Chapter 2

PHYSICAL EXAMINATION OF THE CERVICAL SPINE

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The cervical spine exam is particularly important in patients with axial neck pain, arm pain, neurologic dysfunction of the upper or lower extremities, or bowel and/or bladder dysfunction. Because all of these symptoms can emanate from pathologies related to the cervical spine, spinal cord, or nerve roots, questions related to these types of symptoms should be posed while taking a history. Care should be taken to rule out myelopathy (signs/symptoms of spinal cord compression) to allow the patient an understanding of the risks associated with cervical spinal cord compression. If the patient has radicular complaints (pain, sensory changes, or weakness in a nerve root distribution), it behooves the examiner to try to delineate which nerve root is affected during the history and physical examination. Finally, always ask pertinent questions to help rule out a tumor or infection (night pain, fevers, chills, sweats, or unexplained weight loss).

INSPECTION

VISUAL

Patient inspection starts when the patient enters the room. Observe the patient’s attitude. Note if the patient is in pain, irritated, angry, or frustrated, and if the complaint is a possible cause. Pay particular attention to see if the patient is protecting (splinting) any part of the body. Observe how the patient carries the head. Watch the patient, and note any kyphosis (hunch back), scoliosis (S-shaped curve), torticollis (twisted neck), difference in shoulder height, or other abnormalities. If the patient presents with an abnormality in posture,
determine whether the patient can correct it without assistance. Be sure to note any pain. Try to deduce if the patient’s positioning could be causing the problem, and attempt to determine its relation to the patient’s complaint.

Much can be learned from observing the patient undress. Motion of the head and neck normally should be smooth and fluid. Notice if the patient is limited in any motions or has trouble pulling the shirt over the head, unbuttoning buttons, or bending to take off shoes and socks. Note the patient’s range of motion and amount of pain. Once the patient is undressed, look for any signs of trauma, blisters, scars, discoloration, contusions, limb asymmetry, and atrophy.

**PALPATION**

Before palpating, you may wish first to check for variation in skin temperature and for diaphoresis by comparing symptomatic with asymptotic areas using the back of the hand. Marked changes in temperature may indicate to the examiner areas where care should be taken not to cause unnecessary pain during palpation.

Perform palpation systematically, using first bony and then soft tissue. In soft palpation, take note of tension and tenderness of the skin; the size, shape, and firmness of the muscles and any masses; and any other asymmetric differences found during the exam. Try to differentiate recent soft tissue changes that feel softer and more tender from older changes that will feel harder and more stringy. Also pay particular attention to the peripheral pulse: low pulse rate with low blood pressure could be the result of a sympathectomy from a spinal cord injury.

**Posterior Cervical Spine**

Soft tissue palpation should begin on the posterior aspect of the neck. It is best performed standing behind the patient with the patient seated (Fig. 2–1). Patients who are unable to sit may lie in a prone position on the examination table. The examiner should stand facing the patient’s head.

The posterior aspect of the cervical spine mainly consists of the trapezius, its associated lymph nodes, and the greater occipital nerve.

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*Figure 2–1  Posterior view of the cervical spine, with bony and neural anatomy on the left (greater occipital nerve) and muscular anatomy on the right (trapezius muscle).*
Trapezius

Origin: external occipital protuberance; medial one third of superior nuchal line; ligamentum nuchae; spinous processes from the seventh cervical to the twelfth thoracic vertebrae.

Insertion: lateral one third of the clavicle; acromion process; superior border and medial one third of the spine of the scapula.

Nerve supply: spinal accessory nerve [cranial nerve (CN) XI] and ventral rami of C3 and C4.

Palpation of the trapezius starts bilaterally where the muscle is first located near its superior origin (Fig. 2–2). Find the muscle lateral and inferior to the inion, and palpate toward the acromion (Fig. 2–3). Feel for lymph nodes on the anterior aspect of the muscle. This chain of nodes is usually only palpable and tender from pathologic causes (infectious, tumorous, or viral). Once the acromion is reached, follow the lateral border of the muscle, palpating toward the spine of the scapula. Continue following the trapezius up along its origin on the spinal processes to the superior nuchal line.
Findings: Positive findings associated with the upper trapezius are frequently from flexion injuries as a result of whiplash. Tenderness in the area of the scapular spine insertion may also be indicative of a flexion injury of the cervical spine (Fig. 2–4). Tenderness here can also be related to disorders of the shoulder.

GREATER OCCIPITAL NERVE

Palpation: Starting at the inion, bilaterally palpate for the greater occipital nerves. The greater occipital nerves are not normally palpable but can be sensitive.

Findings: If the greater occipital nerves are palpable/hyperesthetic, it is probably because of inflammation as a result of a whiplash injury.

Figure 2–4  (A–C) Whiplash injury. (B–C) Tenderness of the nuchal ligament can result from this injury.  Palpation of nuchal ligament is helpful in identifying posttraumatic injury.
**Superior Nuchal Ligament**

Palpation: The superior nuchal ligament area is palpable in the midline from the inion to the C7 spinous process (Fig. 2–5).

