FLEX CEUs

Cervical Radiculopathy - Clinical Application of Traction and Exercises

Introduction [1]

Cervical Radiculopathy (CR) involves radicular symptoms including pain and numbness, tingling or loss of sensation down an upper extremity sourcing from a spinal nerve exiting from the cervical spinal cord. CR presents with specific clinical characteristics, is identified via clinical tests and imaging, and a multimodal approach including possibility of operative and/or nonoperative management is effective for treatment. Cervical traction and exercise are common physical therapy approaches that are helpful in treating CR. This course will outline clinical management of patients from diagnosis to treatment for physical therapists and physical therapist assistants.

Section 1: Clinical Presentation

Cervical radiculopathy (CR) involves a specific set of characteristics for a clinical presentation, which will be outlined below. It is important for clinicians including physicians, physical therapists, and physical therapist assistants to understand what factors precipitate CR, what common complaints a patient will have, diagnostic and imaging strategies in order to determine the best plan of care. This section will explain why cervical radiculopathy occurs, how to diagnose it, what pathologies mimic CR and which populations are predisposed to developing CR.

What is Cervical Radiculopathy? [1–4]

CR is the result of a cervical spinal nerve root being damaged which causes an issue with function of the nerve. It commonly occurs because of cervical spine degeneration, disc herniation, cervical spondylosis, and cervical spinal stenosis. Disc herniation accounts for around 20% of CR cases. Other less common causes are cervical spine osteoporosis, bone spurs, spinal instability, trauma, arthritis, cervical stenosis, fracture, tumor, and infection. Trauma and injury are the most common cause of CR in people under 30 years old. These pathologies in turn irritate the dorsal/sensory and ventral/motor nerve roots at the cervical spine causing upper extremity pain, myotome weakness, sensory or reflex impairment. Some have also described tingling, aching, and burning down the upper extremity from shoulder to fingers.

Signs and Symptoms [4–8]

Symptoms of CR from irritation to the nerve roots at the cervical spine are upper extremity pain, myotome weakness, sensory and reflex impairment. Pain patterns in the upper extremities are noted below. Some have also described tingling, aching, and burning down the upper extremity from shoulder to fingers in a dermatomal pattern. Patients can have headaches from occipital nerve distribution, pain in the scapular region. With CR, patients will have arm pain at a rate of 95%, 90% will have sensory impairments, 75% will have reflex impairments, 50-75% will have neck pain, 70% will have motor impairments, and 20% will have anterior chest pain. Nerve roots of C5-7 are impacted most often and sensory or motor symptoms commonly occur on one side with a dermatomal or myotomal pattern. Of the research available currently, there is no large consensus on prognostic factors to predict CR or neck pain in general. Three cited factors to predict neck pain include prevalence of other musculoskeletal disorders, patients coping with pain passively, and patients who have distress psychologically or psychosocially.

1. C2-4 radiculopathy will result in pain in the back of the ear, base of head and temple.
2. C5 radiculopathy will refer pain to the neck, outside of arm to elbow making shoulder abduction, external rotation and elbow flexion weak
3. C6 radiculopathy will create neck, lateral forearm, thumb and index finger pain and weakness in biceps brachii, wrist extensors
4. C7 radiculopathy will create lower neck, interscapular, posterior forearm and middle finger pain and weakness in triceps brachii and wrist flexors
5. C8 radiculopathy will create inter and intrascapular, medial forearm and 4th and 5th digit pain and weakness in the 3rd digit flexors and extensors, thenar and hypothenar muscles, flexor pollicis longus, flexor digitorum profundus and extensor pollicis longus

Diagnosis [7,9]

Cervical radiculopathy does not have a widely accepted method of diagnosis. However, CR can be highly suspected with a combination of signs and symptoms previously

mentioned like weakness, neck and arm pain on one side, numbness and impaired reflexes. A diagnosis of CR is typically made with clinical presentation, medical history and examination and then validated with imaging and electrodiagnostic studies. Electrodiagnostic studies are very supported for diagnosis if a patient has an atypical presentation, weakness rather than pain, and if MRI or CT do not show a singularly focused lesion.

Advanced Imaging [4,7,9]

Imaging is used to rule spinal instability in or out and can be vague for diagnosing CR. It is known that nearly 70% of patients who do not have symptoms in their fifth decade have evidence on imaging studies of degeneration of the cervical spine. Diagnosis is supported by imaging including computed tomography (CT), magnetic resonance imaging (MRI), electromyography (EMG) and nerve conduction studies (NCS).

1. CT
    a. Will gather pictures of bony pathology including spurs, facet hypertrophy, ligament ossification and stenosis at foramen and assists in diagnosis for potential causes of cervical radiculopathy
    b. Computed tomographic myelography
        i. Use of contrast dye injected into the spinal canal to differentiate structures more closely in an imaging study, in the cervical spine to examine the spinal canal and cord
        ii. Can visualize tumor, herniated disc, arthritis, impingement of spinal nerves
        iii. Top imaging choice for identifying nerve root impingement but MRI is the most supported imaging technique for complex cervical radiculopathy and is less invasive
2. MRI
    a. Clinicians should always refer to primary care physician for imaging when patients are suspect for complex cervical radiculopathy

i. Complex CR is caused by myelopathy or abscess, neurologic findings which are progressive and incessant, and if patient's symptoms fail to improve after a month to 1.5 months of conservative treatment

b. MRI is the most effective imaging method for spinal pathology as it can identify bony pathology from other tissue with increased accuracy and is not invasive unlike CT myelography

c. There is conflicting evidence of diagnostic accuracy due to rate of false positives and false negatives

i. MRI accurately predicting CR diagnosis has been reported at rates of near 90%

ii. As mentioned above, the majority of adults after age 50 will have age related wear and tear in their cervical spine including stenosis, disc herniation, osteoarthritis. These findings will show on imaging asymptomatically or symptomatically and can contribute to false negatives and positives

3. Electrodiagnostic studies

a. Often used for ruling CR in or out and involve EMG and NCS. These studies have a role in excluding pathology of peripheral nerves that are similar in presentation to CR

b. Will evaluate only C4 to C8 and T1 nerve roots as they have innervation in the upper extremity

c. EMG

i. Assesses function by stimulating muscles corresponding to myotomes to determine weaknesses per spinal nerve innervation

ii. Small needles are used to stimulate muscles with specific innervation via a myotome pattern to reveal pathology in this pathway

iii. Inaccurate as a tool for diagnosis when a patient is not experiencing weakness

iv. Accuracy of diagnosis for CR using EMG is near 60-90%

d. NCS

i. Nerve conduction study or nerve conduction velocity test

ii. The purpose of NCS is to assess the velocity of conduction of the nerve, amplitude, and to rule peripheral neuropathy out

iii. Electrode patch is attached to the skin and electrical impulse is sent through the electrode to stimulate skin and sensory nerves

iv. Sensory nerve conduction

1. Will most often have a normal conduction of amplitude and latency because compression in CR most often occurs just before the sensory cluster of neurons, the dorsal root ganglion

Physical Therapy Assessment [5,9,10]

Effective physical therapy assessment for CR, involves the clinician examining several aspects of the cervical spine, upper extremity, and thoracic spine always bilaterally to detect potential abnormalities to the asymptomatic side. Clinicians should gather a sufficient subjective history, examine posture, active range of motion of the cervical and thoracic spine and upper extremities, passive range of motion, palpation of muscles surrounding cervical spine and upper extremities, myotome and dermatome testing, accessory joint motion of the cervical and thoracic spine, upper extremities and special tests to rule out conditions that may mimic CR.

1. Subjective History [5]

a. A clinician should ask details about a patient's symptoms including when and where they started, whether the patient had a gradual or sudden onset, whether or not an injury occurred and details surrounding the event, what improves and worsens pain, what the patient's daily routine looks like including what they do for work and what they struggle to do functionally on a daily basis. A clinician should ask whether the patient has noticed signs and symptoms that are typical with cervical radiculopathy including unilateral weakness, paresthesia, and radicular

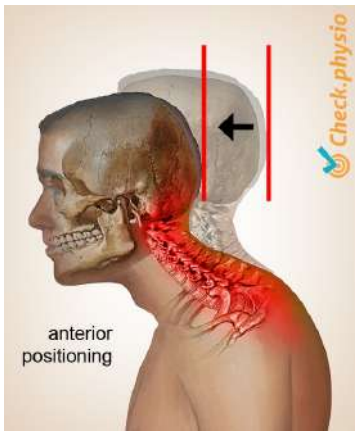
pain. Good clinicians will also attempt to rule in or out possible referrals screening for red flags of differential diagnoses. For example, to rule out cervical myelopathy a clinician should ask about unsteadiness, falls, noticeable discoordination of hands and problems with urine and bowel retention. A patient should fill out outcome measures, which are detailed in a separate section to document progress on neck disability and pain. Intake forms should be thorough and ask details of medications and past medical history to gain information to help with safe and effective management of CR.

2. Posture [11]

    a. Note position of spine and curvature, head position, whether there is lordosis or kyphosis present and any hinged parts of the spine especially at the cervicothoracic or thoracolumbar junction.

        i. Forward head posture as depicted below is a sign of weak anterior and tight/overactive posterior cervical muscles and is common in patients with neck pain

    b. Normally, the center of the scapulae should be directly inferior to the mastoid processes bilaterally. This maintains balance between shoulder girdle anteriorly and posteriorly and cervical musculature attached to the spine and the scapulae, clavicle and glenohumeral joint



https://www.physiocheck.co.uk/condition/88/cervical-posture-syndrome

    c. Note upper extremity posture including level and position of the scapulae, scapular retraction or protraction

3. Active range of motion [12]

   A clinician should have their patients move their cervical spine in flexion, extension, lateral flexion and rotation to assess for deficits bilaterally, and be asking for provocative symptoms throughout the movement. Range of motion can be measured with a goniometer or inclinometer for flexion, extension and lateral flexion. It is important to measure bilaterally and also assess shoulder and thoracic spine mobility as the cervical spine, thoracic spine, scapulothoracic and glenohumeral joint of the shoulder are interconnected.

