PROCEDURAL REPORT

The Occasional ultrasound-guided serratus anterior plane blockade

Carmen L. Soltys[1,2], Eugene P. Landsbergen[2], Corbin E. Chenger[2,3]

[1]PGY-1 Department of Obstetrics, Gynecology and Reproductive Sciences, University of Manitoba, Winnipeg, [2]Department of Family Medicine, University of Calgary Cumming School of Medicine, Calgary, [3]PGY-1 Department of Family Medicine, University of Saskatchewan, Saskatoon, Canada

Correspondence to: Carmen L. Soltys, carmen.soltys1@ucalgary.ca

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INTRODUCTION

An 85-year-old male presents to the emergency department with right-sided chest wall pain and shortness of breath after a ground-level fall. The chest X-ray shows anterior, non-displaced fractures in ribs 6–8 and a small pneumothorax on the right. The patient's comorbidities include chronic obstructive pulmonary disease, lung cancer and brain metastases. His vitals are stable, and his pneumothorax is managed conservatively on 15 L oxygen through a non-rebreather mask. Despite receiving IV hydromorphone, he is in severe pain and taking shallow, frequent breaths. You wonder if there is an alternative to further opioid analgesia at this time.

The rural physician is no stranger to chest wall trauma. From high-velocity accidents to ground-level falls, rib fractures and pneumothorax are common in the rural emergency department. Effective pain management is essential to prevent splinting of respirations and subsequent complications such as atelectasis and pneumonia. Elderly patients (age >65) are more likely to be admitted to a hospital and die due to complications from rib fractures.[1] Opioids are often used to manage chest wall pain and can have unwanted side effects of respiratory depression, suppression of cough reflex, sedation and delirium.

Regional anaesthetic techniques, including epidural and local nerve blockade, have gained popularity in the management of chest wall pain. Epidurals and spinals can be effective for managing pain, but are time-consuming, often unavailable in a rural setting, and not indicated for high chest wall injuries.[2] Local intercostal nerve blockade is possible but impractical and risks causing pneumothorax.

The serratus anterior plane block (SAPB) is an effective, simple and safe regional anaesthetic technique that can be performed by any rural emergency physician with a basic knowledge in ultrasound.[3-9] SAPB provides analgesia to the anterolateral chest wall through blockade of the lateral cutaneous branches of the thoracic intercostal nerves.[10,11] A large volume of dilute local anaesthetic is deposited in the fascial plane superficial to the serratus anterior muscle, and the motion of the chest wall with respiration distributes

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the anaesthetic throughout the fascial plane from approximately T2-12.[11] SAPB decreases subjective pain scores and improves pulmonary function for up to 24 h after administration, depending on the local anaesthetic chosen.[3]

Here, we describe a procedure for ultrasound-guided SAPB that we have found effective in our rural ED.

ANATOMY

The chest wall is primarily innervated by pairs of thoracic intercostal nerves (T1–T11) and subcostal nerves (T12). These nerves innervate skin, muscle, parietal pleura and the periosteum of the rib. The intercostal nerve travels in the costal groove on the inferior margin of each rib through the intercostal muscles. In the mid-axillary line, the nerve gives off a collateral lateral cutaneous branch, which penetrates through the intercostal and serratus anterior muscles to lie in the fascial plane superficial to the serratus anterior.[12]

The serratus anterior muscle covers the lateral chest wall from the anterior margin of ribs 1–10 to the vertebral margin of the scapula. It lies immediately superficial to the ribs and intercostal muscles. It can be visualised on surface anatomy between the pectoralis and latissimus dorsi muscles [Figure 1]. The superficial serratus fascial plane travels between the serratus anterior and the latissimus dorsi.[12] The thoracodorsal artery travels within the superficial serratus fascia in the mid-axillary line and can be used as a landmark to identify the correct plane with Doppler ultrasound.