Findings: Generalized tenderness may indicate a stretch from a whiplash injury. Localized tenderness is not common in cervical spondylotic disease.

**Anterior Cervical Spine**

The anterior cervical spine is best palpated in the supine position (Fig. 2–6). Lay the patient on the examination table, and stand at the patient’s side. Place one hand under the patient’s neck for support, and use the other for palpation. Begin the examination with bony palpation, which consists of the hyoid bone, the thyroid cartilage, the first cricoid ring, the trachea, and the carotid tubercle. Follow this with soft tissue palpation, which consists of the sternocleidomastoid muscle with associated lymph nodes (looking for adenopathy), the carotid pulse, the parotid gland, and the supraclavicular fossa.

*Figure 2–5* Better delineation of this superior nuchal ligament originating on the inion and running in the midline attaching to the spinous processes.

*Figure 2–6* Position of the patient in extension for palpation of the anterior cervical spine.
End palpation of the cervical spine with the patient in the prone position for bony palpation of the posterior head and neck (Fig. 2–7). The posterior bony palpation will include the occiput, the inion, the superior nuchal line, spinous processes of the cervical vertebrae, and the facet joints.

**Bony Palpation (Fig. 2–8)**

When palpating the bony structures, note any asymmetries, misalignments, lumps, abnormalities, and areas of tenderness.

**Hyoid Bone** The hyoid bone is a horseshoe-shaped structure opening toward the spine. It is palpable by placing the thumb and index finger on each side of the neck, above the thyroid cartilage and below the mandible. Ask the patient to swallow, and feel for the hyoid bone as it elevates. Take care when palpating the hyoid bone because moderate pressure may cause it to break. The hyoid bone lies in a horizontal plane at the level of the C3 vertebral body.

**Figure 2–7** Patient in the prone position for bony palpation of the posterior head and neck.

**Figure 2–8** Bony structures of the neck.

**Figure 2–9** Beginning palpation for the thyroid cartilage by starting high in the neck.
Thyroid Cartilage and Thyroid Gland

Begin by locating the thyroid cartilage. Start high in the midline of the anterior neck, and palpate inferiorly until you feel its superior notch (Fig. 2–9). The prominent, superior portion of the thyroid cartilage, commonly known as the Adam’s apple (Fig. 2–10), lies in a horizontal plane with the C4 vertebral body. The inferior portion of the thyroid cartilage lies in a plane horizontal with the C5 vertebral body.

Figure 2–10 Feeling the notch superiorly in the thyroid.
Lateral and posterior to the thyroid cartilage is the thyroid gland (Fig. 2-11). Palpate the thyroid gland on both sides. A normal thyroid gland should be symmetric and smooth. If the gland feels cystic or lumpy, further work-up may be necessary to rule out disease of the thyroid.

**First Cricoid Ring** The first cricoid ring is located just below the thyroid cartilage (Fig. 2-12). Ask the patient to swallow; this will cause the first cricoid ring to elevate and will make palpation easier. The first cricoid ring lies in a horizontal plane with the C6 vertebral body. Take care when palpating the cricoid cartilage; too much pressure may cause the patient to gag.

**Carotid Tubercle of C6** The carotid tubercle is found by moving laterally from the first cricoid ring (Fig. 2-13). Palpate the carotid tubercles one at a time. Bilateral palpation of the carotid tubercles may cause compression on both carotid arteries, causing the patient to faint (Fig. 2-14). Additionally, the depth of palpation necessary for this can be uncomfortable to the conscious patient. It is extremely useful to localize the C6 level when performing anterior cervical surgery.

**Figure 2-11** Lateral and posterior to the thyroid cartilage is the thyroid gland.

**Figure 2-12** The first cricoid ring is located just below the thyroid cartilage.

**Figure 2-13** The carotid tubercle is found by moving laterally from the cricoid ring.

**Figure 2-14** The carotid sheath lies directly anterior to the carotid tubercle.
Trachea  Evaluate the trachea (Fig. 2–15) for any deviation from the midline, and note any abnormal findings.

Figure 2–15  (A) The trachea lies below the first cricoid ring and thyroid gland. (B) Palpation of the trachea.
SOFT TISSUE PALPATION OF THE ANTERIOR CERVICAL SPINE

CAROTID PULSES  The carotid pulses are palpable just lateral to the first cricoid ring and adjacent to the carotid tubercles (Fig. 2–16). The pulses are palpated one at a time to avoid restricting blood flow to the brain. The pulses should be of equal strength. Also feel for hematoma formation or thrills. Use the stethoscope at this point for auscultation.

Figure 2–16  (A) Carotid artery branching showing internal and external divisions. (B) The carotid pulse is palpable just lateral to the first cricoid ring and adjacent to the carotid tubercles.
SUPRACLAVICULAR FOSSA The supraclavicular fossa (Fig. 2-17) lies superior and posterior to the clavicle and lateral to the suprasternal notch. Look for any asymmetry, and palpate for any swelling or bulge.