   Normative values for cervical spine active mobility and what spinal segments are responsible are listed below.

   a. Cervical Spine [12]

      i. Flexion

         1. 80 – 90 degrees

         2. C1 and occiput articulation and small movements anteriorly and posteriorly on remaining cervical vertebrae

      ii. Extension

         1. 70 degrees

         2. C1 and occiput articulation and small movements anteriorly and posteriorly on remaining cervical vertebrae

      iii. Lateral flexion

         1. 20 – 45 degrees

         2. Rotation movement unilaterally as a combination of flexion and rotation throughout the cervical spine

      iv. Rotation

         1. 90 degrees

         2. C1 rotates on C2 to provide around 50 degrees of motion. The remaining rotation comes from the rest of the cervical spine

b. Thoracic Spine [13,14]
    i. Flexion
        1. Around 75 degrees
    ii. Extension
        1. 20 – 25 degrees
    iii. Lateral flexion
        1. 10 – 12 degrees per segment
    iv. Rotation
        1. 30 – 35 degrees
c. Upper extremity [15]
    i. Flexion: 180 degrees
    ii. Abduction: 180 degrees
    iii. Extension: 50 degrees
    iv. External rotation: 90 degrees
    v. Internal rotation: 70 degrees
    vi. Adduction: 45 degrees

4. Passive range of motion
    a. Measuring passive range of motion is similar to active range of motion besides the clinician pushes additionally into the available range of motion in each direction that active range of motion is tested. It is important to test both active and passive range of motion for clinical decision making. For example, if passive is greater than active motion, a clinician can suspect a muscle length issue and if passive and active are the same but restricted motion, a clinician can suspect a joint restriction.
5. Palpation [9]

a. Note and feel for muscle atrophy as this may be related to weakness in pattern with myotomes coming from issues at cervical spine. Detailed notes are helpful for this due to lack of objective testing for muscle palpation, but should be conducted at muscles that are directly innervated by myotomes listed in table in section below. Clinicians should also note muscular hypertrophy as this may occur from imbalances of strength, overuse and possible pain.

6. Resistive testing via Myotome Assessment [5,10,16]

Myotomes are the association between spinal nerves and motor innervation of corresponding muscles. It is important to assess for strength deficits in a myotome pattern as ventral nerve roots from the cervical spine directly innervate muscles from the shoulder down to the fingers. The following is a list of which spinal segments correspond with strength deficits that can be detected during a physical examination. Spinal nerves in the cervical spine from C1 to C7 leave the spinal cord in the space above the bony vertebrae that corresponds to that level while C8 nerve leaves the spinal cord between C7 and T1 bony vertebrae.

Nerve Root	Myotomes – Action, Strength Test	Applicable Muscles for Testing
C1+C2	Cervical flexion	Rectus lateralis, longus colli, cervices and capitis, sternocleidomastoid
C3	Cervical lateral flexion	Trapezius, scalene, longus capitis
C4	Shoulder elevation	Trapezius, levator scapula, scalene, diaphragm
C5	Shoulder abduction	Deltoid, biceps
C6	Elbow flexion, wrist extension	Brachioradialis, wrist extensors, serratus anterior, latissimus dorsi
C7	Elbow extension, wrist flexion	Triceps, wrist flexors
C8	Thumb extension, ulnar deviation	Extensor pollicus longus/brevis, flexor carpi ulnaris

T1	Finger abduction	Lumbricals, interossei muscles

Manual Muscle testing

a. In addition to myotome assessment, clinicians should test individual muscles with manual muscle testing to gain an idea of shoulder girdle weakness.

b. Muscles that would be appropriate to test bilaterally include the following:

   i. Lower and middle trapezius

   ii. Serratus anterior

   iii. Deltoid

   iv. Deep neck flexors

   v. Rotator cuff – external rotation, abduction of glenohumeral joint

7. Dermatome assessment [16,17]

Dermatomes can be described as innervation of sensory information to skin in a distribution, which begins from the posterior/dorsal spinal nerve root at corresponding segments.

Nerve Root	Dermatomal Distribution	Impairment
C1+C2	Head (lateral, anterior and posterior)	Paresthesia
C3	Neck, inferior to mandible	Paresthesia
C4	Shoulder, scapular, upper clavicular	Paresthesia
C5	Deltoid, front of arm to thumb	Impaired biceps reflex

C6	Front of arm, radial aspect of hand, digits 1 and 2	Impaired brachioradialis reflex, paresthesia in thumb
C7	Lateral arm/forearm, digits 2-4	Impaired triceps reflex, paresthesia in digits 2-4
C8	Medial arm/forearm, digits 2-5	5th digit paresthesia
T1	Medial forearm to start of 5th digit	Paresthesia

a. Testing dermatomes

Clinical assessment of dermatomes is completed to assess pain and light touch. Dermatomes are also associated with reflexes, temperature, vibration and pressure. A clinician typically uses various objects to elicit these stimuli and tests the skin of respective dermatomes. These tests are typically performed bilaterally, with the patient's eyes closed and the clinician gives patient instructions to state when and where they feel the sensation. The clinician should vary the speed and randomize the dermatome tested to get an objective assessment where the patient cannot predict the clinicians next chosen dermatome.

a. Pain – Pinprick test

i. Clinician uses a pin to carefully touch skin of respective dermatomes and assesses sharp or blunt sensation

b. Light Touch

i. Clinician uses cotton or other object to brush on area of skin

8. Deep tendon reflexes [18]

Using a reflex hammer, the muscle belly of the tendon that the clinician is testing should be completely relaxed. The clinician should quickly and gently strike the tendon of the respective areas below to assess deep tendon reflexes. These reflexes in the upper extremity may be impaired with CR at the respective nerve roots.

a. Bicep

i. Tests function of C5-6 nerve root

b. Brachioradialis

i. Tests function of C6 nerve root

c. Triceps

i. Tests function of C7-8 nerve root

9. Accessory joint motion [19]

The clinician will instruct the patient to lay in supine to test cervical spine accessory motion and prone to detect thoracic spine mobility. The general idea is to move spinal segments in respective directions to detect decreased mobility or stiffness bilaterally and to reproduce pain in a spinal segment. As the clinician moves segmentally, medially and laterally on each spinal segment they should assess whether a patient has pain or stiffness and document these findings. A clinician who suspects CR as a diagnosis should still examine the upper extremity to rule out other pathology and to potentially treat this area as it can be painful or weak as a side effect of cervical radiculopathy.

a. Cervical spine, thoracic spine

i. Posterior to anterior (PA), medial and lateral segmental movement to detect reduced mobility and pain bilaterally

b. Upper extremity

i. Distraction – joint play in open packed joint position (50 degrees abduction with slight horizontal adduction and external rotation)

ii. Inferior glide – joint play of humeral head moving downward in the joint capsule

iii. Posterior glide – joint play of humeral head moving backward in joint capsule

iv. Anterior glide – joint play of humeral head moving forward in joint capsule

10. Special Tests [7,20–22]

a. Spurling test

i. To perform this test as an examiner, the patient's cervical spine should be in passive extension, rotation to the involved side and loading inferiorly to provide axial compression

ii. Target is to have reproduction of compressive force at the nerve root that is impacted with extension to detect a possible posterior disc bulge/protrusion, rotation to shrink the foramen and axial compression to further provoke nerve symptoms if a nerve root is compressed

https://www.osmosis.org/learn/Spurling_test

b. Neck distraction test

i. Clinician provides distraction or joint separation by holding under the chin and base of the skull for 5-10 seconds. This will relieve symptoms of pain or paresthesia if it is a positive test

c. Valsalva's maneuver

i. Clinician instructs the patient to complete attempted expiration with closed glottis not letting air escape. This is positive if the increase in intrathoracic pressure provokes radicular symptoms down an upper extremity

d. Upper limb tension test A (ULTTa)

i. Test for median nerve compression by progressive movements to put tension on the median nerve. These are shoulder depression, abduction, external rotation, forearm supination, wrist and finger extension, elbow extension and cervical lateral flexion. These positions should be progressed through slowly and the clinician

should ask the patient if/when they feel tension (numbness, tingling, pain) down their upper extremity.

e. Shoulder abduction test

    i. A positive test occurs when a patient places their hand of the affected upper extremity on their head and it lessens symptoms

f. Deep Neck Flexor Endurance Test

    i. Clinician has the patient lay supine on a treatment table, perform craniocervical flexion and lift head off table 1-2 inches. The clinician then times how long the patient's head stays in the air but stops the timer if sternocleidomastoid or scalenes begin to compensate and activate, indicating weakness of deep neck flexors (longus colli, longus capitus, rectus capitus and longus cervices)

    ii. Is often positive with CR due to cervical and shoulder muscle compensations due to neck pain

g. Other Cervical Provocative tests

    i. L'hermitte's sign – After passive cervical flexion patient feels sharp/ shock sensation in upper or lower extremities or spine; often assists with detection of central nervous system disorders such as Multiple Sclerosis

    ii. Hoffman's sign – quick flexion by external force of 3rd digit causes 1st and 2nd digits to move closer together; detects a lesion or cervical cord compression at level of spinal cord

    iii. Adson's test – Positive test occurs if pulse at the radial area disappears when patient inhales with cervical extension and rotation to impacted side; predictive of thoracic outlet syndrome (described in differential diagnosis section)

h. Muscle length testing

    i. General process is to stabilize proximal and distal attachments of muscle and fully elongate the muscle being assessed, compare bilaterally and assess whether or not the muscle achieves normal

elongation. Common muscles to be short with cervical radiculopathy include

1. Pectoralis major
2. Upper trapezius
3. Scalenes
4. Levator scapulae
5. Suboccipitals

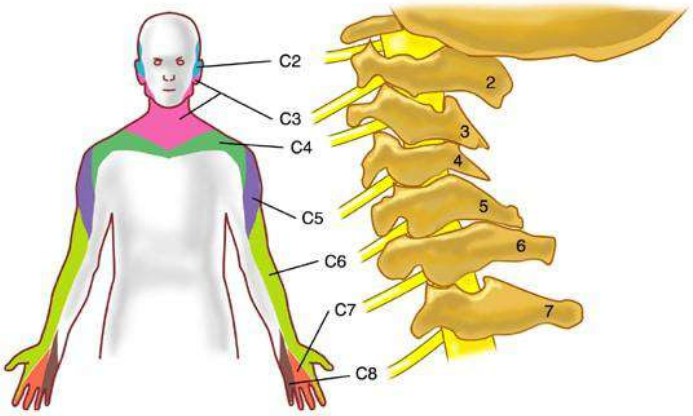
11. Clinical Prediction Rule (CPR) for Cervical Radiculopathy [23]

    The four tests involved in this CPR are:

    a. Positive upper limb tension test A
    b. Distraction test
    c. Spurling's Test
    d. Rotation range of motion in the cervical spine less than 60 degrees.

