



Chapter 1



Proximal Brachial Plexus: Applied Anatomy

- Phrenic Nerve
- Superior Trunk of the Brachial Plexus
- Suprascapular Nerve
- Dorsal Scapular Nerve
- Nerve to Levator Scapulae
- Accessory Nerve
- Transectional Anatomy (C6)



PHRENIC NERVE

The phrenic nerve ([1] on Fig. 1-1) originates mainly from C4 and receives a small branch from the C5 root of the brachial plexus. It runs caudad on the belly of the anterior scalene muscle (Figs. 1-4 and 1-6).

The external jugular vein (Fig. 1-5, *top arrow*) is superficial to the brachial plexus. The sternocleidomastoid muscle (*bottom arrow*) partially or completely overlies the phrenic nerve.

If the sternocleidomastoid muscle is removed, as in the dissection shown in Figure 1-6, the phrenic nerve (*arrow*) can clearly be seen on the belly of the anterior scalene muscle.

Phrenic Nerve Surface Anatomy

Superficially, the phrenic nerve lies just behind the posterior border of the sternocleidomastoid muscle, at the level of C6 or the cricoid cartilage (Fig. 1-7, *arrow*). Electrical stimulation of the phrenic nerve causes contractions of the diaphragm, resulting in clear abdominal twitches. If this is encountered during interscalene block, the needle must be redirected approximately 1 cm posteriorly.

(See phrenic nerve transcutaneous stimulation movie on DVD).

Text continued on page 8

- 1 Phrenic nerve
- 2 Nerve to Levator Scapulae
- 3 Spinal accessory nerve
- 4 Dorsal scapular nerve
- 5 Suprascapular nerve
- 6 Superior trunk
- 7 Middle trunk
- 8 Inferior trunk
- 9 Long thoracic nerve
- 10 Nerves to longus colli and scalene muscles
- 11 Nerve to subclavius muscle
- 12 Lateral cord
- 13 Posterior cord
- 14 Medial cord
- 15 Lateral pectoral nerve
- 16 Medial pectoral nerve
- 17 Upper subscapular nerve
- 18 Lower subscapular nerve
- 19 Medial cutaneous nerve of arm
- 20 Medial cutaneous nerve of upper arm
- 21 Axillary nerve
- 22 Musculocutaneous nerve
- 23 Radial nerve
- 24 Median nerve
- 25 Ulnar nerve

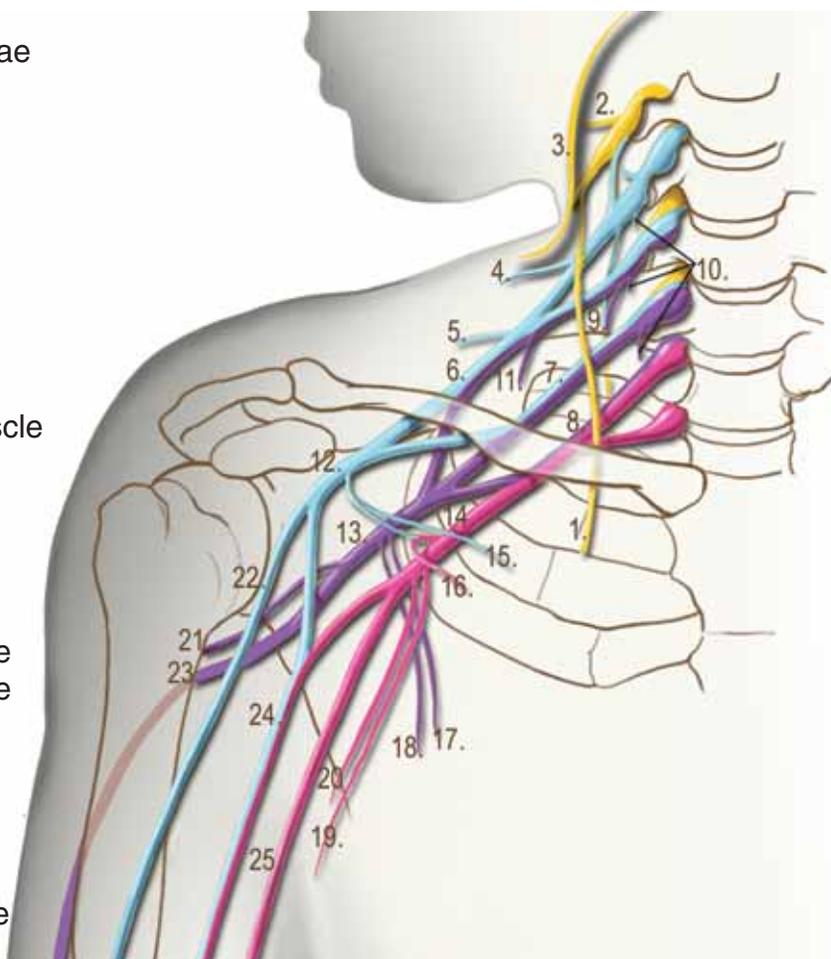


FIGURE 1-1 Schematic representation of the roots, trunks, divisions, cords, and terminal branches of the brachial plexus.

