Chapter 29

Brachial Plexus Blocks Above the Clavicle

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Interscalene Block

Definition

Interscalene brachial plexus block involves injecting local anesthetic around the trunks of the brachial plexus between the anterior and middle scalene muscles at the level of the cricoid cartilage.

Background

Interscalene brachial plexus block is widely used for postoperative analgesia following open and arthroscopic shoulder surgery [1]. Interscalene block is also effective for analgesia following surgery on the clavicle, although in this context, this is likely related to involvement of the cervical plexus. Interscalene block performed using landmark, paresthesia and nerve stimulator-guided techniques have traditionally used large volumes of local anesthetic. Recently, ultrasound-guided techniques have changed the practice of interscalene brachial plexus block. Ultrasound-guided techniques including interscalene block are associated with superior success rates, and both reduced side effects and local anesthetic requirements when compared to traditional techniques [2–4]. For these reasons, this chapter will largely focus on ultrasound technology as the localizing and monitoring technique used for interscalene block. Interscalene block is suitable for both single-injection and continuous techniques.

Anatomy

The brachial plexus is formed from the ventral rami of the C5–C8 and T1 spinal nerves. The roots located within or close to the intervertebral foramen form trunks located between the anterior and middle scalene muscles (the C5–C6 rami unite to form the superior trunk near the medial border of the middle scalene muscle). The anterior and middle scalene muscles run obliquely between the anterior and posterior tubercles (respectively) of the cervical transverse processes and the first rib. The space between the scalene muscles is often described as the interscalene groove and both the brachial plexus (roots, trunks and divisions) and the subclavian artery are located between the muscles. The interscalene approach to the brachial plexus targets the trunks of the brachial plexus between the anterior and middle scalene muscles. Landmark and nerve stimulator techniques use the cricoid cartilage to determine the C6 level. The main targets are the upper (C5, C6 origins) and middle trunks (C7 origin). The neural elements of brachial plexus at this level do not have an extensive connective tissue component compared to a distal peripheral nerve complex. The brachial plexus is deep to the prevertebral layer of the deep cervical fascia, which attaches to the anterior tubercles of the C3–C6 vertebrae. Anatomical variations of the brachial plexus include it being located in the anterior scalene muscle. Medial to the anterior scalene muscle is the carotid sheath and its contents and the entry of the vertebral artery into the transverse foramen of the C6 vertebrae. Deep to the carotid sheath is loose areolar tissue separating it from the prevertebral fascia and the longus colli muscle. Anatomical surface landmarks include the interscalene groove, sternocleidomastoid muscle, and cricoid cartilage. Vascular structures in this region include the superficial cervical artery and vein (usually superficial to the prevertebral fascia) and the external jugular vein [5].

Indications

Surgical

Interscalene brachial plexus block is commonly used for postoperative analgesia following open and arthroscopic shoulder surgery [1]. It is also effective for surgery on the clavicle although the effectiveness of interscalene block for this surgical type is likely related to involvement of the cervical plexus. Interscalene block can be used for surgical anesthesia reducing the risk of side effects associated with general anesthesia [6].

Therapeutic

Interscalene brachial plexus block has also been used for chronic conditions involving the shoulder including frozen shoulder and other conditions where the block facilitates physiotherapy.

Evidence and Safety

The versatility of interscalene brachial plexus block is demonstrated by a study by Roxeborough and colleagues where regional anesthesia was the main component of the intraoperative anesthetic technique, potentially reducing the hemodynamic effects of the sitting position by avoiding general anesthesia and/or positive pressure ventilation [6]. Compared to patients having single-injection interscalene block or general anesthesia, patients receiving continuous interscalene block for outpatient rotator cuff repair surgery had improved pain scores at 7 days following surgery. This study demonstrated intermediate benefits of a continuous technique beyond the early postoperative period and 48 h of local anesthetic infusion [7]. Interscalene brachial plexus block has been subject to large-scale studies investigating quality and safety [1, 8–15].

Contraindications

General

Local infection and skin disease
Patient refusal

Relative

Coagulopathy
Reduced pulmonary reserve

Absolute

Contralateral interscalene block
Contralateral paresis of the recurrent laryngeal or phrenic nerve
Contralateral pneumonectomy or pneumothorax

Advantages/Disadvantages

Advantages

Relatively straightforward anatomy and superficial targets even in obese subjects.
Ultrasound-guided technique can be successful with low dosage techniques.
Suitable for continuous catheter techniques.

Disadvantages

Phrenic nerve blockade is a common side effect.
Being close to the neuraxis introduces specific risks.
The C8 and T1 ventral rami are incompletely anesthetized resulting in incomplete blockade of the medial border of the forearm and hand.

Procedure

Preparation

As with all regional anesthesia procedures, requirements include emergency equipment, monitoring, and assistance.

Materials and Disposables

A 25-mm high-frequency (e.g., 10–13 MHz) linear array transducer is suitable.

Sterile ultrasound probe cover and gel for all procedures.
Routine disposables including fenestrated drape and dressings.