    If all four of these elements are positive, you can rule in CR at a rate of 99% (specificity), rule CR out at a rate of 24% (sensitivity), the positive likelihood ratio is 30 (30 times more likely that these positive tests are occurring with a patient with CR than without) and negative likelihood ratio is near 0.8 (lower than 1.0 means CR not being the diagnosis is unlikely). The following is a description of when these tests are positive.

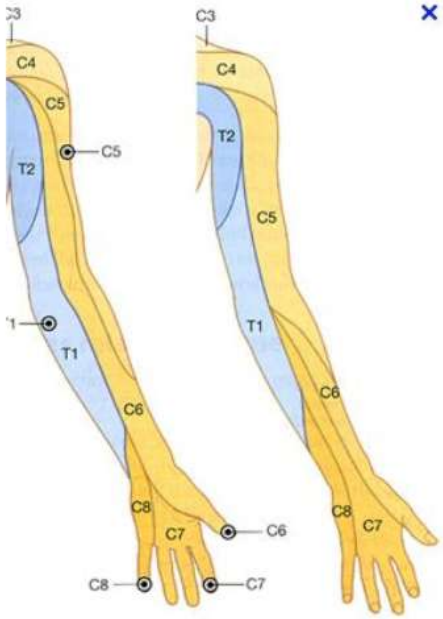
    a. ULTTa is positive with reproducing symptoms, elbow extension greater than 10 degrees from the opposite side or if cervical lateral flexion on painful side lessens symptoms or conversely if cervical flexion toward the opposite side of the pain worsens symptoms.
    b. Distraction and Spurling's A are positive if patient's symptoms are reproduced



https://braceaccess.com/what-are-dermatomes/

Dermatomes and Myotomes

C1	Upper Cervical Flexion
C2	Upper Cervical Extension
C3	Cervical Lateral Flexion
C4	Shoulder Girdle Elevation
C5	Shoulder Abduction
C6	Elbow Flexion
C7	Elbow Extension
C8	Thumb Extension
T1	Finger Adduction



https://studyres.com/doc/7917385/dermatomes-and-myotomes-c1-upper-cervical-flexion-c2-upper

Differential Diagnosis [5,7,24–28]

1. Cervical Myelopathy

a. Impaired function of the spinal cord resulting from compression and spinal canal narrowing

b. Causes upper and lower motor neuron signs of extremities

    i. Upper motor neuron signs occur when there is a lesion from superior to the anterior horn and lower motor neuron signs occur when the lesion occurs after the anterior horn of the spinal cord to muscle

    ii. Upper motor neurons are associated with the central nervous system (brain and brainstem) whereas lower motor neurons are part of the peripheral nervous system and carry out muscle action

    iii. Upper motor neuron sign examples include positive Babinski and Hoffman's reflex, weakness, spastic or rigid muscles, hyperactive reflexes, and tremor

    iv. Lower motor sign examples include flaccidity and loss of muscle tone, atrophy, low reflexes in deep tendon for patella, and muscle twitches

c. Red flag condition warranting immediate referral to imaging and emergency department for possible cord decompression surgery

d. Symptoms are clumsy extremities, impaired dexterity, and gait impairments

e. Severe compression can cause bowel and bladder impairments

f. Clinicians should screen bilateral extremities, upper motor neuron signs including Hoffman's and Babinski reflex, balance screen of Rhomberg. If these are positive, myelopathy may be suspect

    i. Rhomberg balance screen

        1. Patient instructed to stand with feet close to achieve a narrow base of support and this is tested with eyes open and closed. This can be assessed in the semi tandem and tandem position as well

2. These positions should be tested for 30 seconds and if a patient loses balance in under 30 seconds, the test is positive

g. Can mimic multiple sclerosis, motor neuron disease and Parkinson's Disease

2. Thoracic Outlet Syndrome

a. Neurovascular components of the arm are compressed passing through the neck, beneath clavicle, and above the first rib causing pain and paresthesia of the fingers and upper extremity

b. Cluster of tests involving stretching or shortening cervical and shoulder muscles to determine where nerve or artery is constricted

i. Adson's Test – subclavian artery is blocked due to tight scalenes or first rib; positive when abducting the shoulder 30 degrees and extending fully, then adding cervical rotation toward same shoulder takes away pulse in at the radius

ii. ROOS test – 90 degrees of shoulder abduction, flexion and 90 degrees of elbow flexion while the patient makes fist and releases for 3 minutes. If a patient has paresthesia, pain or weakness this test is positive

3. Entrapment Neuropathy

a. Peripheral nerve irritation and compression occurring from nerves going through small spaces. Carpal tunnel syndrome occurs at 10% rate over a lifetime.

4. Complex Regional Pain Syndrome (CRPS)

a. Chronic pain syndrome with fair to poor understanding surrounding cause and management

b. Characterized by sensation, motor and autonomic signs of one extremity, neglecting the affected arm

5. Brachial Plexus Lesions

a. Injury or pathology/lesion impacting any of the brachial plexus nerves innervating the upper extremities, resulting in pain, weakness or neuropathy. Patients will have pain with stretching an extremity in the opposite direction the affected nerve is travelling

6. Malignancy
    a. Tumor or lesions right where the spinal nerves exit the spinal canal will often mimic CR.
    b. Clinicians will be able to differentiate by asking questions of typical presentation with malignancy. Typical characteristics of malignancy are below.
        i. Night pain
        ii. Weight loss
        iii. Bowel and bladder changes
        iv. Unexplained lump
7. Infection
    a. Occur at any level of the cervical spine or higher which when pressed against spinal nerves exiting the spinal column can refer pain/sensory impairments to the upper extremities
    b. Example is meningitis or inflammation of the membrane covering the brain and spinal cord
    c. Patients may present with fever or elevated white blood cell count
8. Migraine
    a. Often severe headache that can cause a pulsing pain often caused by a majority of factors including stress, hormonal changes, caffeine, sensitivity to foods
    b. Can resemble C2-4 radiculopathy but migraines often present with light sensitivity, nausea and visual issues unlike radiculopathy
9. Rotator cuff tear

a. Typically caused by an acute injury such as falling on an outstretched hand which can tear one of the four rotator cuff muscles, the supraspinatus, infraspinatus, teres minor or subscapularis

b. Can resemble C5 radiculopathy; a clinician can differentiate the two because a patient will not have shoulder pain with passive range of motion with radiculopathy and reflexes will be unaffected

10. Carpal tunnel syndrome (CTS)

    a. Syndrome caused by nerve compression of the median nerve through the wrist and hand beneath the transverse carpal ligament

    b. Can resemble C6 radiculopathy; to differentiate CTS from CR, the nerve conduction study is normal in CR and abnormal in CTS, there is shrinking of thenar muscles and a positive Tinel's sign in CTS

11. Posterior Interosseous Nerve (PIN) syndrome

    a. Posterior interosseous nerve is compressed where it goes through the radial tunnel. This compression causes weakness of the wrist and finger extensors

    b. Can resemble C7 radiculopathy and to differentiate, sensation is normal in PIN syndrome along with triceps and wrist flexor strength

12. Cubital tunnel syndrome

    a. Compression of the ulnar nerve at the cubital tunnel where it goes through the elbow

    b. Can resemble C8 radiculopathy; characterized by medical elbow tenderness, hypothenar and adductor pollicis weakness and sensation impairment in hand and 4th and 5th digits. To differentiate, adductor pollicis has normal strength in CR.

Prevalence [1,4,8,29]

General neck pain is reported at an average of near 25% of the population, more commonly occurring in women. Nearly half to three quarters of people with neck pain report it hasn't improved one year later. CR is most common in men and found at a rate

of 107 per 100,000 men and in women at a rate of 64 per 100,000. CR tends to peak in incidence around the beginning of the fifth decade (50-55 years old). Cervical radiculopathy of C7 is most common at around 60% and C6 second most common at 25%. C8 radiculopathy occurs at 6%. Patients develop CR at a higher rate as smokers and with occupations which require frequent lifting of greater than 25 pounds or driving vibrating machinery.

Pathology [3,29–31]

Cervical Radiculopathy occurs anywhere along the spinal cord from any of the eight pairs of nerve roots in the cervical spine. Cervical nerve roots are attached to the spinal cord and travel through intervertebral foramen to allow the upper extremity to function with motor and sensory processes. The motor spinal nerve neurons exit the spinal cord at the ventral or anterior side and allow return of motor information from the spinal nerves of the body. The sensory nerve roots exit dorsal or posterior to the spinal cord and communicate sensation information from the body to the central nervous system. The ventral/motor and dorsal/sensory nerve roots then unite and exit the foramen as a unit to form a spinal nerve. The spinal nerve root covers about one third of the space in the foramen. Pathologies such as herniated discs, cervical foraminal stenosis, bone spur or spinal degeneration can cause impingement of cervical spinal nerves adjacent to the cervical spinal area affected.