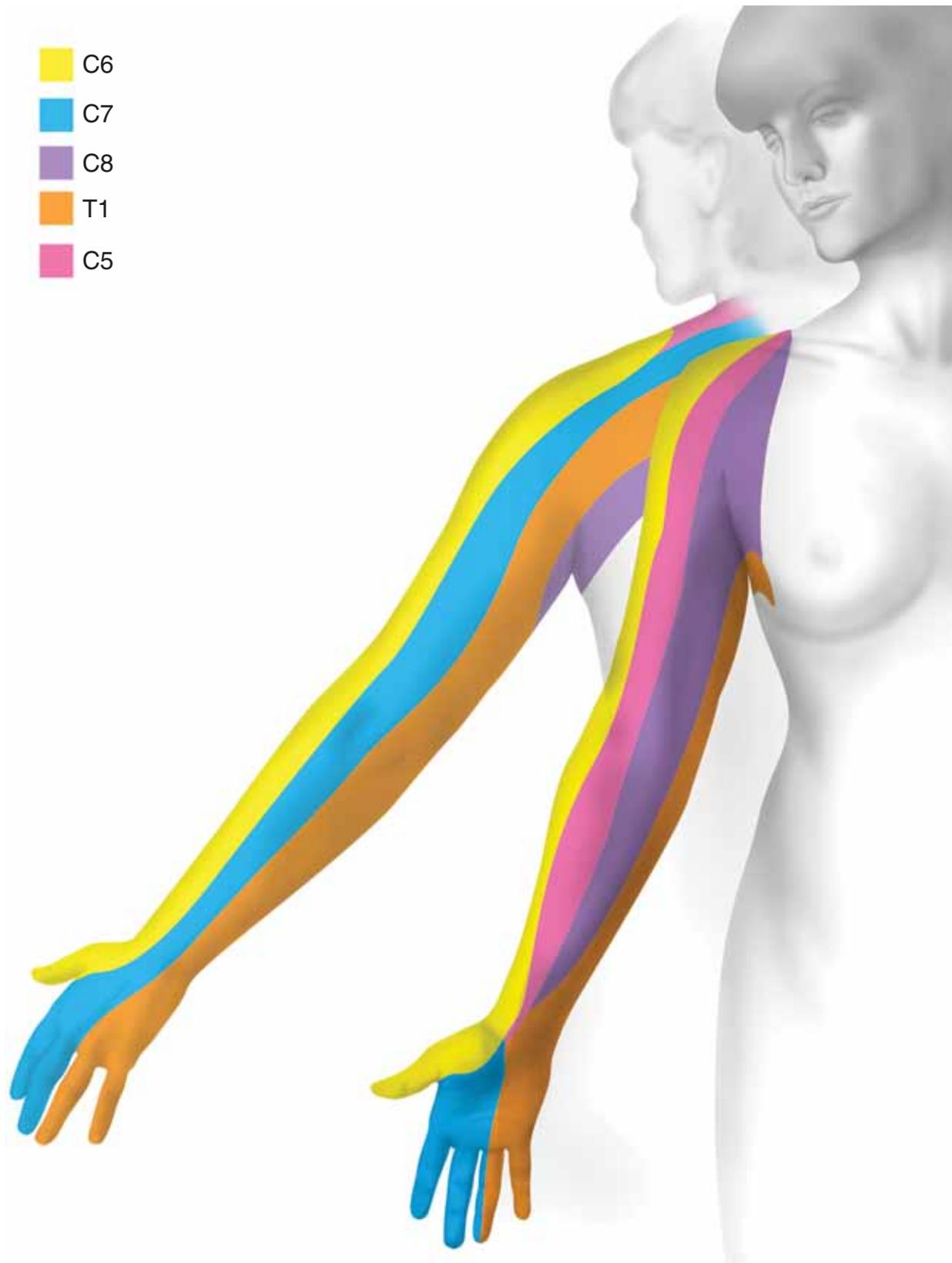


FIGURE 1-2 Dermatomes of the upper limb.



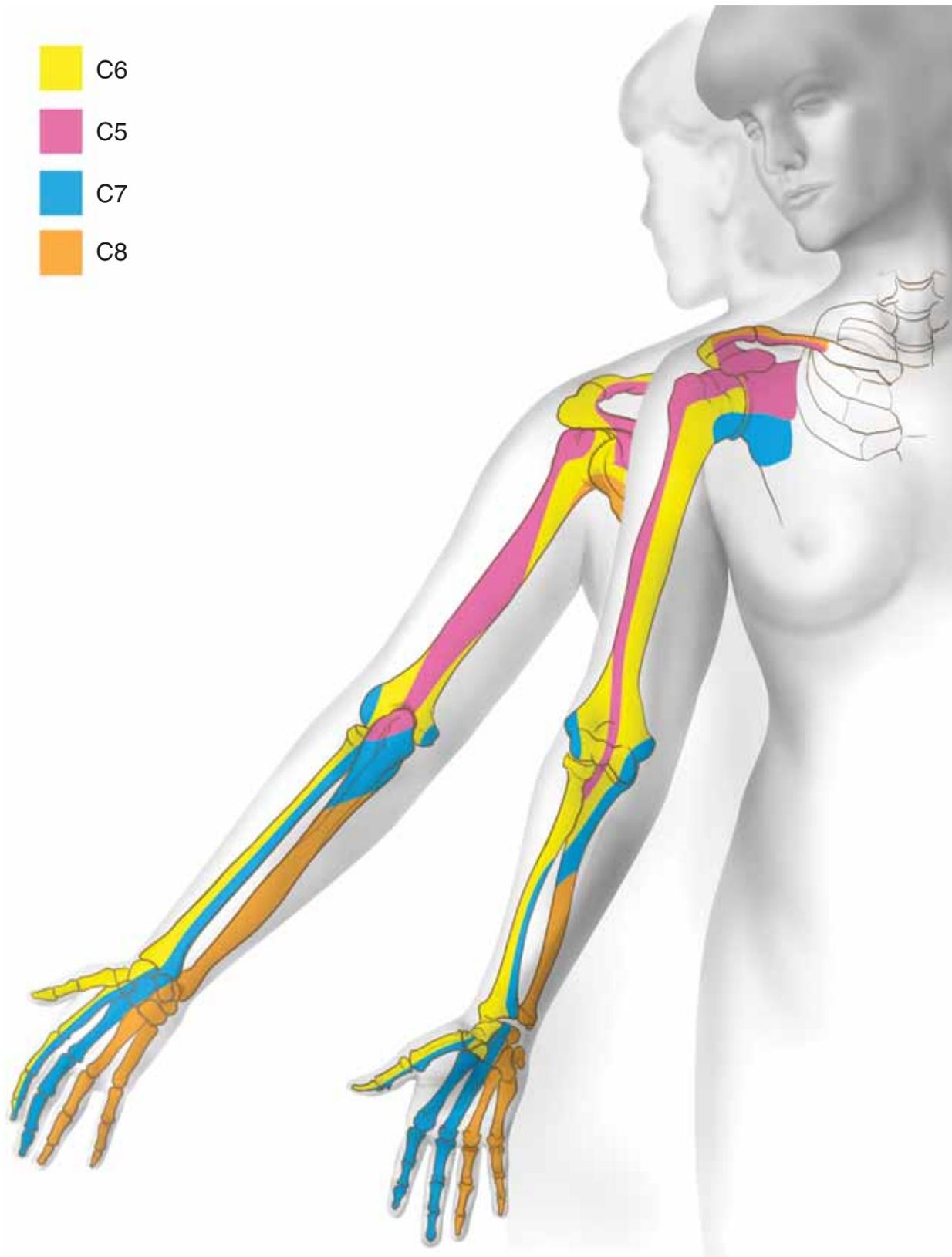


FIGURE 1-3 Osteotomes of the upper limb.