22-gauge 50 mm short-bevel needle for single-injection and 18-gauge Tuohy needle for a continuous catheter technique.

Ten to fifteen milliliter of local anesthetic for block (see section on "Local anesthetic dosage, volume and spread")

Patient Positioning

For single-injection technique, supine with head turned to contralateral side.

For a continuous catheter technique, the patient is placed in the lateral position and a posterior approach is used.

Ergonomics and Pre-scanning

We suggest positioning the ultrasound machine on the opposite side of the bed/trolley at the level of the patient's mid-torso so that the operator looks over the patient's shoulder to directly face the screen. The operator can then position the probe with his/her nondominant hand and advance the needle in-plane using his/her dominant hand. The advantage of these ergonomics is that there is a direct line of sight from the operator's eye over the probe and the in-plane needle toward the ultrasound screen. The same configuration works for both left-sided and right-sided blocks and for both left-handed and right-handed operators.

A sonogram required for an interscalene block is relatively straightforward to obtain and this is in part related to the superficial location of key structures. Figure 29.1a, b demonstrate the approximate transducer positions in the posterior triangle of the neck for the interscalene and supraclavicular approaches respectively and their corresponding sonograms. There are two techniques for assisting in identification of the sonoanatomy of the interscalene brachial plexus block. We recommend identifying the sonoanatomy of the supraclavicular block in the supraclavicular fossa (Fig. 29.1b) and then tracing the plexus proximally (Fig. 29.1a). Alternatively, the sternocleidomastoid may be identified overlying the carotid artery and internal jugular vein and from this position the transducer may be slid laterally. The sternocleidomastoid tapers laterally, and the scalene muscles can be located just deep to its posterior border (Fig.29.1c). Dynamic scanning from the divisions of the brachial plexus proximally to the level of the trunks (and vice versa) is effective for training in imaging the brachial plexus [16]. Note that the transducer movement required to obtain these distinct sonograms is slight (Fig. 29.1a, b). As the scalene muscles course distally, progressively more muscle fibers join from the transverse processes of the lower cervical vertebrae. Consequently, the scalene muscles may be best visualized on ultrasound more caudal than the landmark technique at the level of the cricoid cartilage (C6). This explains why ultrasound-guided interscalene block is often performed with a more caudal needle insertion point compared to landmark techniques. The needle trajectory is commonly a lateral to medial in-plane approach (Fig. 29.1a). This is a significant departure from the landmark technique where the needle entry point for is more cephalad and medial.

The ultrasound appearance of the plexus at the interscalene level can be described as multiple [3, 4] hypoechoic round or oval structures. The neural structures at the interscalene level have reduced connective tissue compared to the divisions; therefore, the targets for interscalene blockade are relatively hypoechoic. Proximal to the interscalene level, the roots of the brachial plexus can be identified adjacent to the transverse processes. The morphology of the cervical transverse processes determines cervical level and therefore the neural origins. The C6 transverse process has a prominent anterior tubercle, and the C7 transverse process has no anterior tubercle. Color Doppler is recommended to scan for vessels in the planned needle trajectory. The vertebral artery may be imaged close to the C7 transverse process deep to the scalene muscles. Other vessels imaged in the neck include the inferior thyroid, transverse cervical (and its descending dorsal scapular branch) and suprascapular arteries. The C5 transverse process has tubercles of even size producing a symmetrical "U" shape on the sonogram. The phrenic nerve can be imaged as a small hypoechoic structure anterior to the anterior scalene muscle only a few mm away from the brachial plexus [17].

Injection Technique: General Comments

For a single shot technique, sterile gloves should be worn and skin asepsis adhered to. For continuous catheter technique, we recommend a full aseptic technique and barrier precautions (gown, gloves, and facemask). Interscalene block is suitable for either in-plane or out-of-plane techniques. Standard strategies to improve in-plane needle imaging are important and particular vigilance must be taken to keep the needle tip in view.