Pathologies associated with development of CR

1. Spondylosis
    a. Occurs at uncovertebral and facet joints and enlargement/hypertrophy occurs at the bone which can irritate the anterior nerve root if it stems from the uncovertebral joint and the posterior nerve root if it stems from the facet joint.
2. Disc Herniation
    a. Intraforaminal – disc material enters foramen of a vertebral segment causing radicular symptoms mostly affecting sensation

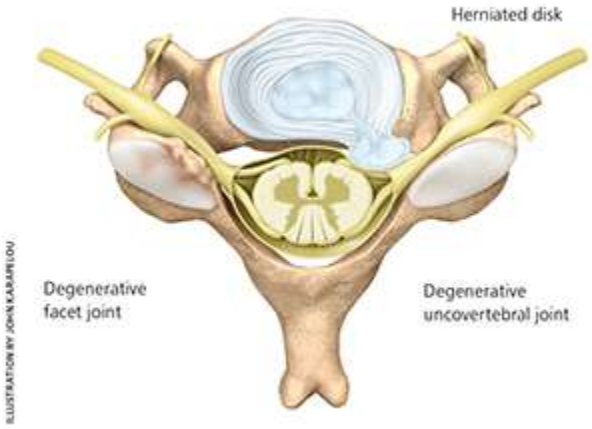
b. Posterolateral – disc material moves posterior and lateral, which can affect the anterior left or right aspect of the spinal cord and spinal nerve. This is a common cause of muscle weakness.

c. Midline – disc material protrudes directly posteriorly, affecting the anterior aspect of the spinal cord and/or both anterior spinal nerves at that segment. This results often in myelopathy (numbness, strength, gait impairments, imbalance and incontinence of urine)

3. Cervical spinal stenosis

    a. Narrowing of cervical foramen from bony growth or osteoarthritis making less room for the spinal cord and the spinal nerve roots. This occurs from normal wear and tear to the spine and is common in people at or older than their fifth decade

Depicting a disc herniation



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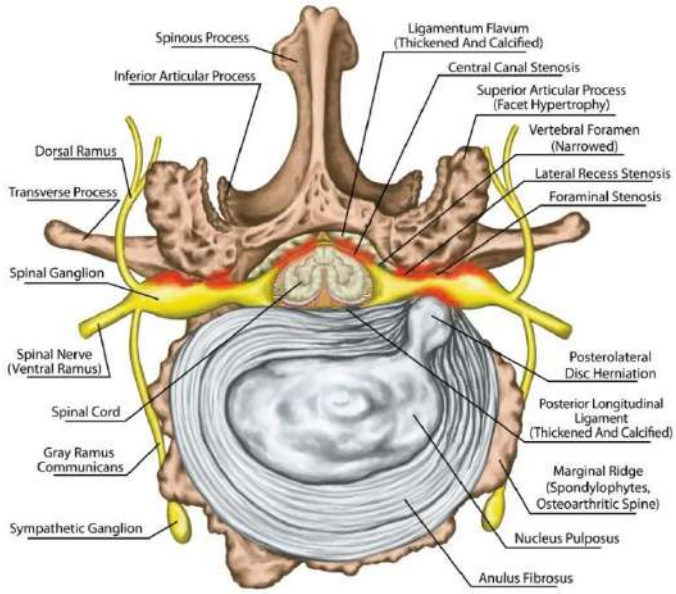
Depicting compression on the spinal nerves due to spondylosis and disc herniation



https://www.spineuniverse.com/conditions/spondylosis/osteophytes-bone-spurs

Prognosis [32,33]

Most patients (around 85%) with mild CR and a conservative treatment course see major improvements in four to six months which last long term (for three years at follow up). Complete recovery averages at 2 to 3 years. Patients who are recovering from work injuries and who had more involved treatment surgically have a worse prognosis. Patients who seek early treatment at the first sign/symptom of radiculopathy, whether conservative or nonconservative, will have the best prognosis. Patients who have symptoms for greater than 6 months, who have high pain scores, radiating symptoms, poor psychosocial status, leaves from work and impairments after surgery often have poor prognostic outlook. The longer a nerve is compressed with cervical radiculopathy, the higher chance of nerve damage being permanent.

Section 1 Summary

As discussed above, cervical radiculopathy presents with radicular pain and sensation deficits following the path of the spinal nerve affected. Patients may have cervical pain on one side and paresthesia or nerve pain down an upper extremity. Common causes of

CR are disc herniation, spondylosis and disc degeneration. It is important to conduct a thorough examination, refer for imaging if necessary and screen for differential diagnoses to effectively and safely manage patients with CR. There are many differential diagnoses that must be tested for as these conditions mimic cervical radiculopathy and involve a different treatment strategy. Patients are most commonly affected from the fifth to sixth decade and the majority of patients will see an improvement within six months with some form of treatment.

Section 1 Key Terms [5–7,31]

1. **Myotome** – muscular innervations from specific spinal nerve roots
2. **Disc herniation** – disc material inflames or pinches a near spinal nerve; most often occurs from trauma
3. **Cervical foraminal stenosis** – the space where a nerve root comes through the spinal canal shrinks and can become pinched
4. **Paresthesia** – prickling, burning, tingling, numb sensation associated with nerve compression
5. **Clinical Prediction Rule (CPR)** – a collection of findings that are statistically meaningful in prediction of prognosis for a patient who completes a treatment
6. **Tinel's Sign** – positive sign for nerve damage and tested by light tap along suspected nerve. This is often used to detect carpal tunnel syndrome
7. **PIN Syndrome** – compression of posterior interosseous nerve (part of radial nerve) which results in weakness and sensory issues in wrist, finger and thumb extension

Section 2: Management Strategies [33]

Treatment for cervical radiculopathy typically falls into one of two categories, operative or nonoperative. Operative strategies include surgery and nonoperative strategies are conservative, including physical therapy, medication, local injection and acupuncture. There are benefits and drawbacks of each management strategy and it is important for clinicians to individualize treatment plans for each patient based on symptoms and

cause of CR. It is accepted that CR benefits most from a multifaceted approach and that operative is no better than nonoperative management in reduction of symptoms.

Operative [33–36]

1. General overview
    a. Surgery success rates range from 80 to 95%. There is a rate of 4% for adverse outcomes for surgery. There is evidence that for cervical radiculopathy, operative and nonoperative management have near the same success rates.
    b. Surgery is indicated when a few factors are present, including pain in a radicular pattern, loss of sensation and muscle strength
    c. Although surgical rates are increasing dramatically, evidence suggest that cervical radiculopathy can resolve with pursuing conservative management at the same rate or more quickly
2. Anterior cervical discectomy and fusion (ACDF) [37]
    a. Spine is accessed through the front (anterior), disc is removed and then fused to gain stability. Surgeons will use an implant made of bone or other biocompatible structure.
    b. Among most performed spine surgeries
    c. Accepted as the most universally used operative strategy for management of CR
    d. Risks
        i. Changes in function of adjacent anatomical structures including vocal changes, esophagus damage, respiration trouble, pain, spinal fusion may not completely heal (nonunion)
3. Cervical disc replacement
    a. Surgeon takes out the damaged disc and puts an either metal or metal and plastic artificial disc in its place to allow nerves to leave the spinal cord and canal

b. Has the smallest amount of repeat procedures

c. Risks

i. Changes in function of adjacent structures including vocal changes, esophagus damage, respiration trouble, pain

4. Minimally invasive posterior cervical foraminotomy

a. Surgeon shaves part of the lamina down to take out problematic tissues including bone, bone spur, disc. This surgery is completed without a fusion

b. Smallest amount of unintended negative events

5. Follow up

a. Physical Therapy typically for 1 to 1.5 months

b. Cervical collar is often indicated

c. Cervical precautions are typically restricted cervical flexion, extension and rotation to allow for bony healing

Nonoperative [8,33,36,38–40]

Nonoperative management is typically completed independent of surgery, as an attempt to heal CR prior to surgery or as a follow up to surgery. Nonoperative management may be pursued more often with some causes of CR rather than others. For example, there are often better outcomes with disc herniation than there are with spondylosis with nonoperative management. Literature suggests additional research to investigate the decision making between pursuing operative vs nonoperative management considering increasing surgical cases with outcomes similar to nonoperative management.

1. Physical Therapy [8,22,23,33,36,38,39]

   Physical therapy is a very common nonoperative treatment for CR. A physical therapist must evaluate and screen for more serious differential diagnoses as indicated in prior sections and take a thorough subjective history assessing how much neck pain impacts daily life in terms of function and pain. Physical therapy assessment is listed in a prior section. Generally, if a clinician does not see improvements in pain and disability in patients after 6 weeks per outcome

measures and reporting, referral should be sent to an orthopedic physician or a general physician to refer to a specialist.

a. Procedures include a combination of strategies including modalities, mobilization, stretching and exercises. Although there are not many protocols available, generally physical therapists should proceed with exercises with mobilization, stretches and traction to gain mobility in the cervical spine and follow this with active exercises.

b. Modalities

    i. Modalities are used for pain control and reducing inflammation in affected tissues. Ultrasound and stimulation of nerves may be tried in the acute phase to help provide control of pain. However, there is low level evidence in any stage of recovery that these modalities will make a difference in pain or disability.

    ii. Ultrasound

        1. Transducer with gel on skin applies sound waves that penetrate skin to provide deep heating to increase circulation and promote healing

        2. Could be useful over lateral cervical muscles including upper trapezius

    iii. Transcutaneous electrical nerve stimulation

        1. Low voltage current delivered via electrodes over skin where underlying muscles have increased tension and pain. This causes endorphins to be released which help blunt pain signals from reaching the brain.

