silverstein, Reuben J. Strayer, Toni M. Torrillo, Knox H. Todd, Regional nerve blocks improve pain and functional outcomes in hip fracture: a randomized controlled trial, *J. Am. Geriatr. Soc.* 64 (12) (2016) 2433–2439.
- [13] A. Scurrah, C.T. Shiner, J.A. Stevens, S.G. Faux, Regional nerve blockade for early analgesic management of elderly patients with hip fracture – a narrative review, *Anaesthesia* 73 (6) (2018) 769–783, <https://doi.org/10.1111/anae.14178>.
- [14] A. Chuan, L. Zhao, N. Tillekeratne, et al., The effect of a multidisciplinary care bundle on the incidence of delirium after hip fracture surgery: a quality improvement study, *Anaesthesia* 75 (1) (2019) 63–71, <https://doi.org/10.1111/anae.14840>.
- [15] B. Johnson, A. Herring, S. Shah, M. Krosin, D. Mantuani, A. Nagdev, Door-to-block time: prioritizing acute pain management for femoral fractures in the ED, *Am. J. Emerg. Med.* 32 (7) (2014) 801–803, <https://doi.org/10.1016/j.ajem.2014.03.027>.
- [16] N. Hernandez, J. de Haan, D. Clendeninn, D.E. Meyer, S. Ghebremichael, C. Artime, G. Williams, H. Eltzschig, S. Sen, Impact of serratus plane block on pain scores and incentive spirometry volumes after chest trauma, *Local Reg. Anesth.* 2 (12) (2019 Aug) 59–66, <https://doi.org/10.2147/LRA.S207791>. PMID: 31447581; PMCID: PMC6684485.
- [17] K.M. O'Connell, D.A. Quistberg, R. Tessler, B.R.H. Robinson, J. Cuschieri, R.V. Maier, F.P. Rivara, M.S. Vavilala, P.I. Bhalla, S. Arbabi, Decreased risk of delirium with use of regional analgesia in geriatric trauma patients with multiple rib fractures, *Ann. Surg.* 268 (3) (2018 Sep) 534–540, <https://doi.org/10.1097/SLA.0000000000002929>. PMID: 30048325.