a

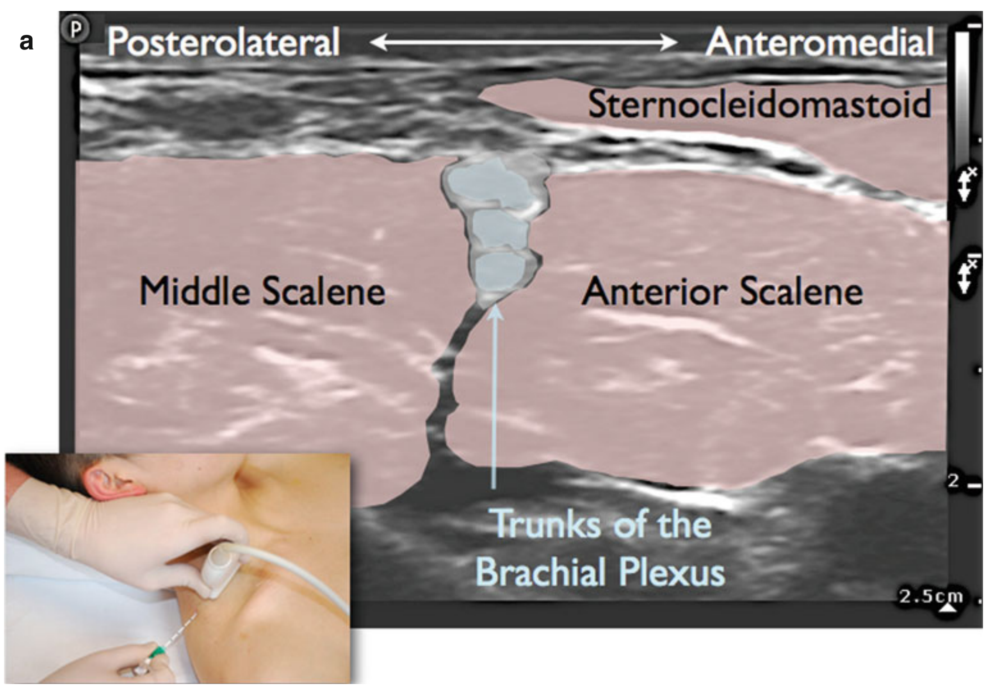

Fig. 29.1 (**a**) Transducer position and corresponding sonogram for the interscalene approach to the brachial plexus. (**b**) Transducer position and corresponding sonogram for the supraclavicular approach to the brachial plexus. (**c**) The great vessels of the neck can be used as a readily identifiable sonoanatomical landmark by which the sternocleidomastoid and scalene muscles (and therefore the brachial plexus) can be located (The inset figure showed the position of the ultrasound probe and the direction of the needle insertion)

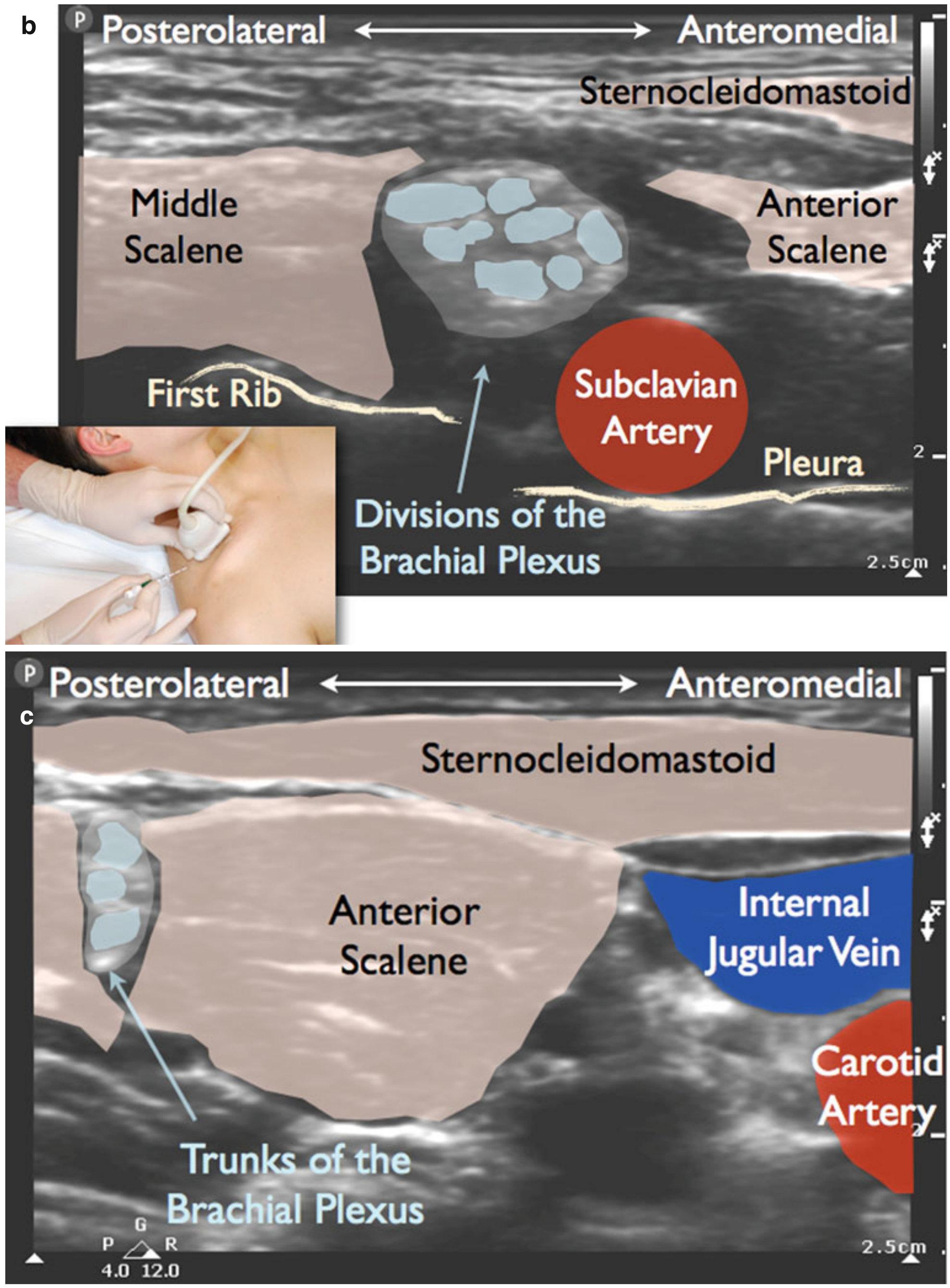

Fig. 29.1 (Continued)