        2. Useful on overactive or sore muscles in cervical spine including upper trapezius, scalenes, levator scapulae, suboccipitals

c. Manual Therapy

    i. Benefits are to create improved range of motion, lessen inflammation and swelling in muscles, improve muscle length and provide relaxation for optimal recovery

ii. Manual therapy is not effective as a singular treatment and should be accompanied by other treatment strategies including traction, medication, and exercise

iii. Mobilization, manipulation and muscle energy techniques have proven tot be effective in combination with exercises that follow to maintain range of motion and tissue extensibility

iv. Evidence that manual therapy and exercise significantly improves pain and disability compared to no treatment

v. Cervical and Thoracic Manipulation

    1. Passive Accessory Intervertebral Movements are designed to mobilize stiff joints in the direction that alleviates restriction

    2. Cervical segmental mobilization improves pain and range of motion from Grade 1 to 4 is more effective than no treatment

        a. Cervical lateral glides in direction that resolves symptoms for 5-10 repetitions of 30 seconds

        b. Cervical posterior to anterior mobilization in pain free grades (Grades 1 and 2 for severe pain and 3 and 4 for moderate or mild pain)

    3. There is little evidence that thoracic manipulation alone will directly improve CR, but many therapists include it in their POC due to generally reduced thoracic extension ROM and as a multimodal approach to improving CR

vi. Neurodynamic mobilizations

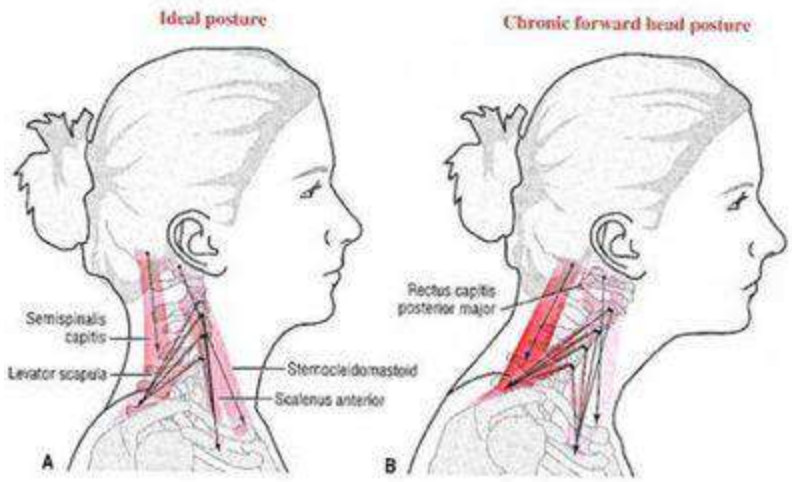
    1. The median nerve (upper limb tension test a) responds to nerve glides to increase the mobility of the median nerve amongst its adjacent structures.

    2. Tensioner – lengthen nerve at both ends of the nerve at the same time

3. Slider – shortening nerve at one end and lengthening at other end
4. This will be discussed in exercises included in a following section

d. Postural Education

   i. Forward head posture can cause smaller space for spinal nerves to exit the spinal column which can lead to development of CR. Additionally with this posture, posterior cervical muscles will develop tension while anterior cervical muscles will develop weakness, further developing an imbalance in posture. Education on posture which is often accompanied by posterior cervical muscle stretches and anterior strengthening, scapular strengthening, and activation are important to correct these imbalances and promote optimal joint position.



https://www.physio-pedia.com/Forward_Head_Posture

e. Exercise is an important component of physical therapy approach to improving cervical radiculopathy. It involves range of motion, stretching and strengthening to soft tissue to restore normal movement patterns. This will be discussed in the following section.

f. Traction has varying levels of evidence in improving CR in patients. The various types, how to perform and effectiveness of traction will be discussed in the following section.

2. Injection Therapy [40]

    a. Cervical epidural corticosteroid injection is injected into the epidural space adjacent to the affected nerve root and spinal segment. The steroid will act locally to lessen inflammation, hopefully giving relief of CR symptoms. This is a preferred treatment when there aren't severe neurological symptoms. Steroids should not be injected when there is risk of infection or if a patient has risk for bleeding excessively (on anticoagulant). Typical steroids include triamcinolone and dexamethasone and the most common level to be injected is C7-T1. Injections can be repeated, generally with months between doses, and around 35% of patients will experience a return of their same symptoms.

3. Cervical collar [41]

    a. Most beneficial in the acute phase for one week of immobility and are typically beneficial for comfort. A collar may be used in conjunction with physical therapy or separate as a recommendation from another clinician. A cervical collar will be effective to bring inflammation down yet there is no evidence that it will decrease the intensity of cervical radiculopathy. Cervical collars are typically semi-hard and keep the neck from moving in directions that are painful allowing reduction of symptoms. Although immobilization of the cervical spine is useful in pain management, patients may become reliant on them and it is imperative to educate patients. Cervical collars should be used sparingly and once a patient has ability to perform active range of motion with mild pain, they should be advised to discontinue use. This will allow the patient to restore normal motion and reduce pain more effectively as the cervical muscles, vertebrae, and nerves will be able to accommodate normal motion. Physical therapists should educate patients that at a certain phase of recovery pain does not equal harm and restoring normal mobility is the key to regaining function.

4. Medication [29,42]

    a. Non-steroidal anti-inflammatory drugs (NSAIDs) are useful for a couple weeks to reduce inflammation in the region affected by CR. This will provide some relief of symptoms and reduce inflammation at the site of CR

b. Oral steroids are sometimes used for short term relief but are not as supported as NSAIDs

c. Opioids are not indicated for pain relief of cervical radiculopathy due to predisposition

d. Epidural steroids often accelerate recovery of function as patients receive one injection in the epidural space outside the affected spinal segment to reduce local inflammation and provide pain relief. Patients report up to 50% relief in the following month after the injection. This window of time is effective in restoring normal movement patterns through physical therapy as well

e. Tricyclic antidepressants

    i. Have been found useful for chronic pain to block pain signals and prevent the reuptake of norepinephrine and serotonin

5. Acupuncture [42,43]

    a. Acupuncture can be helpful as a supportive treatment to other strategies such as physical therapy, steroid injections and/or cervical collar

    b. A very thin needle is placed in certain acupuncture points and adjusted to stimulate this area. This stimulates the endogenous antinociceptive systems which provide pain relief by pain signal effectively reaching the central nervous system later than the acupuncture signal

    c. Some evidence suggests that acupuncture is no better than a placebo, but other evidence suggests that acupuncture is a good adjunct to other treatment strategies in reducing symptoms related to cervical radiculopathy

Section 2 Summary [38]

Generally, operative treatments and nonoperative treatments have similar effectiveness as evidence has not been able to prove that one is more beneficial than the other. Operative treatments are surgical and associated with more risks than nonoperative treatment. With nonoperative treatment, intervention will be most effective with a

multifaceted approach such as combining manual therapy with traction and specific exercises.

Section 2 Key Terms [34]

1. **Anterior cervical discectomy and fusion (ACDF)** – operative strategy for CR involving removal of disc to take pressure off nerve root
2. **Cervical disc replacement** – operative strategy for CR involving replacing a damaged disc with an artificial one
3. **Minimally invasive posterior cervical foraminotomy** – operative strategy for CR where the foramen or space for spinal nerve is surgically enlarged
4. **Neurodynamic mobilizations** – including silder and tensioner where movement in certain pattern mobilizes nerves within the nerve sheath and adjacent structures to reduce radicular symptoms
5. **Transcutaneous electrical nerve stimulation** – TENS, a modality in which electrodes are attached to skin over underlying sore or tight muscles to produce endorphins and blunt pain signals from reaching brain

Section 3: Traction [36]

Traction, whether manual or mechanical, is a current recommended strategy in the management of CR. Traction can be intermittent or continual and provides space between vertebrae to take pressure off spinal nerves coming from the cervical spinal cord thus reducing radicular symptoms. Intermittent traction parameters typically have a traction period and a rest period, for example 10 seconds of traction and 5 seconds of rest. Continual traction maintains the traction force on the cervical spine for a specified time frame, for example 15 minutes. Traction is just one of many approaches in a multifaceted treatment for CR. Side effects of traction include dizziness, headache and nausea and should be monitored throughout treatment and stopped if symptoms develop as this indicates poor tolerance of cervical traction.

Why use traction? [36,44]

Traction has many physiological facts that are supported by evidence. Physiologically, traction has effects of slightly spacing out vertebral bodies, subtle movement of facet joints, widening foramen between vertebrae and slight stretch of muscles and tendons. With both manual and mechanical traction, patients report significant reduction of symptoms after clinical treatment of traction per the Neck Disability Index (NDI) and the Numeric Pain Rating Scale (NPRS). The effects of traction are typically longer lasting with mechanical than with manual traction. Manual or mechanical traction allows a clinician to vary the flexion or lateral flexion of the cervical spine to achieve decompression of the desired spinal nerve.

Clinical Application [44,45]

Traction is often applied in clinical settings for management of cervical radiculopathy as part of a multimodal approach in reducing symptoms. Per a systematic review recently published, it is standard practice to combine mechanical or manual traction with joint mobilization of vertebral bodies surrounding the source of radiculopathy and followed by exercise to stabilize the spinal segments with muscular strength.[44] It is standard practice to give patients a trial of manual traction separating the vertebral bodies of the cervical spine prior to starting mechanical traction to see if it is well tolerated. Poor tolerance includes side effects of dizziness, headache or nausea and traction should be either performed at very light weight or pressure or not at all if symptoms persist. Contraindications for traction include rheumatoid arthritis, hardware from prior surgery, fracture, tumor, infection, blood flow restriction from arterial occlusion, instability of the cervical spine and osteoporosis.

