Chapter

51

Upper Extremity Nerve Blocks

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A six-year-old previously healthy boy with diffuse right shoulder pain presents with osteosarcoma of the right scapula. The orthopedic surgeon has scheduled him for a right scapular resection of tumor. What are the options to provide regional anesthesia for this patient?

INTERSCALENE BLOCK

What Are the Options for Pain Control Postoperatively?

Surgical operations of the shoulder involve a significant amount of postoperative pain. A few options to treat the pain postoperatively include intravenous pain medications, with opiates being the foundation of a standard pain control regimen. In addition, NSAIDs and acetaminophen are frequently employed in a multimodal regimen. Administration of the opioid is most commonly done with patient-controlled analgesia (PCA). Opioid PCAs have been used extensively in children as young as eight years old with great efficacy and pain control. Children less than eight years of age may have difficulty using PCA. An alternative option would be an interscalene brachial plexus nerve block or catheter placement to manage postoperative pain control.

The brachial plexus innervates nearly the entire upper extremity. The plexus arises from the ventral rami of spinal nerves C5-T1 with occasional contribution from C4 and T2. The plexus transitions as it divides into the arm from five roots to three trunks to six divisions to three cords and five major branches. Each of the upper extremity nerve blocks targets a particular portion of the brachial plexus in its division (Figure 51.1).

Drs. Patel and Chandrakantan have contributed equally to this chapter to constitute first authorship.

What Are the Indications for an Interscalene Brachial Plexus Block?

An interscalene brachial plexus block is ideal for any operation involving the shoulder and upper extremity. It involves the blockade of the brachial plexus at the level of the superior (C5/C6), middle (C7), and inferior trunks (C8) in the interscalene groove between the anterior and middle scalene muscles. Since the suprascapular nerve arises off the brachial plexus just after the interscalene groove but prior to the supraclavicular position, a supraclavicular nerve block cannot reliably provide analgesia to operations involving the shoulder. There is a degree of ulnar sparing that occurs making the use of an interscalene block for procedures below the elbow less optimal than a supraclavicular, infraclavicular or axillary brachial plexus block. The block can be done as a single shot or with placement of a catheter to allow for continuous nerve blockade postoperatively to provide analgesia as well as facilitate initial rehabilitation and physical therapy.

What Are the Contraindications to Performing an Interscalene Block?

The standard contraindications for any regional block apply: patient refusal is an absolute contraindication. Relative contraindications include infection at planned injection site, preexisting neurologic deficits, local anesthetic allergy, coagulopathy, as well as impaired respiratory reserve such as contralateral phrenic nerve palsy, diaphragmatic impairment, or chronic obstructive pulmonary disease (COPD).

What Are the Complications and Side Effects Associated with an Interscalene Block?

The complications of an interscalene block include pneumothorax, epidural or subarachnoid injection,