Ultrasound-Guided Approaches

Single-Injection Techniques

The authors' preferred needle trajectory is from lateral to medial (through the middle scalene muscle) using an in-plane technique (Fig. 29.1a). It is sometimes necessary to adopt a brief steep initial needle trajectory in order to pierce the prevertebral layer of the deep cervical fascia that overlies the middle scalene muscle. Once this "pop" has been felt, the needle should be flattened out and advanced toward the plexus. In the authors' experience ultrasound guidance alone is adequate and nerve stimulator guidance is not usually required. The needle is advanced, and a second "pop" may be felt as the needle tip passes through the anterior border of the middle scalene muscle and the plexus. Incremental injection of 1–2 mL of local anesthetic can be used at this point to hydrodissect the plane between the muscles and plexus. Care should be taken to avoid local anesthetic being deposited inside the belly of the middle scalene muscle. Injection of local anesthetic on one side of the trunks at the C5–C7 level should be sufficient.

Continuous Catheter Techniques

The authors' preferred needle trajectory is similar to single-injection techniques except the ultrasound transducer is rotated slightly and translated so that the needle entry point is positioned more cephalad and posterior taking the catheter skin entry point away from the surgical site. The needle trajectory now has a slight caudad angulation. Separating the needle skin entry point increases ease of needle visualization and also creates a tunnel for the catheter, reducing risk of dislodgement. Figure 29.2 demonstrates a patient positioned on their side for an interscalene catheter placement using a posterior in-plane approach. Figure 29.3a demonstrates the needle trajectory with needle at muscle–plexus interface and Fig. 29.3b the post-injection displacement of the middle scalene muscle. The sonogram in Fig. 29.3c shows the catheter following removal of needle. Note that the rotation of the probe may distort the image such that the trunks of the brachial plexus are less well demarcated and the sternocleidomastoid and middle scalene muscles appear elongated. The catheter tip position should be determined before commencing a local anesthetic infusion.

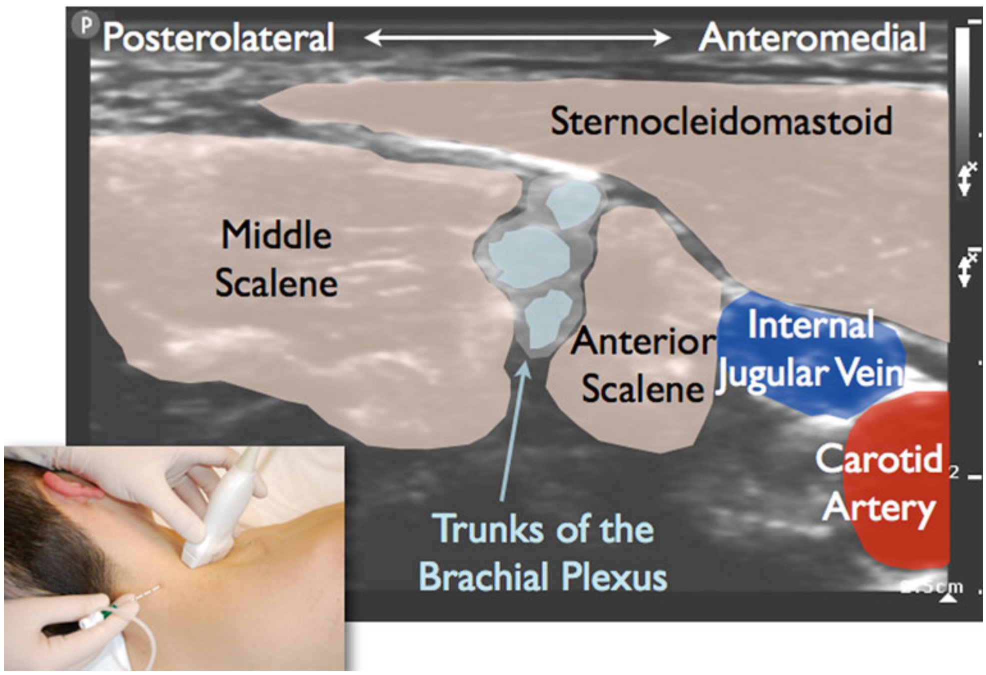

Fig. 29.2 When inserting a continuous interscalene catheter for shoulder surgery, it is desirable to maximize the distance between the needle insertion point and the surgical site (The inset figure showed the position of the ultrasound probe and the direction of the needle insertion)