EQUIPMENT

- Ultrasound with high-frequency linear probe (13-6 MHz)
- Sterile ultrasound gel and sterile probe cover
- Sterile procedure tray
- Sterile gloves
- Sterile skin marker
- Antiseptic skin cleansing agent
- 5-10-mL 1% lidocaine with epinephrine in syringe with 27G needle for skin wheal
- 30-mL 0.25% bupivacaine (one can mix 15-mL 0.5% bupivacaine mixed with 15-mL normal saline in a 30-mL syringe) connected to extension tubing

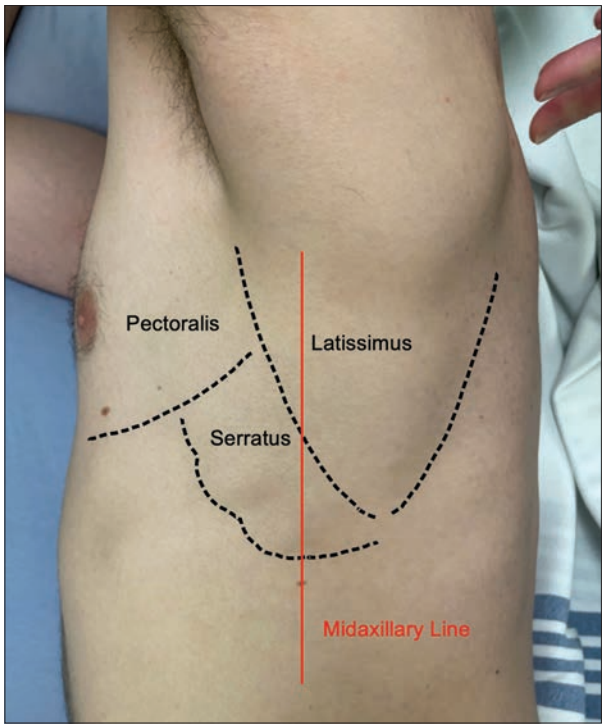

Figure 1: Superficial anatomy in the lateral decubitus position. Gross anatomic structures in the right lateral decubitus position are shown. The patient rests their arm above their head displaying the latissimus dorsi, serratus anterior and pectoralis muscles.

- 22G 50-mm needle. For better visibility, we use a SonoTAP needle with a facet tip. There are many similar echogenic needles on the market (20-22G, preferably a shorter bevel to illicit fascial pop).

PROCEDURE

Pre-procedure

1. Obtain informed consent from the patient. Tables 1 and 2 list contraindications and complications of the SAPB procedure
2. Ensure IV access and place the patient on continuous cardiac monitoring with pulse oximetry
3. Review the possibility of local anaesthetic toxicity, and be aware of access to lipid emulsion therapy if needed. The maximum permissible dose of bupivacaine without epinephrine is 2.5 mg/kg.[13]

Landmarking

1. Have the patient lie in the lateral decubitus position on the side contralateral to their injury with the arm resting above the head, as shown

Table 1: Contraindications to serratus anterior plane blockade
Absolute
Overlying soft-tissue infection at the site of injection
Allergy to local anaesthetic
Relative
Disruption to anatomy from scarring or previous injury
Patient unable to tolerate supine or lateral decubitus position for an extended period of time

Table 2: Potential complications of serratus anterior plane blockade
Failure to provide analgesia
Rebound pain
Intramuscular injection and myotoxicity
Infection
Haematoma
Local anaesthetic systemic toxicity
Pneumothorax

in Figure 1. The supine position is acceptable if lateral decubitus is not tolerated

2. Observe the surface anatomy of the pectoralis anteriorly, latissimus posteriorly and the serratus anterior in between [Figure 1]
3. Place the linear ultrasound probe transversely, in the mid-axillary line, at the level of the nipple (4-5th intercostal space), with the probe marker pointing towards the nipple, as demonstrated in Figure 2
4. Identify, with ultrasound, the landmarks of the rib shadows and pleural line, as shown in Figure 3. The serratus anterior is the muscular structure immediately superficial to the ribs, while the intercostal muscles lie between the rib shadows immediately above the pleural line. The edge of the latissimus will be visible superior and posterior to the serratus and will act as a landmark for the superficial serratus anterior plane. Figure 3 demonstrates the superficial fascial plane that is the target for anaesthetic deposition
5. Table 3 offers additional suggestions for how to landmark on ultrasound
6. Place a gentle mark on the patient's skin at the posterior end of the transducer, which will be the entry point for the needle

Set up a sterile field

1. Set up a sterile field and avoid contamination from non-sterile items

Figure 2: Placement of the ultrasound probe and needle insertion technique. The probe is placed in the mid-axillary line at the level of the nipple, with the probe marker towards the nipple. The needle is inserted in-plane to the probe at the posterior end of the probe.