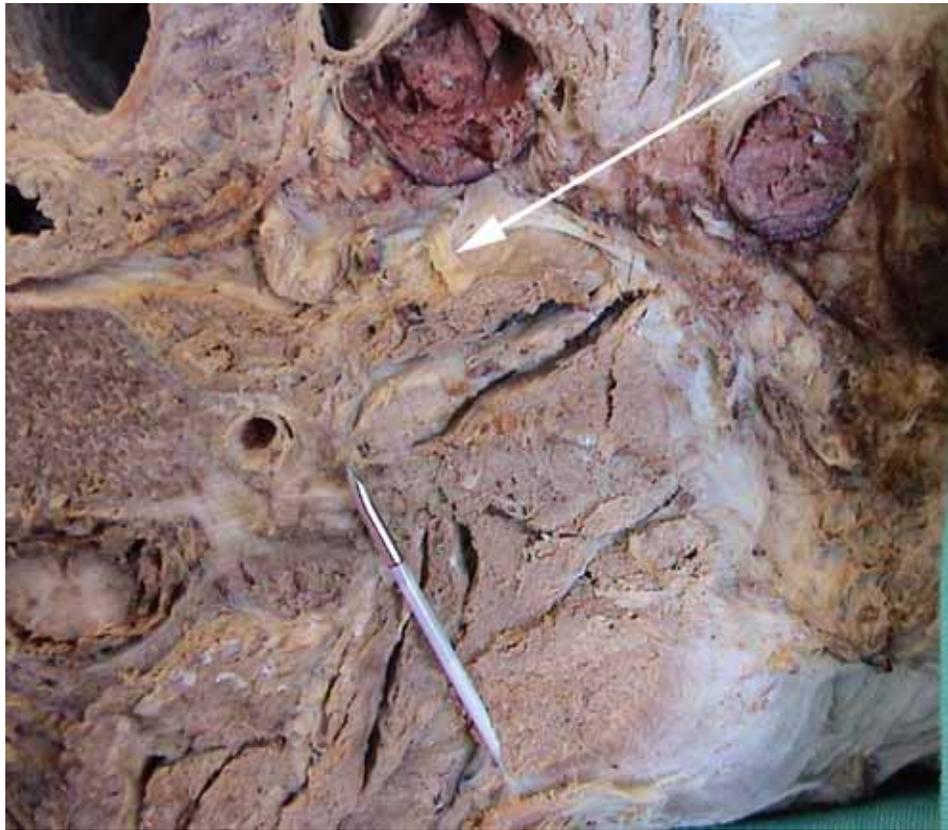


FIGURE 1-4 Transection of the neck at the C6 level. The needle is on the brachial plexus, and the *arrow* indicates the phrenic nerve.



FIGURE 1-5 Lateral view of the posterior triangle of the neck. The *top arrow* indicates the external jugular vein, the *middle arrow* the clavicular head, and the *bottom arrow* the sternal head of the sternocleidomastoid muscle. Note the superficial cervical plexus behind the midpoint of the posterior border of the clavicular head of the sternocleidomastoid muscle.



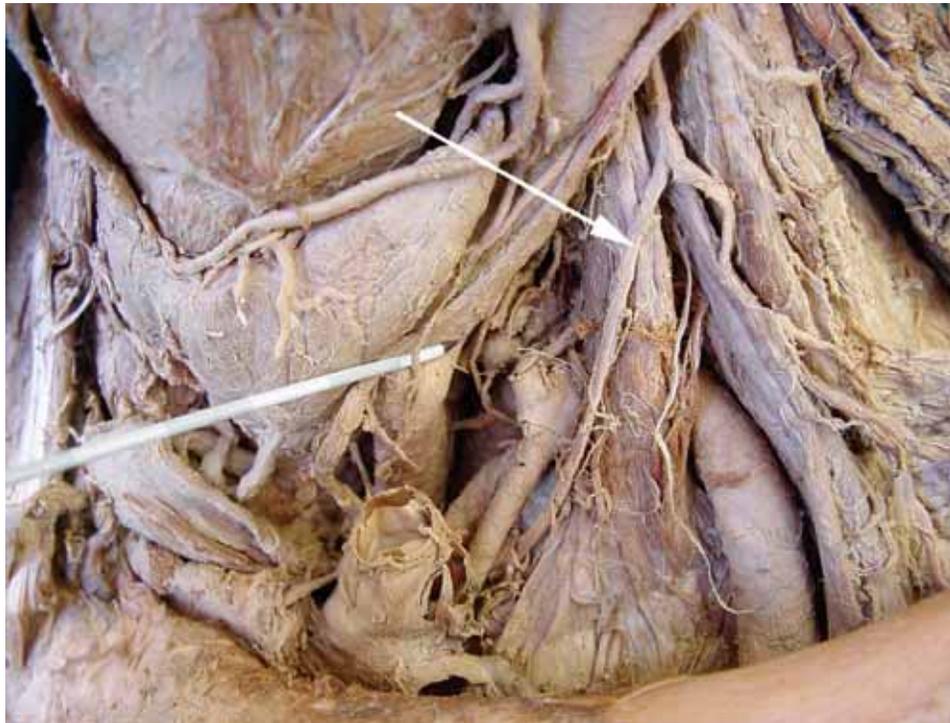


FIGURE 1-6 Lateral view of the neck. The needle retracts the carotid artery, and the stellate ganglion is visible deep to the artery. The *arrow* indicates the phrenic nerve in its position on the belly of the anterior scalene muscle.