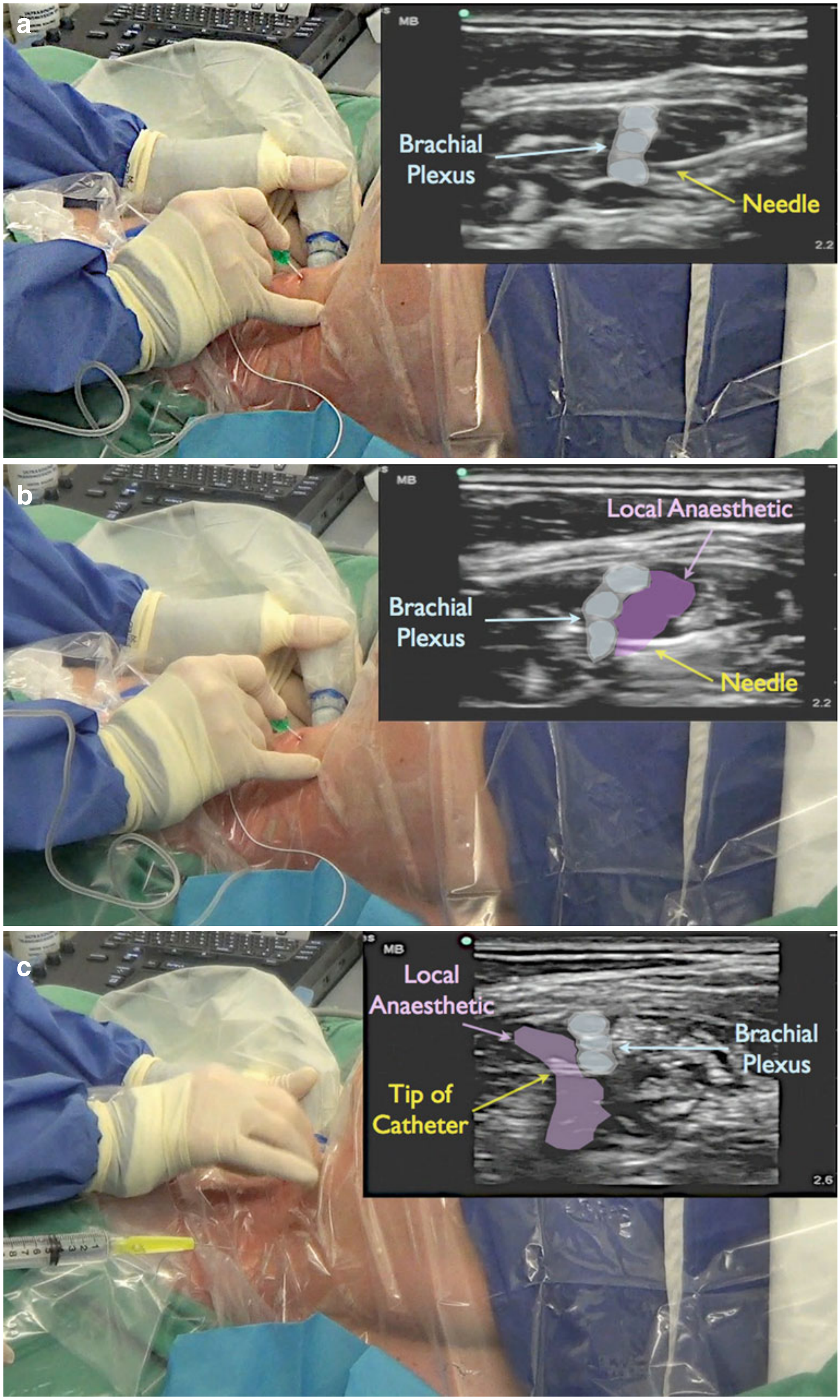

Fig. 29.3 (**a**) Continuous interscalene catheter technique with needle tip located at the anterior border of the middle scalene muscle just posterior to the trunks of the brachial plexus. (**b**) Local anesthetic has been injected separating the trunks of the brachial plexus from the middle scalene muscle. (**c**) A catheter has been threaded beyond the brachial plexus and withdrawn and its position confirmed by injecting through the catheter confirming spread of injectate around the trunks of the plexus (The inset figures showed the ultrasound images corresponded to the stages of the procedure)

Local Anesthetic Dosage, Volume, and Spread

Dosage

The ED_{95} required to achieve postoperative analgesia for C7 interscalene brachial plexus anesthesia has been calculated to be 3.6 mL of ropivacaine 0.75 % [18]. In routine practice, 10–15 mL of local anesthetic such as ropivacaine 0.2–0.75 % is appropriate. The exact concentration will depend on patient factors, the purpose of the block (analgesia or anesthesia), and if a catheter technique is used. If a catheter is placed, the initial dose can be reduced and additional local anesthetic can be injected through the catheter. An infusion of ropivacaine 0.2 % 4–10 mL/h is used for postoperative analgesia.

Distribution

The expected distribution of anesthesia following interscalene brachial plexus block is shown in Fig. 29.4 [19].