2. Use an aseptic wash to clean the patient's skin and place sterile dressings to create a large clean area to work with
3. Sanitise the ultrasound probe, and place a sterile transparent dressing (e.g., Tegaderm) or a sterile probe cover over the probe

Anaesthetic injection

1. We recommend using a two-provider technique, one to hold the ultrasound probe and insert the needle and the other to inject the anaesthetic
2. Use 5 mL of 1% lidocaine with epinephrine to raise a small skin wheal and anesthetise the needle track at the marked site of needle entry
3. Place the ultrasound probe transversely in the same spot as previously landmarked. Insert the 22G 50-mm needle at the posterior end of the transducer [Figure 2], in-plane, taking care to continuously visualise the needle tip with the transducer. Aim for the anterior fascial plane between the latissimus and the serratus; a pop may be felt in the needle once the plane is entered. Aspirate to confirm the absence of vascular puncture, and then slowly inject 1-2 mL of the 0.25% bupivacaine
4. On ultrasound, fluid within the fascial plane will immediately separate the fascia and move away from the needle tip, while anaesthetic placed in muscle will not. Figure 4 demonstrates the separation of serratus and latissimus as fluid is injected into the correct fascial plane. Once

anaesthetic deposition in the correct plane is confirmed, slowly inject the full 30 mL of bupivacaine in a continuous fashion, aspirating intermittently to confirm the absence of vascular puncture and always visualising the needle tip.

It will take approximately 15-30 min for the anaesthetic to take full effect. The patient should be monitored for 30 min after the procedure for signs of local anaesthetic systemic toxicity.

CONTRAINDICATIONS

Absolute contraindications to SAPB are overlying soft-tissue infection at the planned site of injection and allergy to local anaesthetic medications.[14] Antecedent trauma may grossly disrupt anatomic planes and thus preclude successful SAPB. Relative contraindications include disruption to anatomic planes from scarring or fibrosis and inability of the patient to tolerate the lateral decubitus or supine position for a prolonged period of time.[14] Stabilisation and emergent transport to a tertiary care centre for life-saving interventions should not be delayed to administer SAPB.

Table 3: Additional tips for landmarking the superficial serratus anterior plane

Rotate the transducer slightly clockwise or counterclockwise to bring structures into view
Move the probe posteriorly and cranially if unable to visualise the latissimus
Use Doppler to identify the thoracodorsal artery, which travels in the mid-axillary line in the target superficial serratus plane

COMPLICATIONS

While incidence is not well documented, more common complications of SAPB may be failure to provide adequate analgesia, rebound pain as the anaesthetic wears off and unintentional intramuscular injection of local anaesthetic. Failure to provide adequate analgesia is likely the most common, and patients should be made aware of this possibility.[3] The use of ultrasound to confirm injection of anaesthetic into the fascial plane will mitigate the risk of inadvertent intramuscular injection. The potential for local anaesthetic myotoxicity should be considered, although there is limited research regarding the risk or clinical relevance of myotoxicity from fascial plane injection. Myotoxicity, in general, is more likely when there is a high concentration of local anaesthetic or multiple injections.[15]

Other rare complications of SAPB include local anaesthetic systemic toxicity, infection, haematoma and pneumothorax. Local anaesthetic systemic toxicity is possible whenever an anaesthetic is administered, thus care should be taken to ensure that the maximum permissible dose of bupivacaine is not exceeded. Haematoma and infection are conceivable risks, although the incidence of such is unknown and larger studies are needed to comment