FIGURE 1-7 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the phrenic nerve behind the clavicular head of the sternocleidomastoid muscle.



SUPERIOR TRUNK OF THE BRACHIAL PLEXUS

The superior trunk of the brachial plexus is a bundle of nerves formed by the fifth and sixth cervical roots (see Fig. 1-1, [6]). Electrical stimulation proximal on the trunk results in a motor response of the triceps muscle, whereas stimulation distally on the same trunk causes biceps muscle twitches.

Figure 1-8 illustrates the area of sensory innervation of the superior trunk of the brachial plexus.

The brachial plexus (Fig. 1-9, *arrow*) lies between the anterior and the middle scalene muscles. Note again the phrenic nerve on the belly of the anterior scalene muscle and the vagus nerve and carotid artery anterior to that.

Superior Trunk Surface Anatomy

The brachial plexus is posterior to the sternocleidomastoid muscle at the level of the cricoid cartilage (Fig. 1-10, *arrow*). This is commonly referred to as *Winnie's point*, and is typically where an interscalene block is performed for shoulder surgery.

Electrical stimulation of the superior trunk of the brachial plexus causes unmistakable twitches of the biceps muscle, as can be seen on the accompanying recording.

(See superior trunk transcutaneous stimulation movie on DVD).

SUPRASCAPULAR NERVE

The suprascapular nerve branches from the superior trunk of the brachial plexus in the lower part of the posterior triangle of the neck (see Fig. 1-1, [5]).

The suprascapular nerve (Fig. 1-11, *arrow*) lies just behind the middle scalene muscle as it passes posterior and disappears under the trapezius muscle. It supplies the supraspinatus and infraspinatus muscles of the rotator cuff.

Suprascapular Nerve Surface Anatomy

The clavicle, when viewed from anterior, sometimes obscures the surface anatomy of the

suprascapular nerve (Fig. 1-12, *arrow*). In some individuals it can be stimulated laterally in the posterior triangle of the neck.

Electrical stimulation of the suprascapular nerve results in rotation of the humerus because it innervates the rotator cuff.

(See suprascapular nerve transcutaneous stimulation movie on DVD).

DORSAL SCAPULAR NERVE

The dorsal scapular nerve arises from the posterior aspect of C5 and enters the middle scalene muscle (see Fig. 1-1, [4]).

After entering the middle scalene muscle, the dorsal scapular nerve (Fig. 1-13, *arrow*) appears at its posterior border, between the middle and posterior scalene muscles. It then courses downward beneath the levator scapulae muscle. It supplies both rhomboid muscles on their deep surfaces. It often also gives a branch to the levator scapulae muscle.

Dorsal Scapular Nerve Surface Anatomy

The dorsal scapular nerve (Fig. 1-14, *arrow*) is posterior and superior to the brachial plexus, behind the middle scalene muscle.

Electrical stimulation of the dorsal scapular nerve causes contractions of the rhomboid muscles and medial movement of the scapula. This is often confused with shoulder or arm muscle twitches. Because it is not inside the brachial plexus sheath, blockage of this nerve does not result in successful interscalene block.

(See dorsal scapular nerve transcutaneous stimulation movie on DVD).

NERVE TO LEVATOR SCAPULAE

The nerve to the levator scapulae arises from the C4 cervical root and is not part of the brachial plexus (see Fig. 1-1, [2]).

The nerve to levator scapulae (Fig. 1-15, *arrow*) is posterior and superior to the dorsal scapular nerve.