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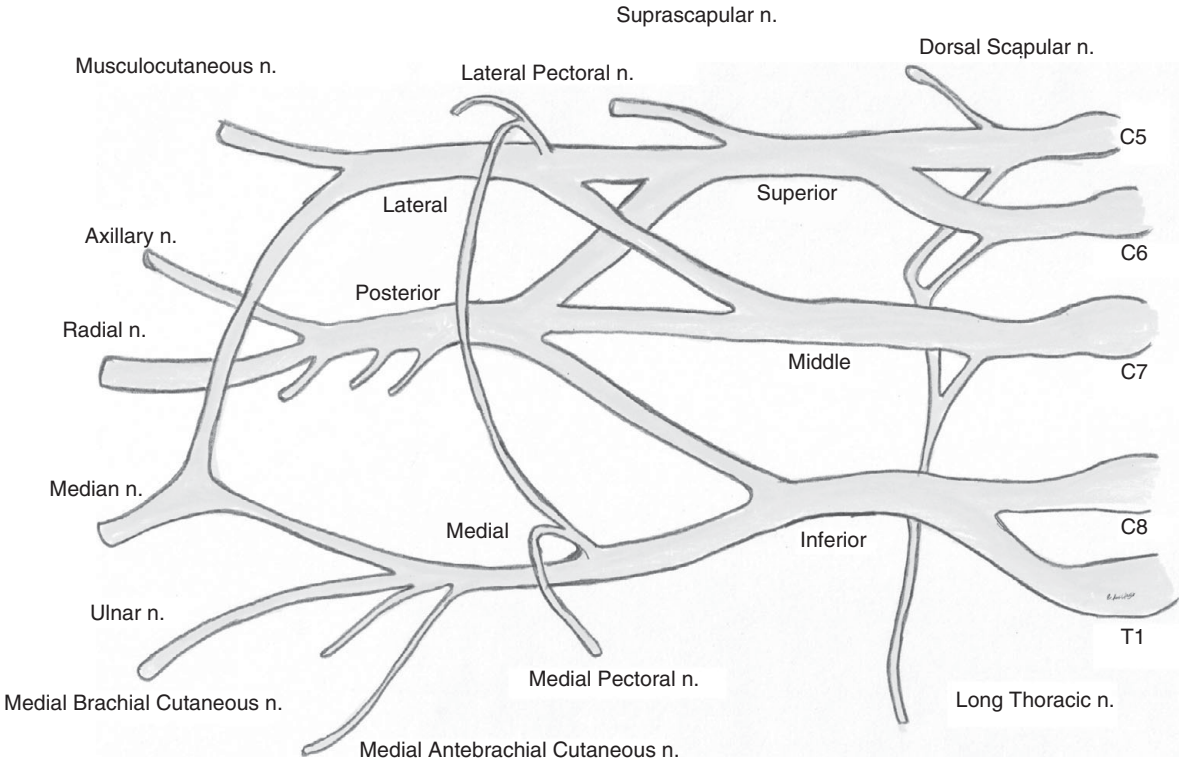

Figure 51.1 From left to right, the axillary, infraclavicular, supraclavicular, and interscalene blocks are highlighted with the division of the brachial plexus targeted. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

permanent neurological injury, and vagal and/or recurrent laryngeal nerve blockade. With the increased utilization and ability to visualize target structures, the rate of complications has fallen precipitously. Common side effects of an interscalene block include a Horner's syndrome from blockade of the cervical sympathetic nerves as well as phrenic nerve blockade. Both nerves are in close proximity to the interscalene brachial plexus and have higher incidences with increased volumes of injection for nerve blockade.

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What Is the Incidence of Phrenic Nerve Blockade When Performing an Interscalene Block? How Can That Be Avoided?

The occurrence of phrenic nerve blockade resulting in ipsilateral diaphragmatic paralysis was traditionally stated to be 100% owing to the close proximity of the phrenic nerve to the interscalene brachial plexus in its interscalene groove. Anatomically, the phrenic nerve lies in an anterolateral position on the anterior scalene muscle surface. However, there is considerable variability in the anatomic position. With use of ultrasound, decreased volume of local anesthetic, and differential needle approaches to avoid the phrenic nerve, there has been a small decrease (<20%) in the incidence of phrenic nerve blockade, but reliably avoiding the phrenic nerve has proven elusive.

Figure 51.2 Patient and probe positioning for in-plane interscalene nerve block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

How Is an Interscalene Block Performed?

With the traditional nerve stimulation technique, the patient was positioned with the head turned toward the contralateral side to be blocked. The interscalene groove was identified at the level of C6 (cricoid cartilage) posterolateral to the clavicular head of the sternocleidomastoid between the anterior and middle scalene muscles. The needle would be advanced until twitches were elicited in the brachial plexus distribution (deltoid, biceps, triceps, or hand).

