

5. UPPER EXTREMITY NEUROANATOMY

INTRODUCTION

Regional anesthesia of the upper extremity involves two major nerve plexuses, the cervical plexus and the brachial plexus. A detailed understanding of the anatomy of these nerve plexuses and surrounding structures is essential for the safe and successful practice of regional anesthesia in this area of the body.

CERVICAL PLEXUS

The cervical plexus is formed from a series of nerve loops between adjacent anterior rami of cervical nerve roots C1 through C4. The cervical plexus is deep to the sternocleidomastoid muscle and medial to the scalene muscles. The deep branches of the plexus are motor nerves. They include the phrenic nerve (diaphragm muscle) and the ansa cervicalis nerve (omohyoid, sternothyroid, and sternohyoid muscles). The named nerves of the superficial cervical plexus are branches from the loops and emerge from the middle of the sternocleidomastoid muscle (Figure 5-1):

- *Lesser occipital nerve* (C2): innervates the skin posterior to the ear.
- *Great auricular nerve* (C2–C3): innervates the ear and angle of the mandible to the mastoid process.
- *Transverse cervical nerve* (C2–C3): innervates the anterior neck.
- *Supraclavicular nerve* (C3–C4): innervates the area over the clavicle and shoulder.

The spinal accessory nerve (CN XI) emerges at the posterior border of the sternocleidomastoid muscle, passing superficial to the levator scapulae muscle to innervate the trapezius muscle. Stimulation of this nerve during interscalene block, which causes the shoulder to shrug, is occasionally mistaken as stimulation of the brachial plexus. Injection of local anesthetic based on this stimulation pattern will result in a failed interscalene block.

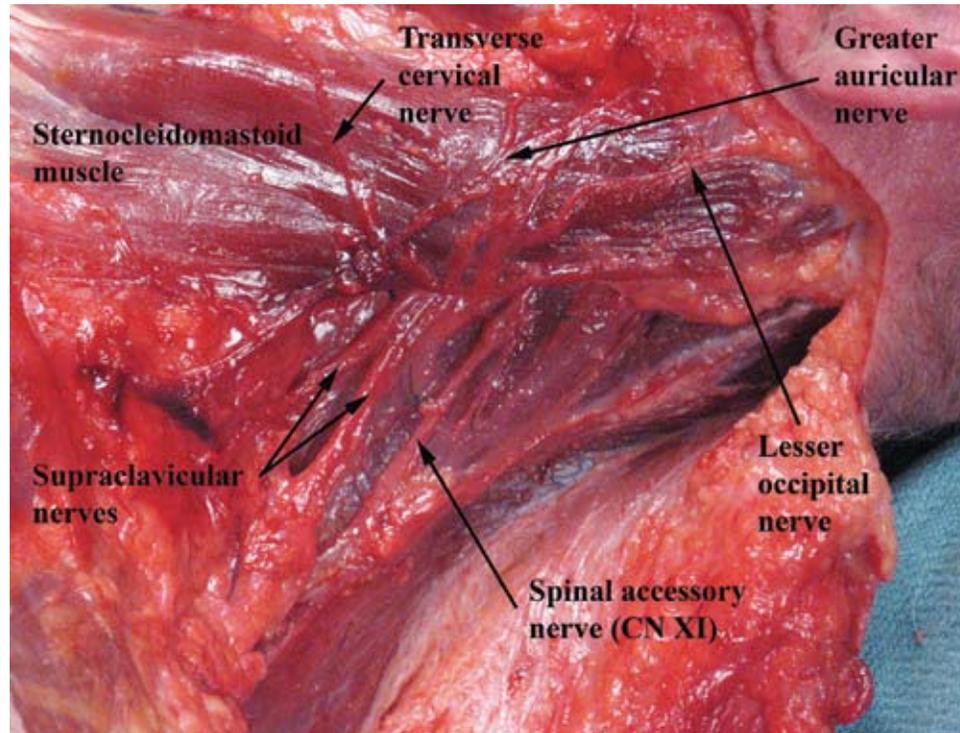


Figure 5-1. Dissection of the superficial cervical plexus in the posterior triangle