Findings: Enlarged lymph nodes and cervical ribs often present in the supraclavicular fossa. A large mass or asymmetry will need further investigation because of the possibility of a tumor.

Figure 2–17  (A–B) Elements of the supraclavicular fossa.
Sternocleidomastoid and Mastoid Process

Origin: sternal head—anterior surface of the manubrium
Clavicular head: superior surface of the medial one third of the clavicle
Insertion: lateral surface of the mastoid process and lateral half of the superior nuchal line

Nerve supply: spinal accessory nerve (CN XI) and ventral rami of C2 and C3

Palpation: Find the sternocleidomastoid muscle at its origin at the mastoid and follow it downward, palpating to its insertion on the clavicle. To find the mastoid process, start at the inion, and palpate laterally on the superior nuchal line until you feel its rounded process (Fig. 2–18). If the patient is able, have the person contralaterally rotate the head and ipsilaterally side bend the neck against resistance (Fig. 2–19).

Figure 2–18 Finding the sternocleidomastoid at its origin at the mastoid is easiest by starting at the inion and palpating laterally on the superior nuchal line until you find the rounded process.

Figure 2–19 If the patient is able, have the person rotate the head contralaterally while side bending against resistance.
This will sometimes cause the patient’s sternocleidomastoid muscle to protrude (Fig. 2–20). Feel for the chain of lymph nodes that runs along the medial border of the sternocleidomastoid muscle (Fig. 2–17).

Findings: Torticollis is the turning of the head to one side because of injury to the sternocleidomastoid muscle. This may result from injury to the spinal accessory nerve, swelling, and/or protective spasm of the muscle, possibly due to stretch associated with a hyperextension injury of the neck, vertebral body disease, or tonsillar infection. Enlarged lymph nodes are a possible sign of infection in the upper respiratory tract.

Parotid Gland Begin palpating the mandible at its union (Fig. 2–21). Follow it posteriorly back until you have reached the angle. The parotid gland lies over the angle of the mandible. If swollen, the angle of the mandible will not feel sharp.

Figure 2–20  Protrusion of the sternocleidomastoid muscle seen with contralateral rotation and ipsilateral side bending of the neck.

Figure 2–21  Palpation of the parotid gland at the angle of the mandible.
Bony Tissue Palpation of the Posterior Cervical Spine

The Spinous Processes

The spinous processes are the most easily palpable bony structures in the spinal exam. Stand at the supine patient’s head. Place your thumb in the anterior midline and wrap your fingers around to the posterior aspect of the spine (Fig. 2–22). Starting high at the base of the skull, probe with your fingers until you find the first process, C2. Continue the exam caudally and end with T1. The spinous processes should lie in line with one another. Feel for misalignments and for any curvature other than the normal lordosis of the cervical spine. Note any pain, tenderness, or swelling in the paraspinal muscles.

Facet Joints

Begin by having the patient completely relax in the prone position. Start palpation of the facet joints by moving laterally on both sides of the C2 spinous process and feel for the facet joints between the vertebrae. Continue palpating to the C7–T1 facet joint and note any tenderness elicited from the examination.
CERVICAL SPINE MOTION TESTS

ACTIVE MOTIONS

Direct the patient to move the head in one of six directions and stop when the movement elicits pain or when the movement’s range has reached its limit. The goal of the active motion exam is to determine range of motion and pattern of movement.

Positioning: The patient should stand or sit in a normal postural position. Observe the patient’s movements from behind or from the side.

Flexion

Instruct the patient to relax the jaw and bring the chin down as far as possible toward the manubrium without flexion of the thorax (Fig. 2–23). The patient should be able to touch the chin to the chest.

Extension

Instruct the patient to bring the head backward as far as possible without movement of the thoracic and lumbar spine (Fig. 2–24). As in flexion, instruct the patient to relax the jaw and leave it open to reduce tension of the platysma muscle. When the head is fully extended, the nose and forehead should be in a horizontal plane.
Left and Right Rotation
Direct the patient to turn the head as far as possible to the left and then to the right (Fig. 2–25). Note the limit of the patient’s rotational motion. Normal rotation of the neck to one side is \( \sim 80 \) degrees. This places the chin above the shoulder. It is normal for rotational ranges to be asymmetric, but this becomes clinically important when pain is restricting motion. If one of the motions elicits pain, direct the patient to repeat the motion in flexion and then in extension. This helps load and unload the facet joints during the particular motion, with extension loading the joints.

Left and Right Side Bending
Instruct the patient to side bend the neck left and then right, without rotation, placing the ear to the shoulder (Fig. 2–26).
PASSIVE MOVEMENTS

When performing the passive movements examination, differences in mobility and range of motion between passive and active movements should be noted. Passive movements commonly do not elicit as much pain, so a greater range of motion can be obtained. Also determine whether the end motion feels firm, flaccid, or rigid. Take great care to be very gentle with any patient with a history of recent trauma; do not perform passive motions until the cervical spine has been cleared for fracture or significant ligamentous injury.

Positioning: The patient should stand or sit in a normal postural position. Observe the patient’s movements from behind or from the side.