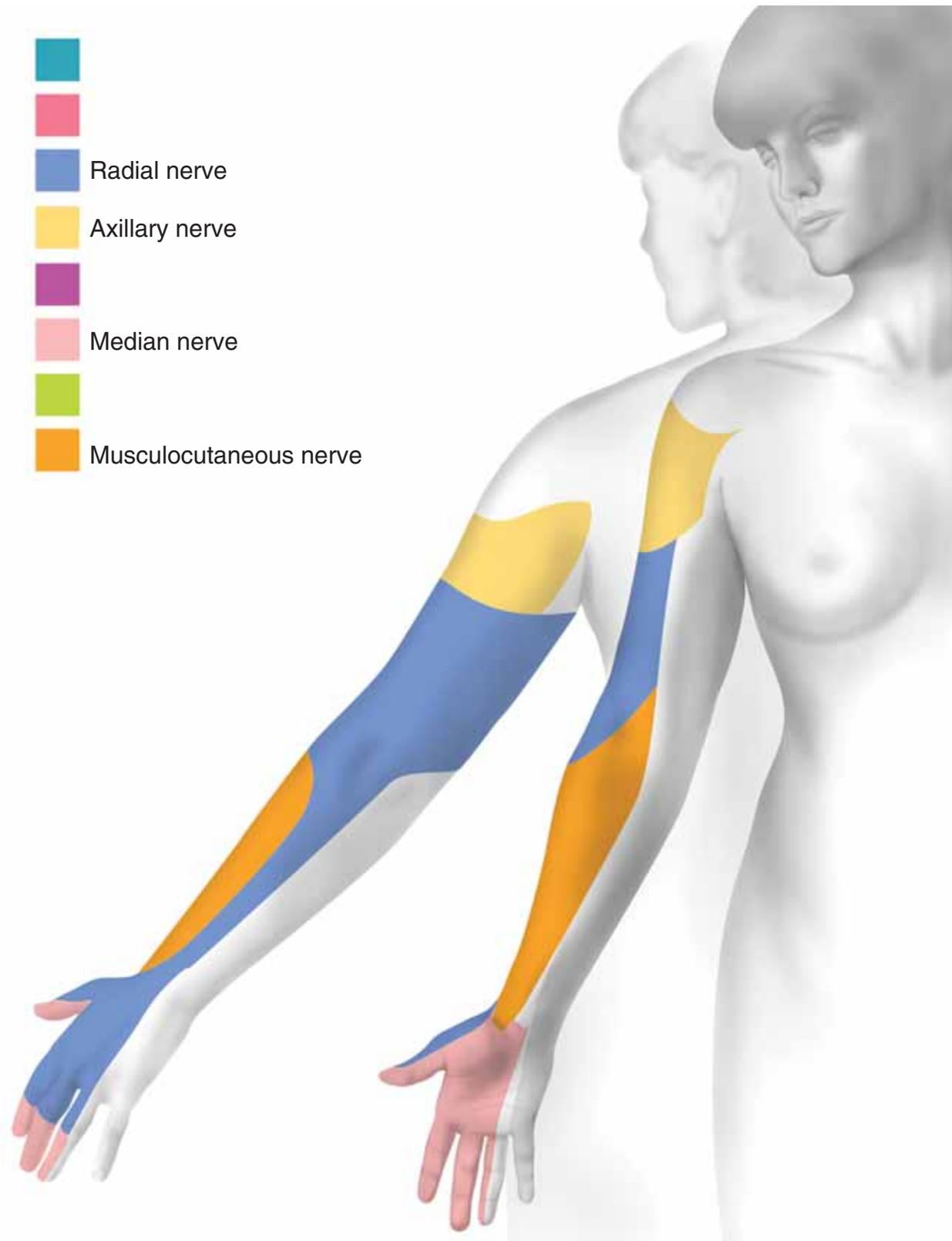


FIGURE 1-8 Neurotomes typically blocked by the interscalene block.





FIGURE 1-9 Dissection of the lateral part of the neck. The *arrow* indicates the brachial plexus between the anterior and middle scalene muscle. The sternocleidomastoid muscle (SCM) is cut away in this dissection.

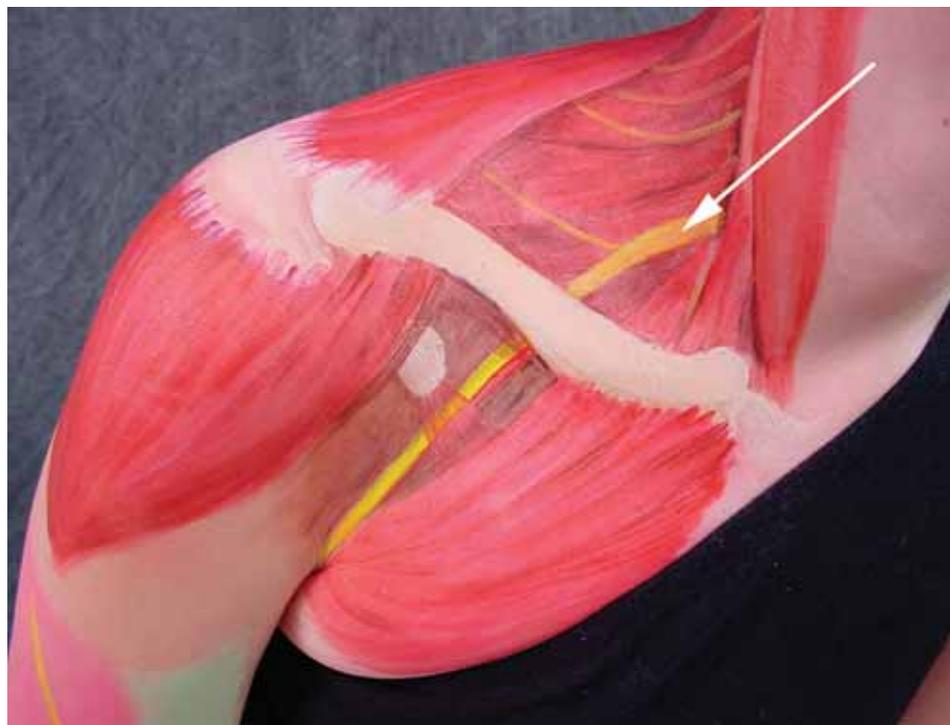


FIGURE 1-10 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the brachial plexus.





FIGURE 1-11 Lateral view of the neck. The *arrow* indicates the suprascapular nerve between the middle and posterior scalene muscles.



FIGURE 1-12 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the suprascapular nerve.





FIGURE 1-13 Lateral view of the neck. The *arrow* indicates the dorsal scapular nerve as it exits between the middle and posterior scalene muscles.



FIGURE 1-14 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the dorsal scapular nerve.





FIGURE 1-15 Lateral view of the neck. The *arrow* indicates the nerve to the levator scapulae muscle.

Nerve to Levator Scapulae Surface Anatomy

The surface anatomy of the nerve to levator scapulae (Fig. 1-16, *arrow*) is superior and posterior to Winnie's point. The only importance of this nerve for the anesthesiologist is to recognize its function, which is innervation of the muscle that elevates the scapula. Like the dorsal scapular nerve, this nerve is not inside the brachial plexus sheath.

Electrical stimulation of the nerve to the levator scapulae causes movement of the scapula. This movement can easily be mistaken for twitches caused by brachial plexus or trapezius muscle stimulation. It is also difficult to distinguish levator scapulae twitches from trapezius muscle twitches. The accompanying recording shows contraction of both these muscles. Both are sometimes confused with brachial plexus stimulation.

(See nerve to levator scapulae transcutaneous stimulation movie on DVD).

ACCESSORY NERVE

The accessory nerve is a cranial nerve and not part of the brachial or cervical plexuses (see Fig. 1-1, [3]). It crosses the posterior triangle of

the neck superficially and is easy to stimulate transcutaneously.

The dissection depicted in Figure 1-17 shows the posterior and superior location of the accessory nerve (*arrow*) in the posterior triangle of the neck.

Accessory Nerve Surface Anatomy

The accessory nerve (Fig. 1-18, *arrow*) emerges beneath the posterior border of the sternocleidomastoid muscle, at the junction of its middle and lower thirds. It passes almost vertically downward on the levator scapulae to disappear beneath the anterior border of the trapezius muscle, at the junction of its middle and lower thirds.

Electrical stimulation of the accessory nerve gives the unmistakable motor response of shrugging of the shoulder owing to trapezius muscle contraction.

(See accessory nerve stimulation movie on DVD).

TRANSECTIONAL ANATOMY (C6)

The roots of the brachial plexus emerge from the neuroforamina of the vertebrae. The roots of





FIGURE 1-16 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the nerve to the levator scapulae muscle.