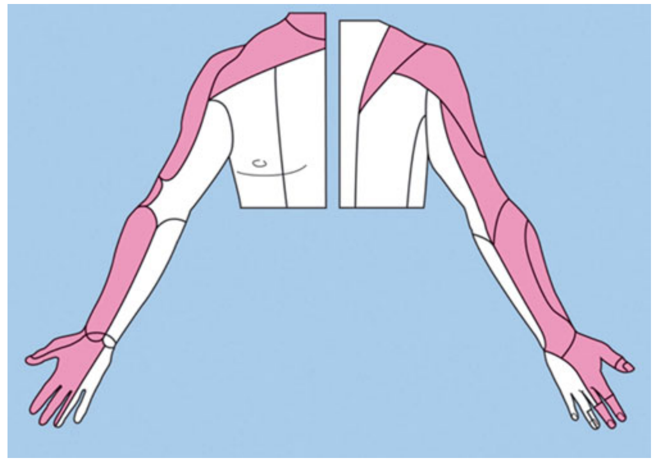

Fig. 29.4 Expected distribution of anesthesia following interscalene brachial plexus block (With permission from Danilo Jankovic)

Side Effects

Phrenic Nerve Block with Ipsilateral Hemidiaphragmatic Paralysis and Dyspnea

Phrenic nerve block occurs commonly following both interscalene and supraclavicular approaches to the brachial plexus. The proposed mechanism is that local anesthetic spreads across the anterior surface of the anterior scalene muscle and involves the phrenic nerve and/or there is cephalad spread toward C4. However, other mechanisms have been proposed including the existence of variations in the origin of the phrenic nerve from the brachial plexus itself [20, 21]. Usually phrenic nerve block is not of concern and management comprises patient reassurance. In patients with reduced pulmonary reserve, phrenic nerve block may be of concern; therefore strategies have been suggested to reduce the risk of phrenic nerve blockade. These strategies include dose reduction, using a more caudal target (C7), using ultrasound guidance, or avoiding interscalene block [22]. Following both interscalene and supraclavicular brachial plexus blockade, ultrasound guidance is associated with a reduced incidence of phrenic nerve paresis compared to nerve stimulator-guided techniques [23, 24].

Recurrent Laryngeal Nerve Block

This may present as hoarseness, occasionally stridor and a sensation of a lump in the throat. A case report has been published where it was thought that a deficient carotid sheath predisposed to recurrent laryngeal nerve block following continuous interscalene block [25].

Cervicothoracic Sympathetic Block

The cervicothoracic sympathetic trunk lies posterolaterally to the prevertebral fascia anterior to the longus colli muscle [26]. This is in close proximity to interscalene or supraclavicular brachial plexus block injection, hence involvement of the sympathetic trunk resulting in Horner's syndrome.

Complications

Pneumothorax

Pneumothorax should be rare with ultrasound-guided interscalene block. Strategies have been suggested to reduce the risk of pneumothorax following ultrasound-guided supraclavicular blockade [27].

Contralateral Spread of Local Anesthetic (Epidural or Intrathecal)

Contralateral spread is a rare complication of interscalene brachial plexus blockade [28, 29]. There may be more than one mechanism responsible for contralateral spread including spread in the tissue planes deep to the prevertebral fascia [30]. The risk of contralateral spread may be increased with increased exposure to the total dosage of local anesthetic (initial bolus and subsequent boluses or infusion). This complication should be taken into account when utilizing these techniques especially in the ambulatory setting.

Catheter Misplacement

Catheter location can be confirmed with a test dose and potentially ultrasound guidance.

Cervical Spinal Cord Injury

The risks associated with performing a procedure close to the neuraxis are clear with interscalene blockade. Permanent neurological injury has been reported following injection of local anesthetic into the cervical spinal cord when an interscalene block was performed under general anesthesia [31].

Vascular Injection

Injection of local anesthetic into the vertebral artery or branches of the thyrocervical trunk can lead rapidly to local anesthetic toxicity.

Nerve Injury

Postoperative nerve injury regardless of etiology is of concern to patients and health-care providers. The reader should be aware that the methods used to capture, define, and report neurologic outcomes vary considerably. A single-center study reported the incidence of postoperative neurologic symptoms including those following interscalene block greater than 6 months duration was 0.9 per 1,000 blocks (95 % confidence interval, 0.5–1.7) [13]. Observational studies consistently report that postoperative neurologic dysfunction may be related to patient and surgical factors and that the incidence of serious permanent neuropathy directly related to peripheral regional anesthesia is rare. Neurologic complications include brachial plexopathy or injury to the dorsal scapular or long thoracic nerve. These nerves pass through or close to the middle scalene muscle and therefore ultrasound-guided interscalene block with a needle trajectory through this muscle, potentially introduces a new risk. Permanent phrenic nerve palsy is also a recognized although likely rare complication of interscalene brachial plexus block [32]. Distal mononeuropathies (involving the median and ulnar nerve) can occur following shoulder surgery and interscalene block, and these complications should be carefully evaluated taking into account all possible causes. Neurologic deficits in the C5–C6 distribution are more likely to be block related, compared to deficits in the ulnar distribution [9].