Extension

To perform passive extension of the cervical spine, begin by asking the patient to open and relax the jaw. Standing by the patient’s side, place your right forearm across the patient’s shoulders, with your right hand on the patient’s far shoulder. This steadies the body so the patient does not bend the thoracic spine with neck extension. Place the fingertips of your left hand on the patient’s forehead and carefully tilt the patient’s head into full neck extension (Fig. 2–27).

Figure 2–27 Passive extension.
Left and Right Rotation

To test passive rotation to the left, stand behind the patient on the right side. With your left hand, cup the patient’s forehead, placing your elbow on the patient’s shoulder for stability. With the right hand, take hold of the back of the patient’s head, and place your elbow on the patient’s right shoulder to prevent rotation of the patient’s body. Slowly rotate the patient’s head with both hands. Repeat the test for rotation to the right (Fig. 2-28).

Left and Right Side Bending

To test left side bending, place your right arm on the patient’s left shoulder. Stand behind the patient. With the right arm, grasp the patient’s head and rest your elbow on the posterior aspect of the patient’s shoulder. Using your right arm, begin to bend the neck to the left side. Be sure to fix the body to minimize movement (Fig. 2-29).

Figure 2-28  Passive left and right rotation.

Figure 2-29  Passive left and right side bending.
RESISTED TESTS

Resistance testing of flexion, extension, rotation, and side bending is used to determine whether a lesion in the C1 or C2 nerve roots exits, which may result in muscle weakness.

Positioning: The patient should stand or sit in a normal postural position.

FLEXION

Primary flexors: sternocleidomastoid muscle
Secondary flexors: scalenus and prevertebral muscles

To examine resisted neck flexion, stand to the side of the patient (Fig. 2–30). Place one hand on the patient’s forehead and the other on the posterior neck. Direct the patient to flex the neck by retracting the chin and pushing the forehead into your hand. Resist the motion.

Figure 2–30  (A) Appropriate resisted neck flexion. (B) Musculature of neck flexion: sternocleidomastoid, scalenus, and prevertebral musculature.
EXTENSION

Primary extensors: splenius, semispinalis, capitis, and trapezius
Secondary extensors: intrinsic neck muscles

To test resisted extension of the neck, stand at the patient’s side, and place the palm of your hand on the patient’s chest (Fig. 2–31). Place the elbow of your free arm on the posterior thoracic spine and that hand on the back of the head. Instruct the patient to push back with the head onto your hand. Resist the movement with an equal and opposite force.

LEFT AND RIGHT ROTATION

Primary rotators: sternocleidomastoid muscle
Secondary rotators: intrinsic neck muscles

Figure 2–31  (A) Appropriate resisted neck extension. (B) Muscles of neck extension: splenius, semispinalis, capitis, and trapezius.
To test resisted rotation, stand behind the patient (Fig. 2–32). To test rotation to the left, place your left elbow on the patient’s left shoulder and place your hand on the patient’s forehead. Place your right elbow on the posterior aspect of the patient’s right shoulder, and your right hand on the back of the patient’s head. Instruct the patient to turn the head to the left, and resist the motion. Repeat the test for rotation to the right.

**LEFT AND RIGHT SIDE BENDING**

Primary side benders: scalenus anticus, medius, and posticus
Secondary side benders: intrinsic neck muscles

*Figure 2–32*  (A) Resisted right and left rotation. (B) Muscles of left and right rotation: sternocleidomastoid and intrinsic neck muscles.
To test resisted side bending to the left, stand behind and to the left of the patient (Fig. 2–33). Place your left elbow on the patient’s left shoulder and your palm on the patient’s head, just above the ear. With the other hand, grasp the patient’s right shoulder. Instruct the patient to side bend the neck to the left, and resist the motion. Repeat the test for side bending to the right.

NEUROLOGIC EVALUATION

C2–C4
The C1 through C4 nerve roots are difficult to test, and lesions to these roots usually indicate a serious condition. The diaphragm is innervated by roots C3, C4, and C5, with the majority of its nerve input from C4. A cord lesion at or above this level will result in a loss of the ability to inhale, causing significant respiratory problems, frequently with a need for mechanical ventilation.

Motor C2–C4
Resisted Bilateral Scapular Elevation
Primary elevators
- Trapezius CN XI
- Levator scapulae C3, C4, and sometimes C5
Secondary elevators
- Rhomboid major
- Rhomboid minor

Figure 2–33 Resisted right and left side bending.
To perform bilateral scapular elevation, place the patient in a standing or seated position (Fig. 2–34). Stand directly behind the patient. Instruct the patient to shrug both shoulders up as high as possible. Place both hands on the patient’s shoulders and attempt to push them toward the floor. This should be impossible to do when C2, C3, and C4 are intact. Weakness found in the scapular exam indicates a serious pathology. Note any differences in elevation heights or any asymmetry in strength. The spinal accessory nerve also plays a role in this motion.