FIGURE 1-17 Lateral view of the neck. The *arrow* indicates the accessory nerve.





FIGURE 1-18 Anterior view of the posterior triangle of the neck. The *arrow* indicates the surface anatomy of the accessory nerve.

C5 and C6 converge to form the superior trunk, the C7 root continues to form the middle trunk, and the roots of C8 and T1 form the inferior trunk (see Fig. 1-1). The posterior aspects of the roots contain sensory fibers that travel to the dorsal spinal horn of the cord, whereas the anterior aspects of the roots consist mainly of motor fibers from the anterior horn of the spinal cord.

Figure 1-19 demonstrates the neurotomes of the brachial plexus. These neurotomes are typically all blocked during posterior root-level block. The intercostobrachial nerve distribution on the medial aspect of the upper arm is not included in the illustration because the intercostobrachial nerve is not a component of the brachial plexus. Also, there is occasional sparing of the superficial cervical plexus with a posterior approach. Although this is rare, it is easily remedied by the addition of a superficial cervical plexus block, just lateral to the midpoint of the sternocleidomastoid muscle (Fig. 1-5).

Figure 1-20 shows an oblique transection through the neck, from the dorsal spine of C6 to the cricoid cartilage. The arrow (see Fig. 1-20, [1]) indicates the body of C6.

The posterior extensor muscles of the neck (see Fig. 1-20, [2]) are usually tender and should be avoided when approaching the brachial plexus roots from posterior.

There is a “window” through which the brachial plexus can be reached from posterior without penetrating the extensor muscles of the neck. This window is between the trapezius muscle (see Fig. 1-20, [3]) and the levator scapulae muscle (see Fig. 1-20, [4]).

The phrenic nerve (see Fig. 1-20, [5]) lies on the belly of the anterior scalene muscle, with the brachial plexus (see Fig. 1-20, [6]) situated between the anterior scalene muscle (see Fig. 1-20, [7]) and the middle scalene muscle (see Fig. 1-20, [8]).

When approaching the roots of the brachial plexus from posterior, the needle is “walked off” the articular column of C6 or short transverse process of the vertebra (see Fig. 1-20, [9]).

The vertebral artery and vein (see Fig. 1-20, [10]) are situated anterior to the brachial plexus, which makes this approach to the brachial plexus attractive because penetration of these vessels from posterior is unlikely. The bony pars intervertebralis and facet joints, which make up the articular column (see Fig. 1-20, [9]), form a

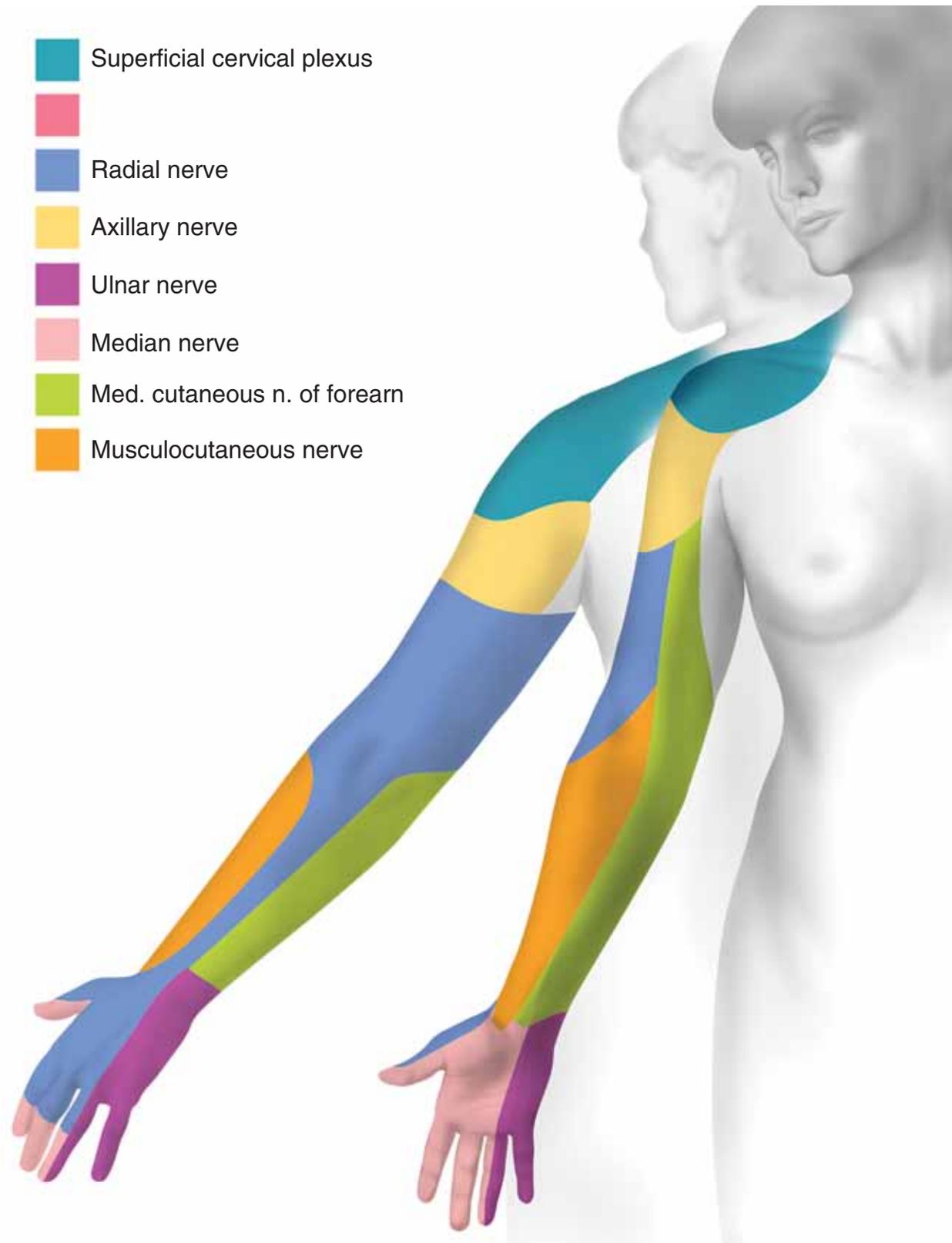


FIGURE 1-19 Neurotomes that can be expected to be blocked by a brachial plexus root block or cervical paravertebral block.