BRACHIAL PLEXUS

The brachial plexus is formed from the five roots (anterior rami) of C5–T1. Occasionally contributions to the brachial plexus come from C4 (prefixed plexus) or from T2 (postfixed plexus). There are seven described variations of brachial plexus anatomy, with the most common variant (Figure 5-2) occurring 57% of the time. Asymmetry between the left and right brachial plexus in the same individual occurs 61% of the time. Brachial plexus anatomy includes the following parts:

- **Three trunks.** The five roots unite to form the three trunks of the brachial plexus; superior (C5 and C6), middle (C7), and inferior (C8 and T1). The trunks pass between the anterior and middle scalene muscles.
- **Six divisions.** Each trunk divides into an anterior division (anterior flexor compartments of the arm) and a posterior division (posterior extensor

compartments of the arm). The brachial plexus divisions pass posterior to the mid-point of the clavicle through the cervico-axillary canal.

- **Three cords.** The divisions coalesce to form three cords. The anterior divisions of the superior and middle trunk form the *lateral cord*. The anterior division of the inferior trunk becomes the *medial cord*. The posterior divisions of all three trunks unite to form the *posterior cord*. The cords are named based on

their relationship to the axillary artery (as this neurovascular bundle passes in its sheath into the axilla).

- **Five terminal branches.** The cords give rise to five terminal branches. The *musculocutaneous nerve* (C5–C7) arises from the lateral cord and innervates the coracobrachialis, biceps brachii and brachialis muscles, and the skin to the lateral forearm. The *median nerve* is a compilation of the lateral cord (C6–C7) and the medial cord (C8, T1). It innervates muscles of the anterior forearm and the thenar half of the muscles and skin of the palm. The *ulnar nerve* is a branch of the medial cord (C7–T1) and innervates the forearm and hand medial to the midpoint of digit four. The *axillary nerve* (C5–C6) is a branch of the posterior cord and innervates the shoulder joint and lateral skin over the deltoid muscle. The *radial nerve* (C5–T1), which is also a branch of the posterior

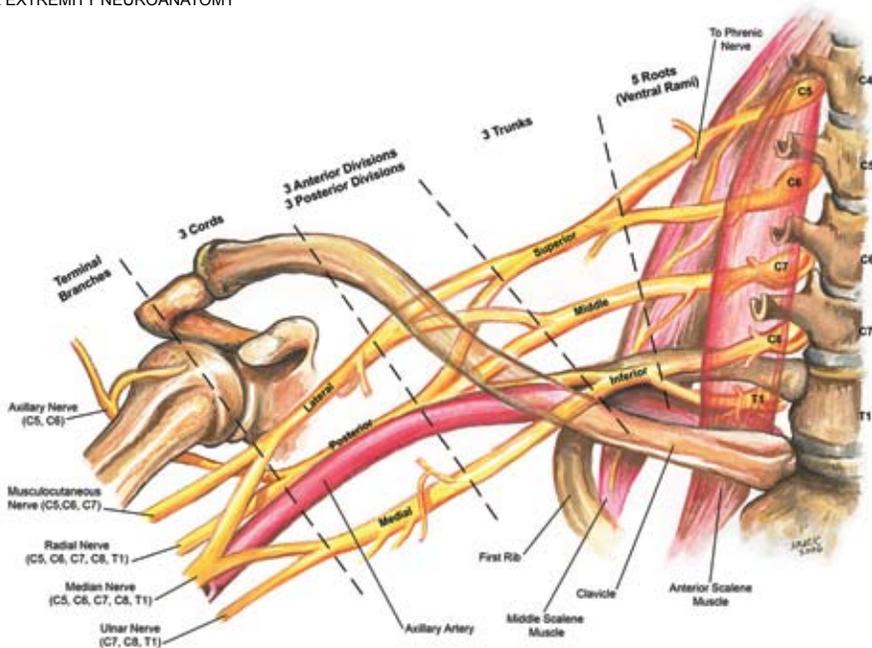


Figure 5-2

cord, innervates all of the muscles of the posterior compartments of the arm and forearm and most of the posterior skin of the upper extremity. Although there are numerous other named branches of the brachial plexus, familiarization with the plexus as outlined above is adequate for most upper extremity regional anesthesia procedures.