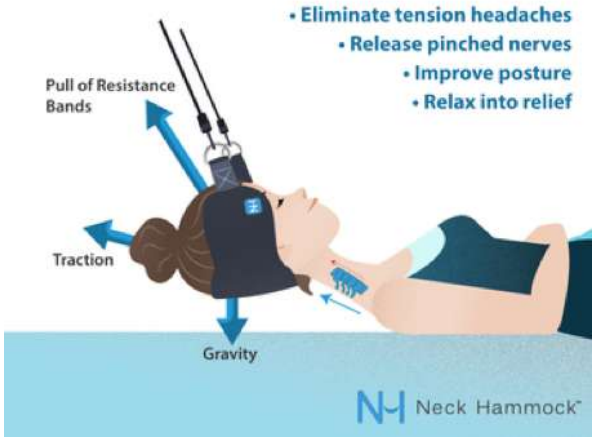
Mechanical Traction [36,46]

1. Mechanical traction force is based on body weight and should be applied at no more than 15% of a patient's body weight, not to exceed 45 pounds
2. Cervical flexion angles vary based on the desired segment to treat.
    a. Traction on a neutral cervical spine will best treat C1-2 CR

        i. Force should not be greater than 10 pounds when treating C1-2 subluxation

    b. Traction with 20 degrees of cervical flexion will be effective from C3 to C8/T1

3. The clinician places a harness around the head and neck, varying based on the traction machine used. Pins are often used at the anterior and posterior skull to stabilize the harness around the head and neck.
4. Up to 6 months after completing mechanical cervical traction patients experience significantly reduced pain
5. At 3-6 months patients experience significantly less disability after mechanical traction
6. Physical therapy follow up interventions include modalities, mobilization and massage, stretching, and exercises
7. A typical protocol is intermittent traction with a total of 2:1 traction vs rest period for a total of 10 minutes.
8. Based on current evidence, mechanical traction is more effective than manual traction when combined with segmental mobilization and exercise44
9. Intermittent mechanical traction with distinct traction periods and rest periods are the most effective form of traction for stiffness in joints and disc degeneration. Intermittent traction increases circulation to the spinal column allowing for increased healing.
10. Continuous traction provides lower weight for a sustained period of time and is most effective for disc herniation and muscular pain



https://neckhammock.com/blogs/blog-posts/what-is-traction-and-why-do-you-need-more-of-it-in-your-life

Manual Traction [36,46]

1. There are a small number of studies that examine the effectiveness of manual traction versus other physical therapy techniques and mechanical cervical traction. There is low quality evidence in short time frames that manual traction will improve neck pain, although patients typically report immediate reduction of symptoms.
2. A typical protocol is with a patient in supine a clinician will flex the cervical spine around 25 degrees, grip with an open palm at the base of the skull (suboccipital region) and stabilize with another hand at the forehead and provide intermittent (10 seconds of traction, 5 seconds of rest) or continual force (typically for 5-10 minutes) away from the patient. The angle of cervical flexion can be experimented with based on thorough discussion of the patient's symptoms as traction is applied. A clinician will then be able to add lateral flexion or extension based on reduction of symptoms. A clinician should ask for symptoms as patients may report they feel less tingling or numbness in their fingers.
3. Clinicians should perform manual traction prior to mechanical to determine tolerance and it is best practice to start gradually and provide more force throughout a treatment based on how a patient tolerates traction.
4. It is beneficial to add other manual therapy techniques such as soft tissue mobilization, joint mobilization or muscle energy techniques.

https://georgialinapt.com/physical-therapy-treatments/cervical-lumbar-traction/

Home Use of Traction [45]

Home traction devices include over the door and other devices, including air traction devices which are pumped up with air to provide joint separation. These devices are available over the counter but patients should be directed by a physical therapist or physician on parameters, risks and side effects prior to home use.

Over the door traction

1. Harness straps under chin and at base of occiput as indicated in picture below. There is a pulley with a weight corresponding to percentage of the patient's body weight, typically around 10-20 pounds that can be used over a door. Intermittent traction is performed by pulling the weight and holding it to relieve pressure for seconds at a time. For example, a patient could go from having the whole weight for 30 seconds and pull it to off weight the spine for 15 seconds and repeat for 20 to 30 minutes.

There are other traction devices on the market, including braces and pumps that are designed to attach at occiput to shoulders and provide distraction or joint separation in the cervical spine. There are benefits to wear these devices for up to 30 minutes two to three times throughout the day to provide relief of compression on spinal nerves causing radiculopathy.

https://www.flipkart.com/dyna-home-cervical-traction-universal-neck-support/p/itmf46d953e76576

Case Study 1

Mike is a 54-year-old male who had a work injury lifting a box overhead to place it on a high shelf. This accident occurred three weeks ago, and immediately after reaching he felt a sharp pain which has improved some since. He has not sought any treatment besides NSAIDs and icing and arrives at a physical therapy clinic to be evaluated due to persistent pain in his right shoulder and elbow as well as dull neck pain. Upon examination, the physical therapist finds that range of motion in the cervical spine is restricted to 30 degrees of rotation to the right side, ULTT in the median nerve on the right upper extremity is positive and the patient reports inability to perform work tasks of reaching and lifting due to pain. Imaging was received later and shows evidence of inflammation around C6-7 and slight disc bulge in that segment.

Reflection Questions

1. What additional assessment items should the physical therapist assess?
2. What type of imaging would be most useful in detecting abnormalities in this patient?
3. What interventions may be useful for managing symptoms in this patient?

4. When should a patient refer out to another provider?
5. What type of traction and parameters would be best for this patient to provide reduction of symptoms?
6. When should a clinician not perform traction on a patient?

Responses

1. Distraction, Spurling's special tests to complete the CPR for cervical radiculopathy, screen for red flags, reflexes, dermatome and myotome testing especially from C5-7 and have patient fill out NDI and NPRS/VAS, PSFS
2. Magnetic Resonance Imaging (MRI) because it differentiates soft tissues well
3. Manual therapy, cervical traction including manual or mechanical, range of motion, strengthening and stretching exercises
4. If there are no improvements within 4-6 weeks or if the patient's condition gets worse, a PT should refer to an orthopedist or a primary care physician for further work up
5. Mechanical traction on an intermittent setting for around 20 minutes with 20 degrees of cervical flexion to best affect nerve roots below C2. Weight should start progressive and not exceed 15% of a person's body weight.
6. If there are signs of infection, cancer, cervical myelopathy, cervical instability, osteoporosis or if a patient becomes lightheaded, dizzy or has moderate to severe pain during set up of traction

Section 3 Summary

When comparing manual versus mechanical traction, intermittent or continuous mechanical is the preferred method when a patient tolerates it. Intermittent is used for joint restriction and continuous is used for muscular tension and soft tissue issues. Mechanical is more effective than manual traction due to consistent technique from a cervical traction machine and not varying on human error and better scores on pain and disability outcomes. Patients often benefit from manual traction in the short term but there is not much evidence supporting it for long term reduction in disability and pain. This may be a result of lack of consistent techniques performed for manual traction

making it difficult to research. Overall, traction is an effective strategy in reducing pain and disability associated with cervical radiculopathy. This is especially true when traction is combined with other conservative management strategies such as other physical therapy modalities or exercises.

Section 3 Key Terms

1. **Manual traction** – superior force applied to cervical spine by a clinician designed to alleviate pressure on compressed spinal nerve
2. **Mechanical traction** – superior force applied to cervical spine by machine which is set to specific parameters by a trained clinician that alleviates pressure on a compressed spinal nerve
3. **Intermittent traction** – Traction time and rest time are two separate distinct periods in order to provide rest to tissues and provide oscillating motion to increase circulation and healing. Performed for joint restrictions
4. **Continuous traction** – performed for injuries to soft tissue and disc herniations at sustained weight for set period of time with no breaks

Section 4: Exercise for Cervical Radiculopathy [1,22]

As discussed above, there are a variety of management strategies for CR. Out of all interventions, exercise in addition to other physical therapy techniques is one of the most effective strategies. Exercise creates pain relief by preventing intense pain or heightened pain, hyperalgesia, and by activating inhibitory nerve pathways to desensitize pain. General exercise principles for CR include returning balance to muscles by strengthening and stretching certain muscles around the cervical spine. This section will highlight specific protocols that are useful for development of exercise programs for patients with CR.

Exercise Protocols [1,22,44,47]

Effective exercise protocols should be individualized for each patient based on symptoms and should aim to create more space in the intervertebral foramen of the affected spinal nerves.