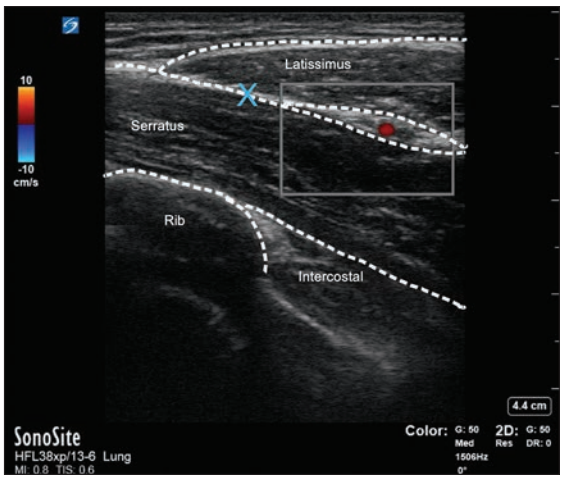

Figure 3: Ultrasound visualisation of the latissimus dorsi and serratus anterior. Colour Doppler has been used to locate the thoracodorsal artery, which appears as a red spot in the photo. A blue X marks the superficial fascial plane.

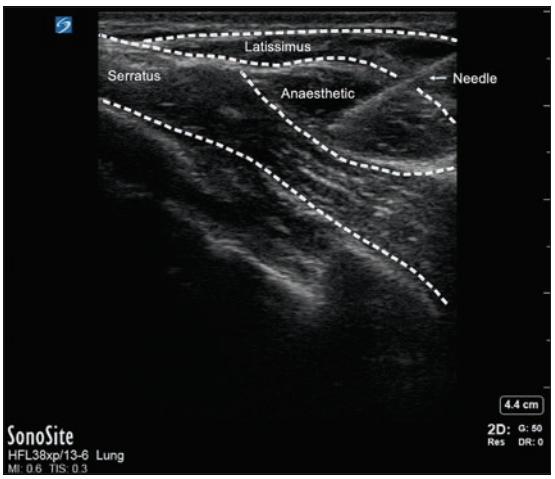

Figure 4: Anaesthetic deposition visualised by ultrasound. An echogenic needle is inserted in-plane to the ultrasound probe and into the superficial serratus anterior fascial plane. Bupivacaine is deposited, creating a separation between the serratus anterior and the latissimus dorsi.

on such. Cessation of Venous thromboembolism prophylaxis is not required before SAPB, but care should always be taken to avoid major vessels.[3,4,6] Pneumothorax is improbable if targeting the superficial serratus plane and would require a major deviation from the described method. There is only one incidence of pneumothorax resulting from SAPB found in the literature, and the authors were targeting the deep serratus anterior plane in that case.[16] We know of no reports of pneumothorax when targeting the superficial plane, and continuous visualisation of the needle entering the chest wall will minimise that risk further. In general, good provider technique and visualisation of the needle and anaesthetic entering the fascial plane will minimise the incidence of complications.

While discussed in this article as a pain management strategy for rib fractures, SAPB has also been used in the acute care setting for the management of herpes zoster pain, and discomfort from chest tube placement.[5,8] SAPB appears to be most effective in treating anterolateral, superficial chest wall pain and may not be a reliable sole source of analgesia in chest tube insertion.[3,4,8,11] However, SAPB can significantly reduce discomfort associated with chest tube placement and make the procedure more tolerable for patients.[8] Potential limitations to this technique include the patient's capacity to consent and their ability to cooperate with positioning. Variations on the technique described include placement of an epidural catheter in the superficial serratus plane for a longer duration of pain control, the methods of which are described elsewhere.[7]

In the case described earlier, we felt that giving further opioid analgesia would be unhelpful and instead performed a SAPB on the patient. Within 30 min, his respiratory rate had slowed, and he was comfortably taking deep respirations. The patient was admitted for observation and developed no further complications from his rib fractures.

CONCLUSION

SAPB is an effective and safe way to manage chest wall pain in the ED, providing pain relief for 12-24 h after injection and is technically simple to perform.

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