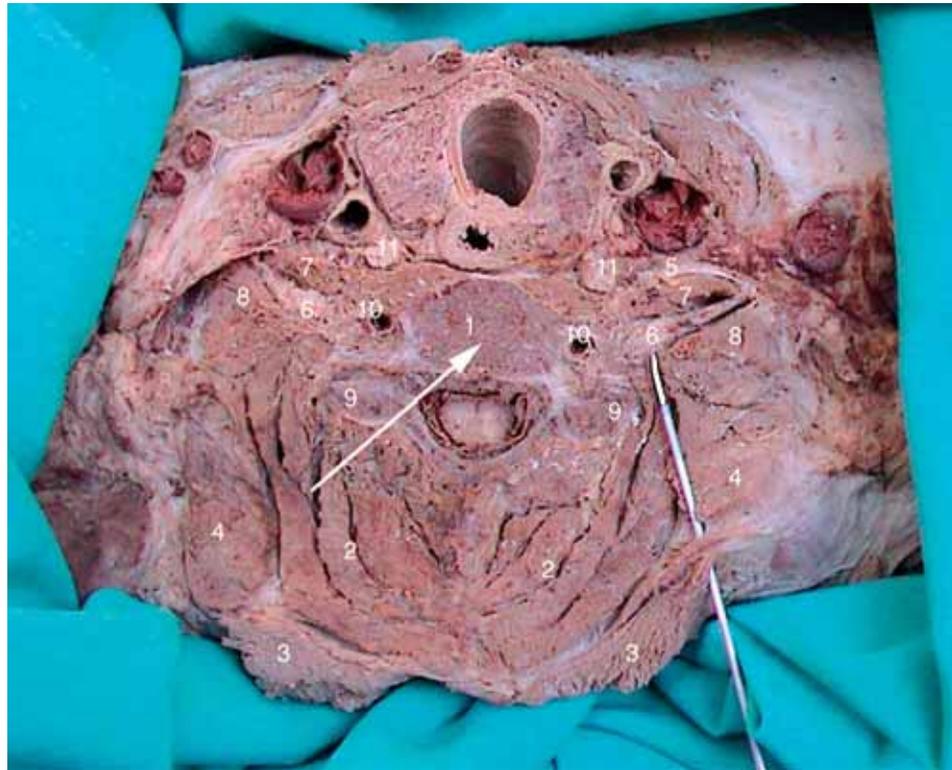


FIGURE 1-20 Transection of the neck. The *arrow* indicates the body of C6. 1, Body of C6; 2, extensor muscles of the neck; 3, trapezius muscle; 4, levator scapulae muscle; 5, phrenic nerve; 6, brachial plexus; 7, anterior scalene muscle; 8, middle scalene muscle; 9, pars intervertebralis [articular column]; 10, vertebral artery and vein; 11, superior cervical (stellate) ganglion.

“wall of bone” that protect the vertebral artery and vein during a posterior approach.

The location of the cervicothoracic sympathetic chain (stellate ganglion) explains why Horner’s syndrome is a common companion of nerve blocks in this area (see Fig. 1-20, [11]).

In a magnified transectional view, the phrenic nerve (Fig. 1-21, *arrow*) can be seen on the belly of the anterior scalene muscle. Note that the nerve is outside of the fascia that covers the anterior scalene muscle and brachial plexus. This fascia extends from the paravertebral fascia, which forms the brachial plexus sheath more distally.

Surface Anatomy for Posterior Approach to Brachial Plexus

The surface anatomy for the posterior approach to the brachial plexus (the cervical paravertebral block) starts with a line that is drawn from the dorsal spine of C6 to the suprasternal notch (Fig. 1-22). This line passes through a point in the apex of the “V” formed

by the anterior border of the trapezius muscle and the posterior border of the levator scapulae muscle.

The arrows in Figure 1-23 indicate the anterior border of the trapezius muscle.

The arrows in Figure 1-24 indicate the posterior border of the levator scapulae muscle.

The needle is aimed mesiad, anterior, and approximately 30 degrees caudad, toward the suprasternal notch (Fig. 1-25).

The needle, attached to a loss-of-resistance-to-air syringe and a nerve stimulator set at 1.2 to 3 mA, is walked off the bony articular column of the vertebra in a lateral direction. Muscle twitches and loss of resistance to air appear approximately simultaneously.

If surgery is to the shoulder, anterior muscle twitches are sought. These are the major pectoral muscle, biceps, or deltoid muscles, representing the C5/C6 roots. If surgery is to the wrist or elbow, triceps muscle motor response is sought, representing the C7/C8 roots. It is important to place the catheter on the correct root.