The predominant method of performing an interscalene block currently is with ultrasound guidance (Figures 51.2–51.4). For smaller children, a linear ultrasound transducer with the smallest available footprint allows for optimal visualization of target structures with adequate surface area for needle approach. The ultrasound image below is the desired image to acquire.

Local anesthetic would be deposited in aliquoted fashion with frequent aspiration to avoid intravascular or intrathecal injection. Typical dosing for a single-shot block would be 0.2–0.4 cc/kg of ropivacaine 0.2%–0.5% or bupivacaine 0.25%–0.5%. If a catheter is placed for postoperative pain control, a typical infusion rate is 0.1–0.2 mL/kg/h of ropivacaine 0.1–0.2% or bupivacaine 0.1–0.25%.

What Are the Indications for a Supraclavicular Brachial Plexus Block?

A supraclavicular brachial plexus is the ideal regional block for any operation involving the hand, wrist, forearm, elbow, and distal humerus. This block should cover tourniquet pain.

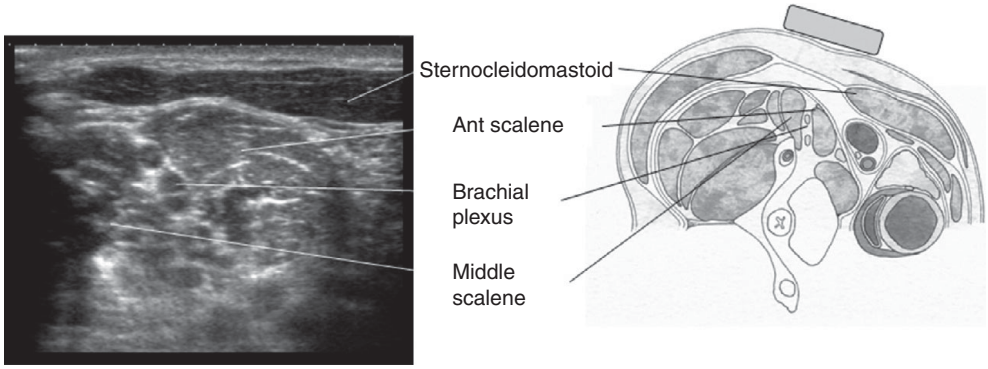

Figure 51.3 Interscalene anatomy. Reproduced with permission from Arthurs G, Nicholls B (eds.) 2016. *Ultrasound in Anesthesia, Critical Care, and Pain Management*. Cambridge, UK: Cambridge University Press

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What Are the Complications and Side Effects Associated with a Supraclavicular Block?

Phrenic nerve paralysis is fairly common with a supraclavicular block and should be performed with caution in children with respiratory issues (poor reserve, contralateral pneumothorax, diaphragmatic paralysis).

Pneumothorax, while rare, is a known complication following supraclavicular block.

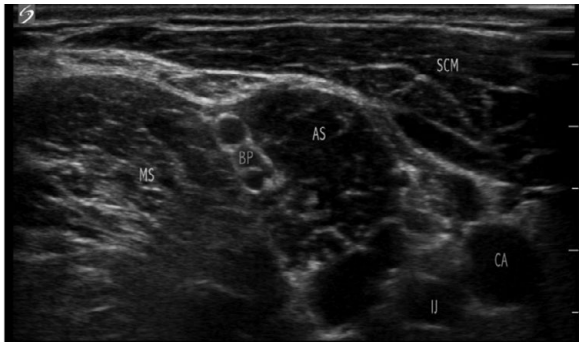

Figure 51.4 Ultrasound anatomy of interscalene nerve block. CA, Carotid Artery; IJ; Internal Jugular Vein; SCM, Sternocleidomastoid; AS, Anterior Scalene; MS, Middle Scalene; BP, Brachial Plexus

Figure 51.5 Probe positioning for supraclavicular block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

How Is a Supraclavicular Block Performed?