1. Active range of motion (AROM) exercises [1,22,44]

   Active range of motion exercises are designed to restore normal motion in the joints affected. A clinician should begin AROM exercises in pain free ranges which may mean very little active movement and progress from there to larger ranges based on pain and tolerance. It may be useful to couple motions (lateral flexion and rotation) if these coupled motions alleviate pain and paresthesia as this will facilitate decompression of spinal nerves. AROM exercises can be initiated by active assisted range of motion, instructing the patient to place hands on either side of the face gently supporting neck motion with upper extremities as well.

   a. Cervical range of motion

      i. Cervical spine motions include flexion, extension, rotation, lateral flexion and combined movements of each of these. Early mobility, especially with moderate to severe pain, will respond well to slow, gentle range of motion in each of these directions at 10-20 repetitions repeated throughout the day (up to 10 times).

      ii. The most effective range of motion for CR include lateral flexion and contralateral rotation but should always be prescribed as an exercise if the motion is pain free

      iii. Lateral flexion

         1. Side flexion of the cervical spine away from the affected side is proven to take pressure off the compressed spinal nerve.

https://learnmuscles.com/blog/2017/08/03/motions-cervical-spine/

iv. Rotation

1. Most effective toward the nonaffected/contralateral side for 10-15 repetitions 10 times per day.

https://learnmuscles.com/blog/2017/08/03/motions-cervical-spine/

b. Thoracic range of motion

i. Depending on examination, thoracic extension is often most impaired with neck pain. Patients could perform extension exercises including prone press ups as described above or thoracic extension over the back of a chair

ii. Clinicians should also examine thoracic mobility for stiffness in intervertebral movement to determine rotational, extension or flexion deficits and prescribe thoracic ROM exercises accordingly

c. Shoulder range of motion

i. Shoulder glenohumeral flexion, extension, internal and external rotation and abduction should be assessed and prescribed as a range of motion exercises if there are deficits.

ii. Scapular retraction, protraction, elevation, depression, upward rotation and downward rotation should be assessed and prescribed as ROM exercise if there are deficits. It is important to cue patients out of aberrant or compensatory movements to activate scapular muscles in the correct sequence. These exercises would start as active range of motion and progress to isometric holds for increasing activation, and eventually to resistive exercise as long as patient demonstrates good form

iii. Patients will commonly have aberrant movement patterns for scapular retraction, depression and rotation

1. If this is the case, patients should perform these motions with cueing to decrease compensation of other muscles to restore normal scapulothoracic motion

2. A simple exercise for this is shoulder clocks focusing on retraction and depression

d. Neurodynamic mobility [47]

i. ULTTa (also named ULTT1) glides for Median nerve detected on an ULTT from the assessment may be effective in reducing nerve tension by improving mobility

ii. Other ULTT can be done to assess neural mobility of the radial and ulnar nerves and sliders and tensioners can be performed for those as well

1. ULTT 2A will also detect median nerve compression and is examined with shoulder depression, elbow extension, external rotation of arm, wrist and finger extension
2. ULTT2b will detect compression of radial nerve with shoulder depression, elbow extension, internal rotation of arm, wrist and finger flexion
3. ULTT3 will detect ulnar nerve compression with shoulder depression, abduction, external rotation, wrist/finger extension, elbow flexion

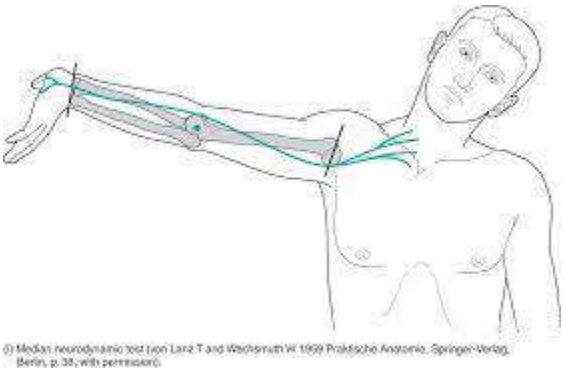
iii. Patients should only complete movement that is pain free and symptom free for sliders and tensioners, meaning progressively adding motion at wrist, elbow, shoulder and cervical spine one joint and movement at a time and stopping when there is pain or nerve symptoms (radicular symptoms, paresthesia, numbness)

iv. Sliders and tensioners are generally performed 2-3 sets of 10 repetitions

v. Slider – sitting patient will depress shoulder, abduct shoulder and flex elbow, slowly extending elbow laterally and extending wrist until 90 degrees of glenohumeral abduction while laterally flexing cervical spine toward affected side, then flex elbow and wrist while laterally flexing cervical spine opposite of the affected side

https://www.calibratepilates.com/blog/neurodynamics

vi. Tensioner – sitting patient will depress shoulder abduct shoulder, flex elbow, slowly extend elbow laterally and extending wrist until 90 degrees of glenohumeral abduction while laterally flexing cervical spine away from affected side, then flexing elbow and laterally flexing cervical spine toward affected side and flexing wrist



i) Median neurodynamic test (von Lanz T and Wachsmuth W 1999 Praktische Anatomie. Springer-Verlag, Berlin, p. 38, with permission).

2. Self-mobilization [48]

    a. Sustained Natural Apophyseal Glides (SNAGs)

        i. Using the edge of a towel or a strap a therapist can train patients to stabilize with a strap to gain mobility of segments of cervical spine. Rotation can be achieved with placing strap at desired spinal segment, rotating spine in desired direction and using belt in hands to continue movement at oscillations of small or large amplitude

        ii. This technique takes a good amount of training in the clinic and if a patient is not extremely successful with it in front of the clinician, they should not do it as a take home exercise

https://www.michaelcurtispt.com/stiff-neck/

3. Stretching [1]

    a. After a clinician assesses muscle length of cervical, shoulder and scapular musculature, specific stretches should be added to a patient's home exercise program.

    b. Stretches generally should be performed 2-3 sets of 30-60 seconds and should never be painful

    c. Common muscles that are shortened and need stretching include upper trapezius, anterior scalenes, suboccipitals, pectoralis major/minor

        i. Seated trapezius stretch

            1. Stabilize shoulder, take opposite hand at top of skull and laterally flex away from affected side

        ii. Seated scalene stretch

            1. Stabilize shoulder, laterally flex and rotate cervical spine according to desired scalene to stretch based on figure below

1. Middle Scalene 2. Anterior Scalene 3. Posterior Scalene

http://www.361clinic.com/2020/03/03/try-these-3-stretches-that-target-your-scalene-muscles-in-your-neck/

iii. Suboccipital release

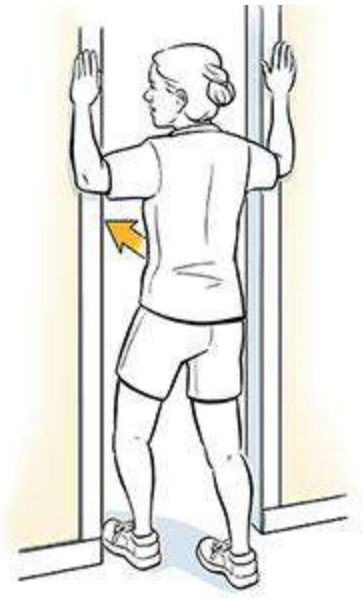
1. One technique for self suboccipital release is to lay supine with two tennis balls at the base of the skull.
2. Holding this position for 30 seconds to 1 minute for a few sets should help lengthen these muscles

https://www.synergychiros.com/blog/post/melting-the-body-suboccipital-release-and-the-stillpoint.html

iv. Pectoralis major/minor stretch

1. Abduct and flex arm and stabilize at doorway via picture below

2. Tight pectorals will pull the glenohumeral head anteriorly and contribute to weakness in the scapular retractors and stabilizers



https://www.saintlukeskc.org/health-library/doorway-pectoral-stretch-flexibility#

4. Strengthening [1,45]

After a patient progresses from active range of motion exercises for initial activation of cervical, scapular and shoulder girdle they are ready to progress to isometric and isotonic exercises. These exercises should be practiced in the clinic to monitor for compensations and form fatigue or the point where aberrant movements occur to determine the amount of sets and repetitions.

a. Isometrics

i. Initial phase of rehabilitation which will aim to stabilize the gains in range of motion achieved from manual therapy, traction, active range of motion and stretching.

b. Strengthening/isotonic exercises

i. Safe to perform once a patient no longer has radicular symptoms.

ii. Clinicians should test for weaknesses per the assessment section in cervical strength and scapular/shoulder strength and direct patients in strengthening exercises accordingly at low weight and many repetitions at first (around 20)

iii. Strengthening should progress slowly with trials of repetitions in the clinic to prescribe appropriate resistance and repetitions based on goals.

    1. For activation, aim for 3 sets of 15-20 repetitions

    2. For progression to strengthening aim for 2-3 sets of 8-12 repetitions

iv. Strengthening should target weak cervical muscles and weak scapular muscles to achieve eventual balance between the cervical spine and shoulder girdle.

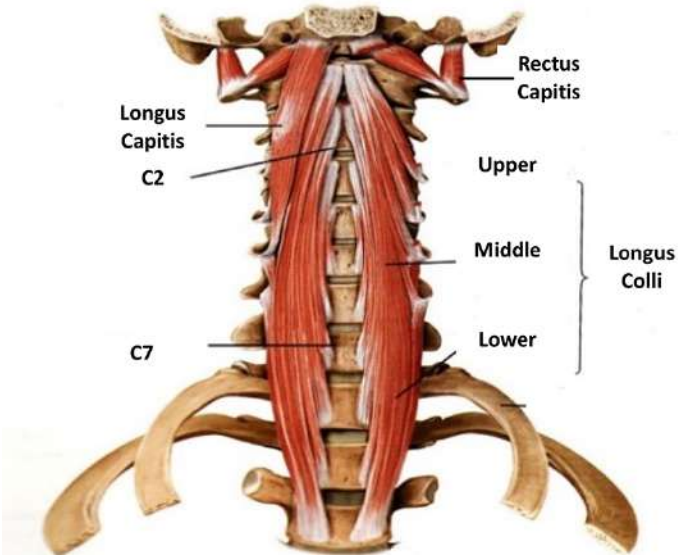
    1. Cervical Strengthening

        a. Deep neck flexor strengthening exercises typically begin in supine with instructions for slight craniocervical flexion and therapist cueing patient to prevent compensations such as sternocleidomastoid or scalene activation

            i. 2-3 sets of 10 repetitions holding contraction for 5-10 seconds

            ii. This would then be progressed to activation of deep neck flexors in supine, with progressive cervical flexion and lifting head up while continuing to contract the correct muscles

            iii. Deep neck flexors include muscles just anterior to the cervical spine, the longus colli, longus capitus, rectis capitus and longus cervices



https://chiroup.com/watch-video-the-most-overlooked-cause-of-neck-problems/

b. Axial extension

i. In sitting, begin with cervical retraction by pulling the chin toward the spine. Then progress to cervical extension while maintaining the retraction (have patient look up while having chin tucked)

ii. This is a progression of deep neck flexor training and should only be performed with pain free motion.