Considerable controversy has arisen about the existence of a nerve “sheath” surrounding the brachial plexus and including the artery, vein, and investing connective tissue. Anatomical dissection of the brachial plexus consistently reveals a distinguishable sheath of fibrous tissue surrounding the brachial plexus, vasculature, and loose investing connective tissue. In Figure 5-3, the platysma muscle has been reflected, exposing the brachial plexus sheath just posterior to the omohyoid muscle and lateral to the sternocleidomastoid muscle. In Figure

5-4, the omohyoid muscle has been retracted, and the sheath has been filled with normal saline. The nerves of the brachial plexus can now be seen through the “window” created by the fluid-filled sheath.

The existence of nerve sheaths is not unique to the brachial plexus and can be demonstrated on neurovascular structures throughout the human body. The practice of regional anesthesia depends on the anatomical fact of the sheath. The sheath improves the success of single injection blocks and continuous peripheral nerve catheters by containing the local anesthetic near nervous tissue targets and allowing the anesthetic to surround and bathe the nerves.

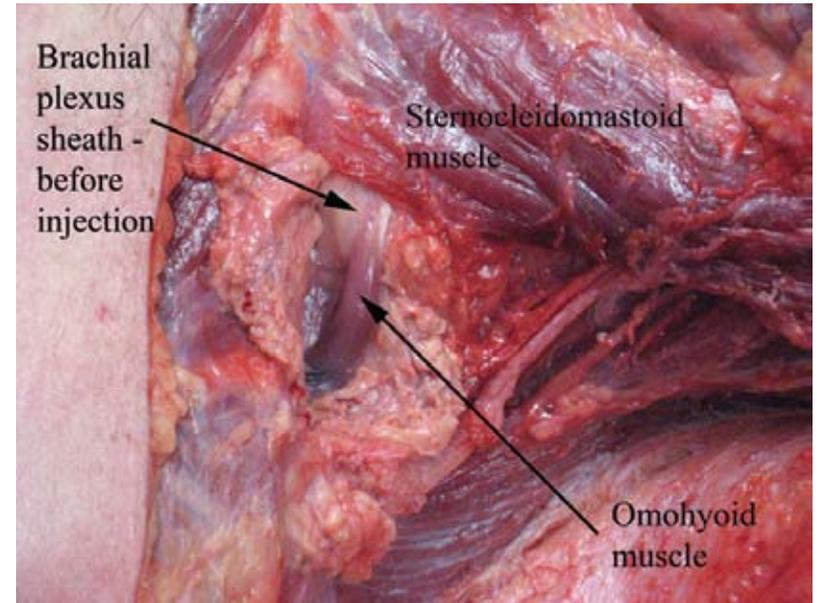


Figure 5-3. Sheath prior to injection with saline

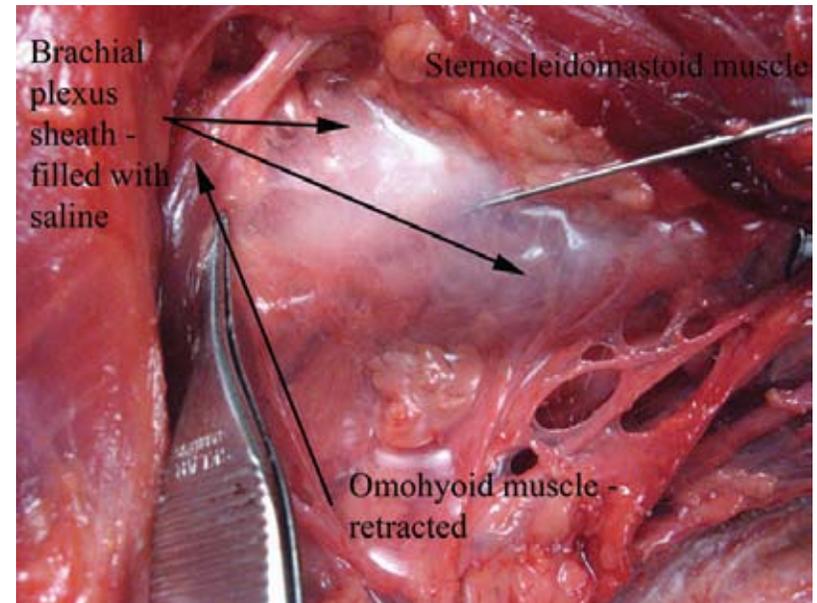


Figure 5-4. Sheath injected with normal saline. Note the nerve tissue visible within the sheath.