Scanning should be performed above the clavicle. Superficial to the first rib and the subclavian artery is the location where the brachial plexus trunks divide into divisions and where the block is performed. The patient is positioned supine with the head turned to the contralateral side. The probe positioning can be seen in Figures 51.5–51.7.

INFRACLAVICULAR BLOCK

A nine-year-old male is scheduled for urgent reimplantation of his right index finger after partial amputation from a woodcutting accident. He has no other past medical history of note. The anesthesiologist has a detailed discussion with the family about regional blocks, specifically infraclavicular catheter placement.

What Are the Indications for an Infraclavicular Block? What Are the Landmarks of Note?

The indications for an infraclavicular block include elbow, forearm, and hand surgery. The supraclavicular and infraclavicular blocks are essentially interchangeable based on the patient's anatomy. As the names imply, the approach for the supraclavicular block is above the clavicle, while the infraclavicular block is below the

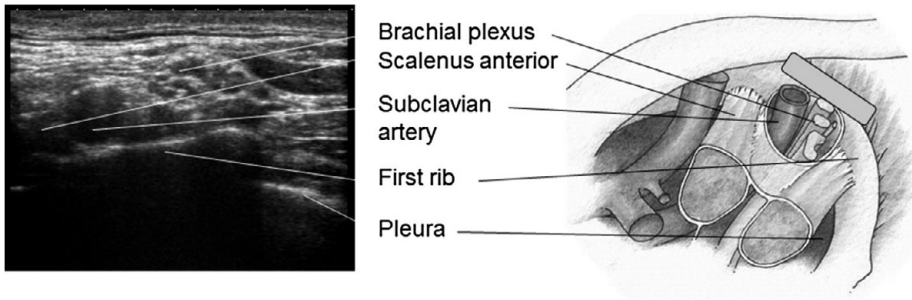

Figure 51.6 Supraclavicular block anatomy. Reproduced with permission from Arthurs G, Nicholls B (eds.) 2016. *Ultrasound in Anesthesia, Critical Care, and Pain Management*. Cambridge, UK: Cambridge University Press

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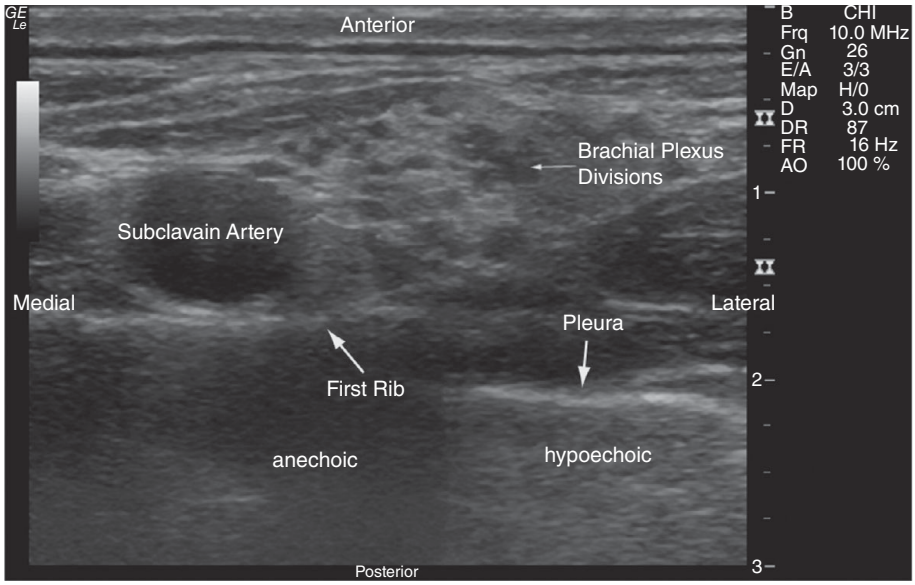

Figure 51.7 Left ultrasound guided supraclavicular block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

clavicle. The boundaries for block placement for the infraclavicular block are: medially by the ribs, laterally by the coracoid process, superiorly by the clavicle, and anteriorly by the pectoralis minor muscle. The apex of the lung is also very close to the needle placement side, so the use of ultrasound is now the standard of care.