2. Scapular Strengthening

a. Designed to strengthen rhomboids, lower, middle and upper trapezius, serratus anterior and rotator cuff

b. Retraction with resistance, either theraband/elastic will strengthen middle trapezius and rhomboids

c. Prone push ups are beneficial in strengthening scapular protractors including serratus anterior

c. I’s, Y’s and T’s

https://www.pinterest.com/pin/696651254633092228/

i. Extension of shoulders with arms adducted (“I”) will strengthen scapular retractors, rotator cuff, middle and lower trapezius

ii. Lower trapezius, rotator cuff are strengthened by resistive shoulder flexion and slight abduction. A typical exercise is “Y” which a patient lies prone and moves their extended upper extremities in flexion and slight abduction, either with or without weight and progressed if a patient displays no compensations

iii. Horizontal abduction in prone (“T”) will strengthen rhomboids and middle trapezius with no resistance and reaching progression with dumbbells of 1 pound and up with clinician watching closely for compensations

Case Study 2

Sandy is a 68-year-old female who was recently discharged from an acute hospital stay for a fall at home and an exacerbation of chronic obstructive pulmonary disease. She is a former smoker and has comorbidities of Type 2 Diabetes Mellitus, osteoporosis and hypothyroidism. Since being home and prior to her hospital stay and arriving at a physical therapist’s outpatient clinic for generalized strengthening and balance remediation she has had right neck pain. When inquired further, she reports it occasionally radiates down her right arm to her middle finger. She reports ignoring these symptoms while in the hospital but states it is limiting her from reading, walking for exercise and sewing. She reports her pain currently at a 6/10 and only reaches a 4/10 when she wakes up for the day. The hospital did take imaging due to neck pain upon arrival to the emergency department, which showed no acute abnormality to the cervical spine.

Reflection Questions

1. What diagnosis should the physical therapist suspect and what differential diagnoses should they screen for?
2. What characteristics in this patient should a physical therapist be cautionary of when performing an assessment and treatment for neck pain?
3. Describe additional assessment items a physical therapist should perform for this patient
4. Describe a safe and effective treatment plan for this patient based on information given.

Responses

1. A physical therapist can suspect cervical radiculopathy with these symptoms but must conduct a clinical assessment and screen for signs of fracture, infection, tumor, cervical myelopathy
2. Physical therapists should be cautious when performing traction and manual therapy in patients with osteoporosis to be sure not to cause fracture of weak bone. This patient also has balance impairments from the fall at home and the PT should be wary of giving standing and unsupported exercises for practice at home to avoid falls.
3. Active and passive range of motion, CPR for cervical radiculopathy including Spurling's, distraction, ULTT, and rotation measurement to determine whether CR is plausible, myotome and dermatome testing, deep neck flexor endurance, scapular strength and postural assessment
4. This patient would respond well to low grade (1-2) mobilization, active range of motion exercises and progressing to cervical and scapular strengthening from isometric to isotonic based on pain, nerve sliders if radicular symptoms persist and a home exercise program of safe exercises to perform either supine or sitting. This patient is not a good candidate for traction due to osteoporosis

Section 4 Summary

Exercise generally is helpful with management of symptoms for patients with CR. It is proven that exercise in combination with other nonoperative techniques is among the best treatment strategies for patients with CR. Exercise including active range of motion, stretching, low grade mobilization and strengthening are very safe for patients who may be at risk for adverse side effects from traction, surgery and injection. It is important to consider each patient's individual circumstances and pathology and prescribe a range of motion, strengthening, stretching, mobilization and nerve mobility exercises accordingly. Patients should be given a home exercise program highlighting some form of active range of motion exercise and self-mobilization if able, stretching, and strengthening exercise where appropriate muscles are contracting with not many cues in the clinic. Exercise performance should be reviewed at follow up sessions to ensure appropriate sequencing of muscle contraction and should always be pain free.

Section 4 Key Terms [47]

1. **Isometric** – contraction of a muscle without movement of a joint
2. **Isotonic** – contraction of a muscle with active movement of a joint
3. **Deep neck flexors** – longus colli, longus capitus, rectus capitus and longus cervices which act together to stabilize the anterior aspect of the cervical spine
4. **ULTT** – upper limb tension test which are provocative tests that determine nerve mobility in the upper extremities
5. **Aberrant movement** – any motion that differs from the normal movement pattern

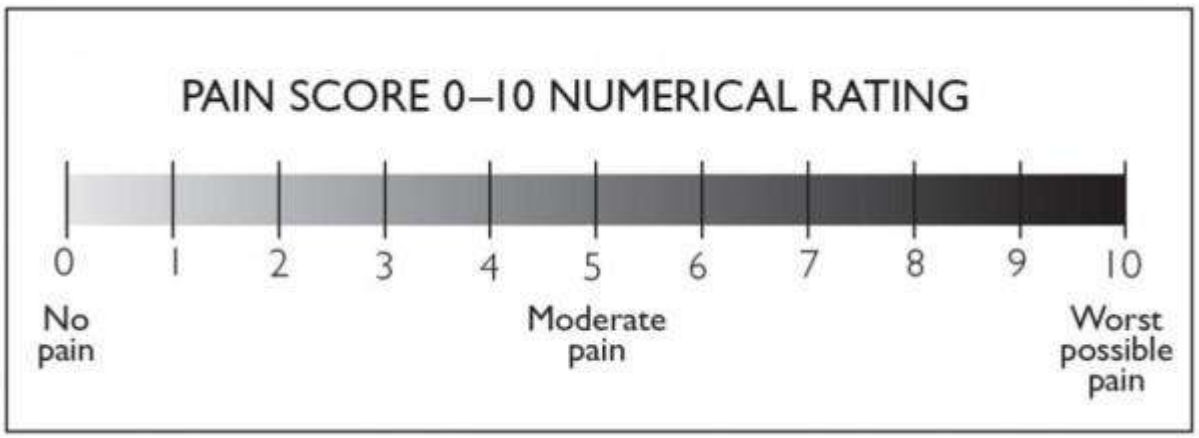
Section 5: Functional Outcome Measures [11,33,49–53]

It is imperative for clinicians to assess outcome measures at initial, progress and discharge visits for a variety of reasons. Outcome measures allow the clinician and patient to see improvements or worsening symptoms and disability throughout treatment, allowing more objective adjustment to treatment plan and hopefully increasing patient satisfaction. By consistently collecting outcome measures, clinicians

will be more able to help a variety of patients with similar conditions by correlating outcome measure scores to specific interventions. Clinicians can use outcome measure scores to demonstrate improvement to patients who may be frustrated with their progress as well.

1. Neck Disability Index (NDI)
    a. Ten questions relating to pain, disability, ailments associated with neck pain including headache, problems with concentration, reading and sleep
    b. Question scoring ranges from 0 or no disability to 5 or complete disability, therefore higher scores indicate a higher amount of disability. The lowest score is 0 and highest is 100
    c. Utilized in adults across the lifespan
    d. The minimal detectable change (MDC) for CR is 10 to 13.5 points
    e. The minimal clinically important difference (MDIC) for CR is 14 to 16.
    f. NDI is adequately reliable for test-retest reliability
2. Visual Analog Scale (VAS)
    a. Scale usually in picture form that allow patients to rate their symptoms (typically pain) on a scale which is measured out in typically 10 cm
    b. Score ranges from 0 to 100 and is often accompanied by description (mild, moderate, severe, etc)
    c. MCID is 1.4 cm

3. Numeric Pain Rating Scale
    a. 0 to 10 scale with 0 being no pain and 10 being the most severe pain imaginable.
    b. Highly reliable and valid
    c. A reduction of 2 points is clinically significant



4. Disabilities of Arm, Shoulder and Hand (DASH)
    a. Useful in differential diagnosis for CR and to capture upper extremity symptoms and disability
    b. 30 questions rating from 1 to 5 on difficulty of tasks; higher scores are higher disability
    c. MDC and MCID are around 15%
5. Patient Specific Functional Scale (PSFS)
    a. Patients are able to report three to five functional activities that are important to them but are having difficulty doing related to symptoms
    b. Patients rate difficulty on 0 to 10 scale (0 unable to do the activity, 10 represents normal function in this activity)
    c. Not specific to CR, but is useful in gathering picture of improvement or worsening ability to perform activities that are important to the patient
    d. PSFS is valid but not very reliable with CR

Section 5 Summary

Outcome measures including NDI, VAS, NPRS, DASH and PSFS are useful in managing patients with CR as they provide objective data on patient symptoms at initial, progress and discharge visits. These are self-report outcome measures which are typically given to

patients in an intake form in a clinic. Outcome measures are useful to show patients objective data of progress over a treatment period.

Section 5 Key Terms

1. **Functional outcome measure** – typically a patient reported form that is filled out at specific time periods during a course of clinical treatment to capture a numeric value on quality of symptoms
2. **MDC** – minimal detectable change; the amount of change in a time frame that is clinically different
3. **MCID** – minimal clinically important difference that represents meaningful difference in function to a patient

Conclusion

Cervical radiculopathy is a relatively common pathology in the cervical spine which affects people most often of working age and results from compression of one or more spinal nerves exiting the cervical spinal column laterally. CR has a specific set of clinical assessments including a subjective history screening for radicular symptoms and precipitating factors and a movement assessment including strength, range of motion, and compression, distraction, and sensation testing. Patients may be treated with operation or conservative/nonoperative management and these strategies have been proven to produce similar outcomes but less side effects with nonoperative management. Nonoperative treatment includes physical therapy focusing on mobilizing the cervical spine through manual therapy and traction and designing a specific exercise program to restore normal movement patterns and prevent recurrence of CR. Overall from diagnosis to treatment, successful treatment of CR involves a multifaceted, individualized approach and will require persistence from the clinician and patient to see a full resolution of symptoms.

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