Documentation

The following documentation is recommended following interscalene blockade: (1) needle type, length, and gauge; (2)

aseptic precautions, (3) anatomical, structures imaged; (4) monitoring techniques, verbal contact with a lightly sedated responsive patient, ultrasound guidance, nerve stimulation, injection pressure monitoring; (5) in-plane versus out-of-plane technique; (6) spread of local anesthetic; (7) local anesthetic dosage; and (8) complications.

Supraclavicular Block

Definition

Supraclavicular brachial plexus block involves injecting local anesthetic around the divisions of the brachial plexus deep to the prevertebral fascia posterolateral to the subclavian artery.

Background

Supraclavicular brachial plexus block was described in the early twentieth century by Kulenkampff and Persy [33] and was initially popular providing more effective anesthesia than other approaches to the brachial plexus. However, literature reviews and case series suggest an incidence of pneumothorax ranging from 0.5 to 6 % [34] and its popularity reduced [35]. Pneumothorax was the main deterrent to choosing this approach to the brachial plexus. More recently however, due to the popularity of ultrasound-guided regional anesthesia, with the potential to image the needle, brachial plexus, and pleura, the supraclavicular approach to the brachial plexus has increased in popularity as evidenced by case series [36], description of techniques [37], controlled clinical trials [38], and registries reports [11].

Anatomy

The anterior scalene muscle ends as a narrow tendon to insert on the scalene tubercle of the inner border of the first rib. Therefore, at this level, the anterior scalene muscle has a different morphology compared to at the interscalene level. In contrast, the middle scalene muscle inserts into a relatively larger area of the upper surface of the first rib (quadrangular area) and the muscle is relatively fleshy at the supraclavicular level. The prevertebral fascia over the brachial plexus at this level is well formed and distinct. The omohyoid muscle descends from the hyoid bone passes beneath the sternocleidomastoid over the carotid sheath to lie in the posterior triangle. The cylindrically shaped inferior belly of the omohyoid is often imaged and it passes almost horizontally above the level of the clavicle. The posterior triangle of the neck near the supraclavicular brachial plexus contains prominent vascular structures. These vessels include the dorsal scapular and suprascapular arteries (branches of the thyrocervical trunk or subclavian artery) often close to the planned needle trajectory or plexus and in some instances the vessels bisect the plexus [5].

Indications

Surgical

Supraclavicular brachial plexus block is indicated for surgery on the shoulder and entire upper extremity. Potentially supraclavicular block may miss the suprascapular nerve (C5 origin from the upper trunk) and supraclavicular nerve (C4 origin) from the cervical plexus, both important for innervation of the shoulder. Supraclavicular block may be "ulnar sparing" if local anesthetic fails to reach the anterior division of the inferior trunk due to its deep anteromedial location between the subclavian artery and the first rib. However a properly executed supraclavicular block has the potential to anesthetize the entire upper limb. It is suitable for surgical anesthesia or postoperative analgesia.

Evidence and Safety

Supraclavicular block is considered a reliable, fast-onset approach to the brachial plexus, and the term *spinal of the arm* reinforces this concept. However, randomized controlled trials have demonstrated that the supraclavicular approach has similar [38] or reduced [39, 40] efficacy compared to other approaches to the brachial plexus from below the clavicle. Controlled clinical trials also demonstrate that the rate of ulnar nerve sensory block is reduced following ultrasound-guided supraclavicular block compared to other approaches from below the clavicle [40, 41] and that the volume required for sensory blockade is not that different to the volume required using techniques not employing ultrasound guidance [42]. The supraclavicular block has been subject to large-scale studies investigating quality and safety [11, 36, 43].

Contraindications

General

Local infection and skin disease
Patient refusal

Relative

Coagulopathy
Reduced pulmonary reserve

Absolute

Contralateral supraclavicular block
Contralateral paresis of the recurrent laryngeal or phrenic nerve
Contralateral pneumonectomy or pneumothorax

Advantages/Disadvantages

Advantages

Relatively straightforward anatomy

Produces anesthesia/analgesia the entire upper extremity

Disadvantages

Phrenic nerve blockade is a common side effect.

Being close to the pleura introduces specific risk of pneumothorax.

The C8 and T1 ventral rami may have slow onset or incomplete blockade (medial border of forearm or hand).

The posterior triangle of the neck is a rich vascular area.

Not ideal for continuous catheter technique.

Procedure

Preparation

As with all regional anesthesia procedures, requirements include emergency equipment, monitoring, and assistance.

Materials and Disposables

A 25 mm width high-frequency (e.g., 10–13 MHz) linear array transducer is appropriate for most adult patients. Occasionally a morbidly obese patient has a deep target, and an intermediate frequency probe may be helpful for both tissue penetration and to increase the width of the field of view.