Figure 2–34  (A) Resisted scapular elevation. (B) Muscles of scapular elevation: trapezius, CN XI, levator scapulae, rhomboid major and minor.
Sensory C2–C4

The sensory dermatomes of C2, C3, and C4 give sensation to the back of the skull and neck (Figs. 235, 236). Because these roots have no significant myotome, the diagnosis of upper cervical radiculopathy relies often on these dermatomal abnormalities, which must be tested specifically with a pinwheel. The lower cervical dermatomes demonstrate a well-defined dermatomal map displayed in the figures.
Figure 2–35 (A) Sensory dermatomes of the cervical and upper thoracic spine. (B) Sensory dermatomes of the skull involving C2, C3, and CN V. (C) Sensory dermatomes of the skull and upper shoulder girdle.

Figure 2–36 (A) Sensory dermatomes of C4–T2. (B) Dorsal dermatomes of C4–T2.
C5

**Motor C5**

C5 is best tested by the deltoid muscle. The deltoid is innervated almost entirely by C5, whereas the biceps is innervated by both C5 and C6.

**Shoulder Abduction (C5)**

Primary abductors (Fig. 2–37)
- Deltoid: axillary nerve C5, C6
- Supraspinatus: suprascapular nerve C5, C6

Secondary abductors
- Serratus anterior

To perform shoulder abduction, have the patient stand or sit with the arms resting alongside the body. To test the left shoulder, stand to the left of the patient, and place your left hand on the patient’s distal upper arm. Place your right hand on the hip or shoulder to stabilize the patient. Instruct the patient to push the arm into abduction, and resist the motion. Repeat the test on the right shoulder. Testing bilaterally and simultaneously provides excellent comparison between the right and left sides (Fig. 2–38).

**Shoulder Flexion (C5, C6)**

Primary flexors
- Deltoid: axillary nerve C5
- Coracobrachialis: musculocutaneous nerve C5, C6

Secondary flexors
- Pectoralis major
- Biceps

To test shoulder flexion, stand behind the patient with one hand on the shoulder and the other arm wrapping around the biceps (Fig. 2–39). Instruct the patient to flex the elbow to 90 degrees. Then instruct the patient to flex the shoulder, bringing the arm forward. Resist the patient’s movement.
**EXTERNAL ROTATION OF THE SHOULDER (C5, C6)**

Primary external rotators
- Infraspinatus: suprascapular nerve C5, C6
- Teres minor: axillary nerve C5

Secondary external rotators
- Deltoid

To test external rotation of the shoulders, have the patient stand before you with arms resting alongside the body and both elbows flexed at 90 degrees (**Fig. 2–40**). Instruct the patient to then externally rotate both hands against resistance.

**Figure 2–39**  
(A) Shoulder flexion.  
(B) Muscles of shoulder flexion: deltoid, coracobrachialis, pectoralis major, and biceps.

**Figure 2–40**  
External rotation of the shoulder.
INTERNAL ROTATION OF THE SHOULDER (C5, C6)

Primary internal rotators (C5, C6)
- Subscapular: subscapular nerves C5, C6
- Pectoralis major: C5, C6, C7, C8, T1
- Latissimus dorsi: thoracodorsal nerve
- Teres major: lower subscapular nerves C5, C6

Secondary internal rotators
- Deltoid

Test the resisted internal rotation of the shoulder in the same manner as resisted external rotation (Fig. 2–41).

The test for internal rotation is not as accurate as those for flexion, extension, and abduction of the shoulder because of C6, C7, C8, and T1 involvement.

ELBOW FLEXION (C5, C6)

Primary flexors
- Brachialis: musculocutaneous nerves C5, C6
- Biceps: musculocutaneous nerve C5, C6

Secondary flexors
- Brachioradialis
- Supinator

Figure 2–41  Internal rotation of the shoulder.

Figure 2–42  Elbow flexion. Care should be taken to resist pronation in an attempt to keep the test to that of pure biceps function (C5).
With the patient standing or sitting, stand in front of the patient, and place one hand on the elbow and wrap the other around the wrist. The hand on the elbow fixates the arm during the exam. The patient begins with the elbow flexed at 90 degrees and is instructed to further flex the arm. As the arm flexes, increase resistance to provide maximum resistance when the arm and forearm create an angle of \( \sim 45 \) degrees. Care should be taken to ensure full supination of the wrist to test the C5 myotome (Figs. 2–42, 2–43). Patients with C5 weakness will inadvertently cheat by pronating the wrist and use the C6 innervated muscle to resist.

**Figure 2–43** (A) Pure biceps function with full supination. (B) Utilization of the pronator to assist with flexion when the hand pronates, lending C6 innervation to the strength testing. (C) Attachment to both biceps and forearm musculature, demonstrating the ability to assist with elbow flexion.
Sensory C5

C5 is tested by its sensory contribution to the axillary nerve. It supplies sensation to the lateral aspect of the upper arm (Fig. 2–36).