What Are the Contraindications to Infraclavicular Catheter Placement?

There are very few true contraindications to catheter placement. A lot of the patient factors (anxiety, movement) are not present in the pediatric population as the majority of blocks are performed on anesthetized patients. However, given the proximity to the great vessels, caution should be exercised in patients with coagulopathy/documented local anesthetic allergies. Caution should also be exercised in patients who have preexisting neurological deficits in the limb under consideration.

Is There a Benefit of Ultrasound Over Nerve Stimulation Techniques for Catheter Placement?

There is clear and compelling data from multiple studies that utilization of ultrasound decreases the number of needle passes and time to block placement, and increases block efficacy. This effect seems to be more pronounced in younger children. Whether the addition of nerve stimulation to ultrasound adds more benefit is unclear. In the authors' experience, when the nerve bundles are clearly visualized it probably does not add more value to simultaneously use nerve stimulation.

Figure 51.8 Patient and probe positioning for in-plane infraclavicular nerve block. Reproduced with permission from Mannion S, Iohom G, Dadure C, Reisbig MD, Ganesh A (eds.) 2015. *Ultrasound-Guided Regional Anesthesia in Children*. Cambridge, UK: Cambridge University Press

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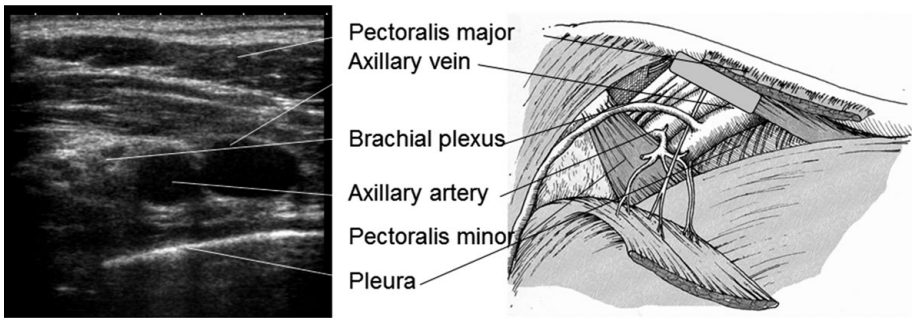

Figure 51.9 Infraclavicular anatomy. Reproduced with permission from Arthurs G, Nicholls B (eds.) 2016. *Ultrasound in Anesthesia, Critical Care, and Pain Management*. Cambridge, UK: Cambridge University Press

Figure 51.10 Probe and needle position for performance of in-plane infraclavicular block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

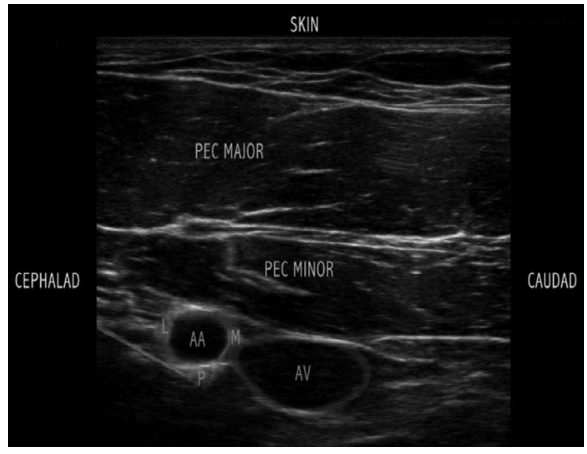

Figure 51.11 Ultrasound anatomy of the infraclavicular block. AA, Axillary Artery; AV, Axillary Vein; L: Lateral Cord; M, Medial Cord; P, Posterior Cord