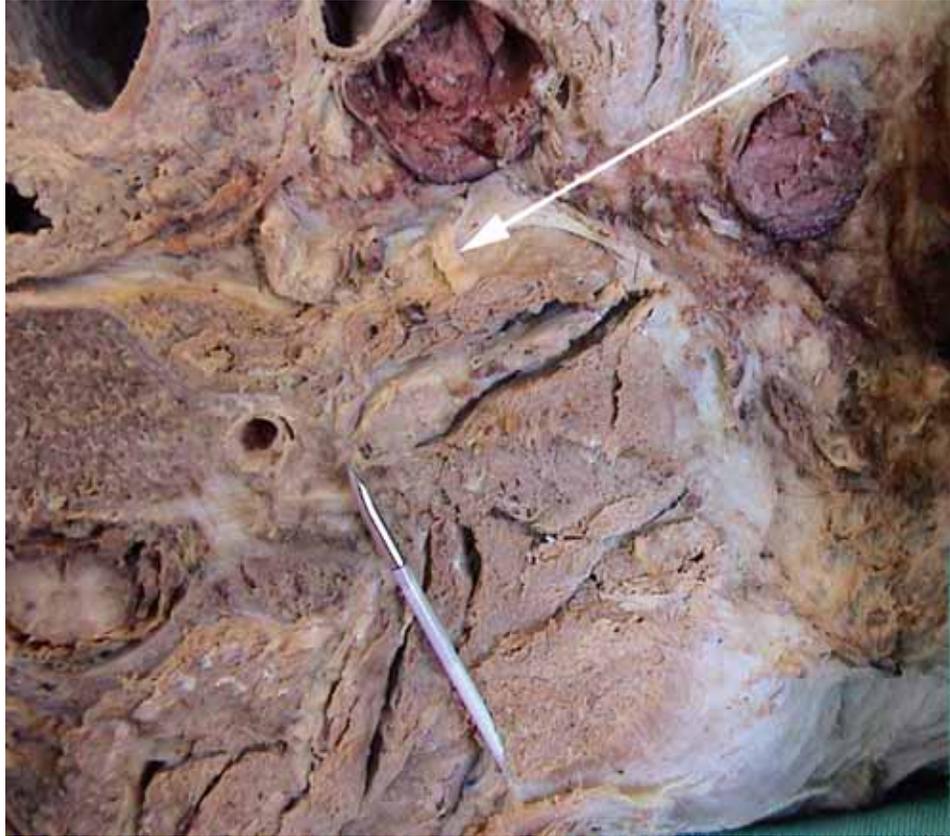


FIGURE 1-21 Magnified view of transection of the neck. The *arrow* indicates the phrenic nerve.



FIGURE 1-22 Lateral view of the neck indicating the surface anatomy of the cervical paravertebral block. The line joins the dorsal spine of C6 with the suprasternal notch.



FIGURE 1-23 The *arrows* indicate the anterior border of the trapezius muscle.

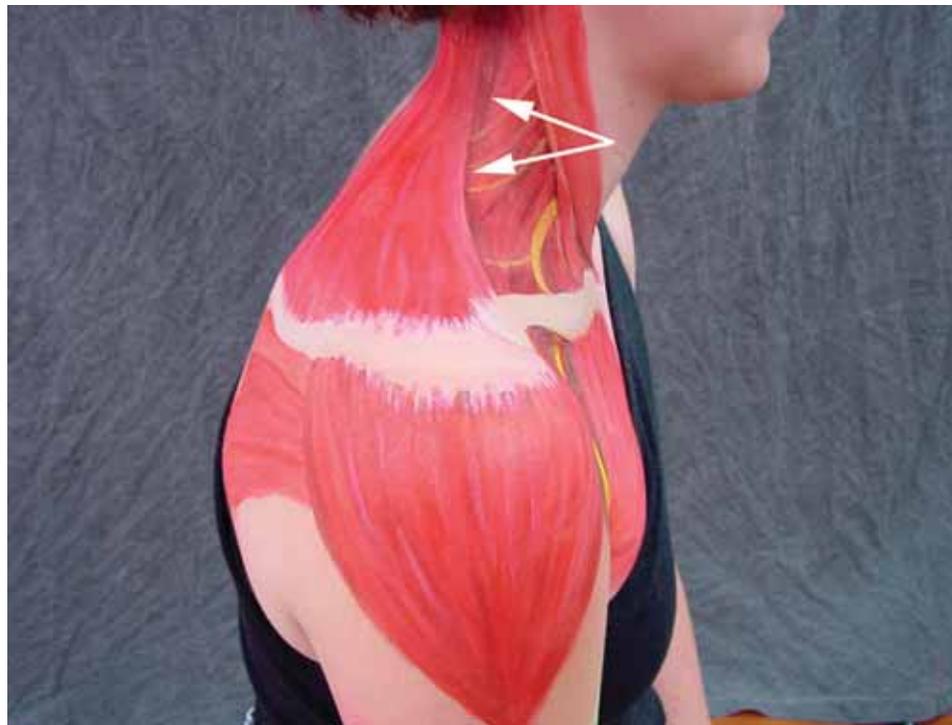


FIGURE 1-24 The *arrows* indicate the posterior border of the levator scapulae muscle.



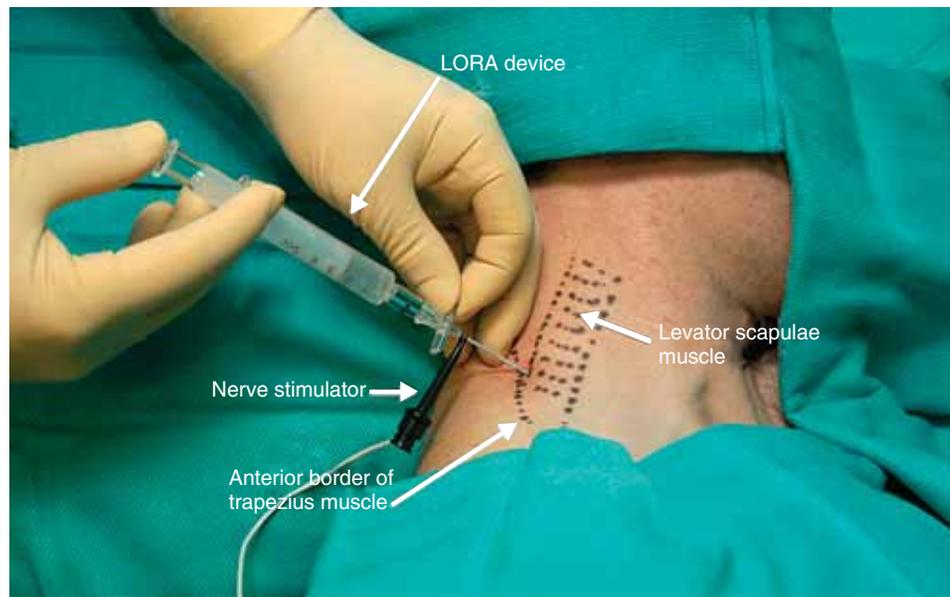


FIGURE 1-25 Needle entry is in the apex of the “V” formed by the anterior border of the trapezius muscle and the posterior border of the levator scapulae muscle. The needle is aimed at the suprasternal notch. A loss-of-resistance-to-air syringe and nerve stimulator are applied to the needle.

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