Biceps Reflex: C5

Instruct the patient to sit or stand with the left forearm flexed and relaxed at an angle of 90 degrees. Face the patient, standing to the person’s left side. The patient’s forearm rests over your left forearm. Grasp the patient’s left elbow with your left hand, placing your thumb over the biceps tendon. Strike your thumb over the tendon with the reflex hammer, watching for contraction of the biceps muscle (Fig. 2–44).

Figure 2–44  (A) Position for the biceps reflex test, with the examiner’s thumb over the biceps tendon. (B) A normal biceps reflex is a slight flexing of the elbow. (C) Biceps tendon attaching to the biceps muscle.
C6

Motor C6

Motor testing of the C6 nerve root is difficult because the testable muscles of C6 are also partially innervated by other nerve roots. Because the wrist extensors have a larger C6 contribution, they can be used for testing along with the biceps (Fig. 2–45).

Figure 2–45  (A) Resisted wrist flexion. (B) Muscles of wrist flexion.
Elbow Flexion (C5, C6)
See C5 level motor testing for instructions.

Wrist Extension (C6)

Primary extensors
- Extensor carpi radialis longus: radial nerves C5, C6
- Extensor carpi radialis brevis: radial nerves C5, C6
- Extensor carpi ulnaris: radial nerve C6

Have the patient stand with the arms at the sides and relaxed. Position yourself to the left of the patient. Grasp the patient’s elbow at the proximal forearm. Place your free hand on the dorsal aspect of the patient’s hand. Instruct the patient to extend the wrist against resistance (Fig. 2–46). Alternatively, have the patient extend the wrist and attempt to force the wrist into flexion (Fig. 2–47). Unbreakable strength is 5/5.

Sensory C6
C6 is tested by its sensory contribution to the musculocutaneous nerve. It supplies sensation to the lateral forearm, thumb, index finger, and one half of the middle finger (Fig. 2–36).

Figure 2–47  Alternate wrist extension test. The patient extends the wrist, and the examiner attempts to force the hand into flexion.

Figure 2–46  Muscles of wrist extension.
Brachioradialis Reflex: C6

Instruct the patient to sit or stand with the forearm flexed and relaxed at an angle of 90 degrees. Face the patient, standing to the person’s right. To test the patient’s left brachioradialis reflex, rest the patient’s forearm on your right forearm. Grasp the patient’s arm with your right hand over the triceps. Using the reflex hammer, strike the brachioradialis tendon at the musculotendinous junction in the midportion of the radius to elicit a jerk (Fig. 2–48). Repeat the test on the right arm.

Figure 2–48 (A) Brachioradialis reflex target for reflex hammer. (B) Reflex arc with wrist extension. (C) Elicitation of brachioradialis reflex.
C7

Motor C7

Motor function of C7 is tested by the strength of the triceps and the flexors of the wrist. For triceps testing, have the patient attempt to push you away as you hold the arm in elbow flexed position. With the wrist flexed, attempt to extend the wrist.

Shoulder Adduction

Primary adductors

- Pectoralis major: C5, C6, C7, C8, T1
- Latissimus dorsi: thoracodorsal nerves C6, C7, C8

Secondary adductors

- Teres major
- Deltoid

To test for shoulder adduction, have the patient sit or stand with the arms hanging alongside the body. Place a hand either on the hip or on the shoulder for body stabilization (Fig. 2–49). Grasp the elbow with your other hand. Instruct the patient to hold the arm close to the body as you forcefully try to abduct the arm.

Elbow Extension

Primary extensors

- Triceps: radial nerve C7

Secondary extensor

- Anconeus

With the patient standing or sitting, stand in front of the patient. Place one hand on the elbow, and grasp the patient’s wrist with the other hand (Fig. 2–50). The hand on the elbow fixates the arm during the exam. With the elbow fully flexed, instruct the patient to extend the arm. As the arm extends, increase resistance to provide maximum resistance when the arm and forearm create an angle of ~60 degrees.
Wrist Flexion

Primary flexors
- Flexor carpi radialis: median nerve C7
- Flexor carpi ulnaris: ulnar nerve C8

To test wrist flexion, instruct the patient to make a fist and grasp the hand from the palmar side (Fig. 2-45). Hold the underside of the patient’s wrist with the other hand for support. Instruct the patient to flex the wrist while you attempt to pull it into extension.

Figure 2-50  (A) Triceps testing (C7). (B) Origin and insertion of triceps muscle.
Sensory C7
C7 most commonly provides sensation to the middle finger, although sensation is sometimes supplied by C6 and C8 (Fig. 2–36).

Triceps Reflex: C7
To test the triceps reflex, stand in front of the patient and grasp the inner aspect of the arm. Instruct the patient to fully relax the arm. To elicit a jerk, tap the triceps tendon with the reflex hammer just proximal to the olecranon where the tendon crosses the olecranon fossa (Fig. 2–51).

C8
Motor C8
Motor function of C8 is best tested by finger flexion and thumb adduction.