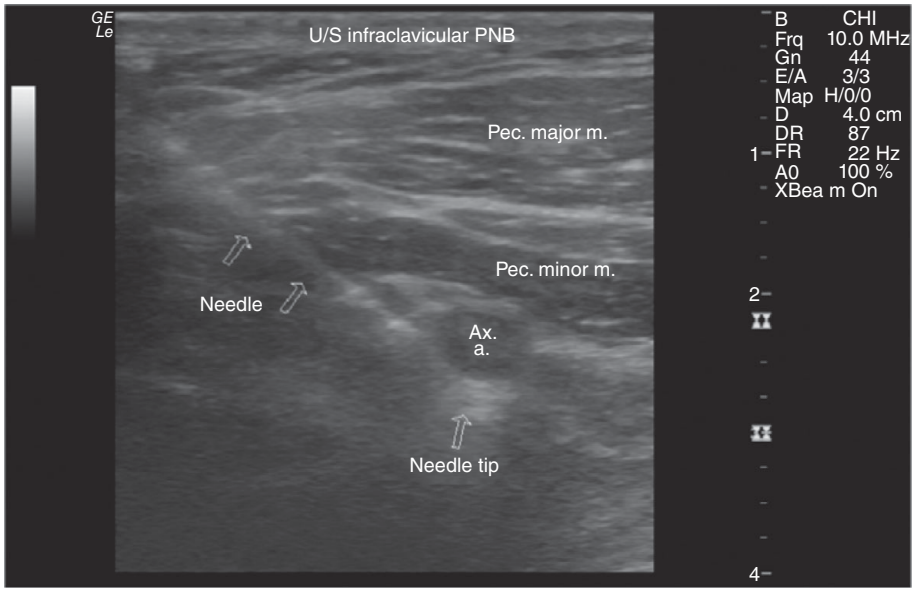

Figure 51.12 In-plane approach to the infraclavicular nerve block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

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Table 51.1 Summary of the brachial plexus terminal branches and their function. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press.

Brachial plexus terminal branch	Cutaneous sensation	Joint sensation	Motor action
Axillary nerve (C5, C6)	Over deltoid muscle	Glenohumeral	Abduction of arm
		Acromioclavicular	Flexion of arm
			Extension of arm
			Lateral rotation of arm
Radial nerve (C5–T1)	Posterior arm and forearm	Elbow	Extension of arm
	Dorsum of hand	Radius–ulna	Extension and supination of forearm
	Dorsum of first three fingers and lateral half of fourth finger to DIP	Wrist	Extension of wrist, fingers, and thumb
			Abduction of thumb
Median nerve (C5–T1)	Thenar eminence	Elbow	Pronation and flexion of forearm
	Palmar surface of first three fingers and lateral half of fourth finger	Radius–ulna	Flexion of the wrist, fingers, and thumb
	Dorsum of first three fingers and lateral half of fourth finger distal to DIP	Wrist	Abduction of thumb
		Fingers	Opposition of the thumb
Musculocutaneous nerve (C5–C7)	Lateral aspect of forearm	Elbow	Flexion of arm
		Proximal radius–ulna	Flexion and supination of forearm
Ulnar nerve (C8–T1)	Hypothenar eminence	All in hand except thumb and ulna-carpal	Flexion of wrist and fingers, especially fourth and fifth
	Dorso-medial surface of hand		Adduction and flexion of thumb
	Dorsal and palmar surface of fifth finger and medial half of fourth finger		Opposition of fifth finger
			Spreading and closing of fingers

What Medications/Dosages Are Used for the Continuous Catheter? What Is the Best Way to Secure the Catheter?

There is no de facto drug, concentration, or regimen established for infraclavicular blockade. Single shot blocks are typically dosed at 0.2–0.5 mL/kg of ropivacaine 0.2–0.5% or bupivacaine 0.25–0.5% with strict adherence to toxic dose limits. For continuous catheter infusions, typical dosing is 0.1–0.2 mL/kg/h of either ropivacaine 0.1–0.2% or bupivacaine 0.1–0.2%.