Patient Positioning

Supine with head turned to contralateral side

Ergonomics and Pre-scanning

Position the ultrasound machine so that the practitioner directly faces the screen. The exact location and arrangement of the bed/trolley, machine, regional trolley, and operator is influenced by personal preferences and handedness. The authors prefer to hold the needle for this approach with their dominant hand regardless of side blocked. Place the probe immediately cephalad to the clavicle along its lateral border. Slide the probe medially until the subclavian artery is identified as a large pulsatile hypoechoic structure. The brachial plexus between the anterior and middle scalene muscles can be traced from the interscalene to the supraclavicular level (Fig. 29.1a, b) and vice versa [16]. The change in morphology of the neural elements is distinct as the brachial plexus changes from trunks to divisions. The ultrasound appearance at the supraclavicular level can be described as a "bunch of grapes" or as having a "honeycomb" appearance. The plexus is immediately posterior and lateral to the artery. If the plexus is imaged immediately cephalad to the artery, the operator should tilt the transducer caudal so as to image the plexus so that it is posterolateral to the artery. This is the sonogram required for upper extremity anesthesia/analgesia. If the main surgical region is the proximal humerus, then a sonogram with the plexus immediately cephalad to the artery is appropriate.

Ultrasound-Guided Technique

Single-Injection Techniques

The authors' preferred needle trajectory is from lateral to medial using an in-plane approach. As with interscalene block, ultrasound guidance alone without nerve stimulation is adequate.

Continuous Catheter Techniques

In the author's experience, the supraclavicular block is not ideal for a continuous catheter technique. The catheter does not feed well and dislodgement is common at this location. However, a catheter at the more cephalad interscalene location can be directed caudal so that the catheter is located at the level of the divisions (refer to section "Continuous catheter technique," Interscalene brachial plexus block).

Local Anesthetic Dosage, Volume and Spread

Dosage

Surgical anesthesia: 25–30 mL ropivacaine 0.75 %; postoperative analgesia: 20–30 mL ropivacaine 0.2–0.5 %.

Distribution

The expected distribution of anesthesia following supraclavicular brachial plexus block is shown in Fig. 29.5 [19].

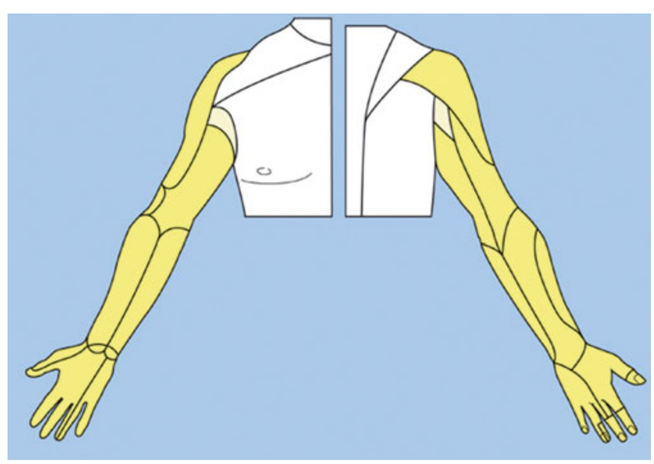

Fig. 29.5 Expected distribution of anesthesia following supraclavicular brachial plexus block (With permission from Danilo Jankovic)

Side Effects

Phrenic Nerve Block with Ipsilateral Hemidiaphragmatic Paralysis and Dyspnea

Phrenic nerve block occurs more commonly following interscalene than the supraclavicular approaches to the brachial plexus. There are variations in the origin of the phrenic nerve including from the brachial plexus itself [21]. Usually phrenic nerve block is not of concern and management comprises patient reassurance. Following both interscalene and supraclavicular brachial plexus blockade, ultrasound guidance is associated with a reduced incidence of phrenic nerve paresis compared to nerve stimulator-guided techniques [23, 24].

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Complications

Pneumothorax

Pneumothorax should be rare with ultrasound-guided techniques. Strategies have been suggested to reduce the risk of pneumothorax following ultrasound-guided supraclavicular blockade [27].

Vascular Injection

This risk relates to the vascular structures such as the dorsal scapular artery in the posterior triangle of the neck.

Nerve Injury

Postoperative nerve injury regardless of etiology is of concern to patients and health-care providers. The reader should be aware that the methods used to capture, define, and report neurologic outcomes vary considerably. A single-center study reported the incidence of postoperative neurologic symptoms including those following supraclavicular block greater than 6 months duration was 0.9 per 1,000 blocks (95 % confidence interval, 0.5–1.7) [13]. Observational studies consistently report that postoperative neurologic dysfunction may be related to patient and surgical factors and that the incidence of serious permanent neuropathy directly related to peripheral regional anesthesia is rare.

Documentation

The following documentation is recommended following supraclavicular blockade: (1) needle type, length, and gauge; (2) aseptic precautions; (3) anatomical, structures imaged; (4) monitoring techniques, verbal contact with a lightly sedated responsive patient, ultrasound guidance, nerve stimulation, injection pressure monitoring; (5) in-plane versus out-of-plane technique; (6) spread of local anesthetic; (7) local anesthetic dosage, and (8) complications.

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