Finger Flexion C8
Primary flexors
- Flexor digitorum profundus: ulnar nerve and anterior interosseous branch of median nerves C8, T1
- Flexor digitorum superficialis: median nerves C7, C8, T1

To test finger flexion, instruct the patient to make a fist. Curl your fingers under the patient’s fingers and try to extend them. Grasp and secure the arm and wrist of the patient with your free hand (Fig. 2–52).
Adduction of the Thumb

Primary adductor
- Adductor pollicis: ulnar nerve C8

To test thumb adduction, the patient’s palm faces upward. Stabilize the wrist by holding the ulnar side of the wrist and hand.

Figure 2–52  (A) Testing finger flexion. (B) Muscles of finger flexion.
Take hold of the thumb in an abducted position and instruct the patient to adduct the thumb against resistance (Fig. 2–53).

**Sensory C8**

C8 provides sensation to the ulnar side of the distal forearm, the ring finger, and the little finger (Fig. 2–36).

**T1**

**Motor T1**

Motor function of T1 is best tested by finger abduction and adduction.

*Figure 2–53  (A) Testing thumb adduction. (B) Muscles of thumb adduction: adductor pollicis.*
LITTLE FINGER ADDUCTION

Primary adductor
- Palmar interossei: ulnar nerves C8, T1

To test finger adduction, instruct the patient to abduct the little finger. Grasp the patient’s wrist for support with the index finger of your other hand, and hook the patient’s abducted little finger (Fig. 2–54). Further instruct the patient to adduct the little finger against the resistance.

Figure 2–54  (A) Testing little finger adduction. (B) Muscles of little finger adduction: palmar interossei.
FINGER ABDUCTION

Primary abductors (Fig. 2–55)
- Dorsal interossei: ulnar nerves C8, T1 (Fig. 2–56)
- Abductor digiti minimi: ulnar nerves C8, T1 (Fig. 2–57)

To test finger abduction, hold the patient’s wrist for support. Instruct the patient to extend and spread the fingers. Attempt to adduct the fingers in pairs. First adduct the index and middle fingers, then the middle and ring fingers, and finally the ring and little fingers.
Sensory T1
T1 is tested through its sensory contribution to the medial brachial cutaneous nerve. It supplies sensation to the medial side of the distal upper arm and proximal forearm.

SPECIAL TESTS

Foramina Compression Test (Left and Right) (Modified Spurling’s Maneuver)
To test for foramina compression, stand behind the seated patient. Place a hand on the side of the patient’s head above the ear. The other hand rests on the patient’s shoulder for support. Move the head into a slight rotation and side bend to one side, while at the same time extending the patient’s neck (Fig. 2–58). Once the head is in the correct position, add a brief axial pressure to the head. A positive test results in a root compression, indicating inadequate space in the intervertebral foramina.

Figure 2–58  (A) Modified Spurling’s maneuver. (B) Mechanism of foraminal compression with modified Spurling’s maneuver.
**Lhermitte’s Test (or Phenomenon)**

This phenomenon is often reported by patients as shocks or weakness in their arms and/or legs whenever they bend their head forward. To test this, ask the patient to flex the head forward, and determine if symptoms occur in a shooting fashion down the arms and/or legs (Fig. 2-59). This usually is caused by anterior compressive lesions, which are made worse by flexion and are a sign of myelopathy.

![Figure 2-59](image)

*(A)* Lhermitte’s test (or phenomenon) flexion of the neck, causing sensations into the arms from spinal cord compression. *(B)* Mechanism of spinal cord compression in Lhermitte’s phenomenon.
**Axial Separation (Distraction) Test**

Use this test to help determine appropriate treatment and the effects of neck traction. To perform the axial separation test, stand to the left of the seated patient. Hold the patient’s head with the right hand under the occiput and the left hand beneath the mandible. Perform a distraction of the head. This is performed in slight flexion and extension and in a neutral position (Fig. 2–60).

*Figure 2–60*  
(A) Axial separation (distraction) test.  
(B) Mechanism of action of the axial distraction test opening foramina.  
(C) Effect of extension in the axial distraction test.  
(D) Effect of flexion in the axial distraction test.
EXAMINATION OF THE BLOOD VESSELS

Modified DeKleyn and Nieuwenhuyse Test

To perform the modified DeKleyn and Nieuwenhuyse test, have the patient rest in a supine position with the head over the edge of the exam table. Support the head with both hands. Perform the following passive movements for 2 minutes each, returning the head to a neutral postural position for at least 1 minute between motions (Fig. 2-61): extension; rotation (left and right); extension with rotation and side bend to the same side (Fig. 2-62); flexion with rotation to one side and side bend to the opposite side. Stop the examination if a symptom is reproduced and remains for 15 seconds. The test is positive if a motion performed during the examination elicits a new symptom that persists or the same symptom as the patient’s complaint (Fig. 2-63). Once a position is found positive, the exam ends without performance of the other positions.

Figure 2-61  Modified DeKleyn and Nieuwenhuyse test.

Figure 2-62  Rotation and side bending during modified DeKleyn and Nieuwenhuyse test.