While the evidence is weak to declare a best method to secure the catheter, it is generally thought

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that anchoring the catheter through the pec major and pec minor muscles and tunneling the catheter subcutaneously will provide for greater security.

What Are the Expected Post Op Considerations for Continuous Perineural Catheter Placement?

Catheter dislodgement is common but ensuing complications are quite rare. This should be suspected when the patient has a block that is wearing off despite adequate infusion rates and local anesthetic concentration. Occasionally, the catheter can be repositioned under ultrasound alone, however due to its inherent flexibility this is rarely successful. Often, catheter malposition or poor blockade requires insertion of a new catheter under the same conditions as noted previously. Clinicians should also be wary of the presenting symptoms of LAST, which is covered elsewhere in this book.

Figure 51.13 Probe and needle positioning for axillary nerve block. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

AXILLARY NERVE BLOCK

What Are the Indications for an Axillary Nerve Block?

The axillary nerve block targets terminal branches of the five major nerves of the brachial plexus.

The axillary nerve block is suitable for surgical procedures involving the distal arm. Targeting individual nerves is appropriate for highly specific surgical procedures for which other nerves need not be blocked.

0.1–0.3 mL/kg of local anesthetic is typically sufficient to provide coverage (Table 51.1, Figures 51.13–51.14).

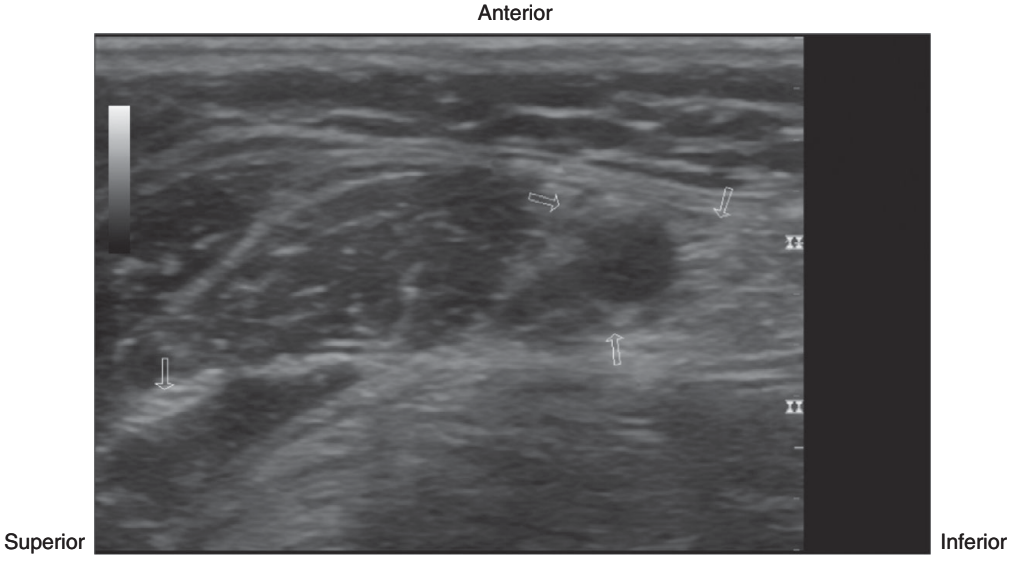

Figure 51.14 Caption: ultrasound anatomy of the axillary nerve block. CBM: coracobrachialis muscle. Reproduced with permission from Arbona FL, Khabiri B, Norton JA (eds.) 2011. *Ultrasound-Guided Regional Anesthesia: A Practical Approach to Peripheral Nerve Blocks and Perineural Catheters*. Cambridge, UK: Cambridge University Press

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Suggested Reading

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