Figure 2-63  Mechanism of arterial compression during rotation and side-bending maneuver.
If the patient complains of dizziness, vestibular dysfunction must be ruled out before considering vertebrobasilar syndrome. Dizziness elicited during the combined movement of extension with rotation is considered by some to be pathognomonic of vertebrobasilar syndrome.

**Adson’s Test**

Use the Adson’s test to determine compression of the subclavian artery (Fig. 2–64). To perform this test, locate the radial pulse on the wrist with the patient sitting or standing. Continue to feel the pulse as you abduct, extend, and externally rotate the patient’s arm. Once the arm is in the proper position, instruct the patient to take a deep breath, hold it, and rotate the head toward the tested arm. The test is positive if the pulse is reduced or lost. A positive test indicates compromise or compression of the subclavian artery. This can occur as the result of the existence of a cervical rib or tightened scalenus anticus and medius muscles.

![Adson’s Test](image)

*Figure 2–64  (A) Adson’s test. (B) Mechanism of arterial compression during Adson’s test.*
Vertebral Artery Motion Test

Use the vertebral artery motion test to determine if vertebral artery symptoms are elicited by movements that stress the arteries (Fig. 2–65). To perform the vertebral artery motion exam, instruct the patient to stand with the legs shoulder-width apart. Stand in front of the patient, and place both hands on the shoulders to keep the patient’s body from moving. Instruct the patient to rapidly turn the head from side to side for 10 seconds or until symptoms are reproduced. If the exam produces symptoms, check to see if the pupils are symmetric. Asymmetric pupils after the vertebral artery motion test may indicate reduced blood flow through one of the vertebral arteries.

Figure 2–65  (A) Vertebral artery motion test. (B) Mechanism of production of vertebral artery symptoms due to stress of vertebral arteries during motion test.
Hoffmann’s Test
Hoffmann’s test is used to determine an upper motor neuron lesion above T1. To perform the Hoffmann’s test, instruct the patient to completely relax the hand. Flick the nail of the middle finger. If the muscles of the hand and thumb flex, the patient has a positive Hoffmann’s sign. This indicates that a lesion originates in the central nervous system and is not a radiculopathy or a peripheral nerve lesion (Fig. 2–66).

Crossed/Inverted Radial Reflexes
Another sign of cord irritation/myelopathy, spasticity, or disinhibition, this pathologic reflex occurs when the reflex arc spreads beyond the normal expected response. For example, when percussing the biceps tendon with a hammer, both a biceps and a wrist extensor reflex are elicited (crossed radial reflex) (Fig. 2–67).

Figure 2–66  Hoffmann’s test. (B) Positive Hoffmann’s test with finger and thumb flexion after flicking the middle fingernail.

Figure 2–67  (A) Testing for biceps reflex. (B) Elicitation of crossed radial reflex with wrist extension upon percussion of biceps reflex.
When hitting the brachioradialis, both a wrist extensor and finger flexor responses are elicited (inverted radial reflex) (Fig. 2–68). Both findings should prompt investigation for cord compression.

**Cervical Rib Exam**

To perform the cervical rib exam, palpate the radial pulse, and apply traction to the patient’s arm (Fig. 2–69). If the pulse is reduced or lost, it may suggest a cervical rib. Evidence of ischemia in one hand and a murmur of the subclavian artery may also indicate an obstruction caused by a cervical rib. Bilateral symptoms of ischemia are suggestive of other pathologic conditions such as Raynaud’s disease.

*Figure 2–68*  
(A) Testing for brachioradialis reflex.  
(B) Elicitation of inverted radial reflex with finger flexion upon percussion of the brachioradialis.
Figure 2–69  (A) Cervical rib exam applying traction while palpating the radial pulse. Reduction or loss of radial pulse is suggestive of a cervical rib.

(B) Anatomy of the cervical rib.

(C) Compression of the subclavian artery with the cervical rib.
**Valsalva Test**

The Valsalva test is used to detect for a space-occupying lesions in the spinal canal (Fig. 2–70). To perform this test, instruct the patient to hold the breath and bear down, as done when lifting weights improperly or straining to empty the bowels. If this action produces or increases preexisting pain or other symptomatology, the test is positive. Note in which dermatomes the patient feels the pain; this could be indicative of the cord level of the lesion. Positive Valsalva tests can be caused by herniated disks or tumors.

*Figure 2–70  (A) Valsalva test. (B) Mechanism of pain or other symptomatology with Valsalva test. Increase in intra-abdominal pressure leads to heightened irritation of spinal cord with preexistent pathology.*
STATIC/DYNAMIC ROMBERG’S TEST

To perform the static Romberg’s test, have the patient stand with the hands outstretched and palms up with the arms at 90 degrees of flexion (Fig. 2–71). Then have the patient close the eyes. If the patient loses balance or falls backward, or if the arms rise slowly to above parallel, it is a sign of proprioceptive deficit either from central (possibly cerebellar) dysfunction or from myelopathy.

For the dynamic Romberg’s test (also known as heel-toe walking), instruct the patient to walk in a straight line, heel to toe (Fig. 2–72). Difficulty doing so is often a sign of proprioceptive deficit, as above.