Upper Extremity Pain: Where's the Pathology—Neck or Shoulder?

ABSTRACT

Neck and shoulder disorders are among the leading causes of pain and disability. History and physical examination are key components to clinical diagnosis and to determining whether the source of the arm pain is the neck or the shoulder. When consistent with the history, it is recommended to perform targeted provocative tests or manoeuvers. Several studies have shown that using a test item cluster improves diagnostic accuracy more than any single test item alone. Imaging, electrophysiological and laboratory studies are usually unnecessary unless there are clear clinical indications.

KEYWORDS: Cervical radiculopathy, Neck pain, Shoulder pain, Clinical diagnosis, Provocative tests

CME Pre-test Quiz

INTRODUCTION

Upper extremity pain is a common complaint; however, determining the origin of the pain can be a clinical challenge. Possible pain generators include irritation of neural elements, the musculoskeletal structures of both the shoulder and cervical spine or, in some cases, the thoracic viscera.[1,2] While most people develop asymptomatic degenerative changes with aging most of these do not yield clinically relevant symptoms.[3,4]

The initial assessment of a patient suffering from pain in the neck, shoulder or upper extremity includes a detailed history and a focused physical exam; when clinically appropriate x-rays may rule out bony lesions. The pain should be classified as intermittent or constant, recognizing that more serious conditions such as cervical myelopathy, tumour, infection, fracture, or inflammatory processes usually pre-

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sent as constant pain. Ominous signs and symptoms such as fever, unexpected weight loss, a localized swelling or cardiovascular complaints should trigger directed investigation, imaging and laboratory tests.

Cardiovascular pathologies may present with pain in the shoulder, arm or anterior chest. Neck pain can also be referred to the upper left anterior chest ("cervical angina") leading to unwarranted anxiety and investigation for nonexistent cardiac etiologies.[5,6,7]

Cervical myelopathy could lead to irreversible damage so a history of loss of hand dexterity or gait disturbances should trigger further investigations. The modified Japanese Orthopedic Association (mJOA) score can determine the urgency for referral.[8,9]

Neck, shoulder and upper limb pain are frequently associated with a heightened emotional response and psychological issues. Finding someone a "pain in the neck" accurately reflects a physical response to stress. The level of dysfunction can impact recovery and should be assessed by inquiring for false beliefs on the effect of activity, the expectation of a lack of recovery or unrealistic goals for treatment. These negative beliefs are risk factors for chronicity.[10]

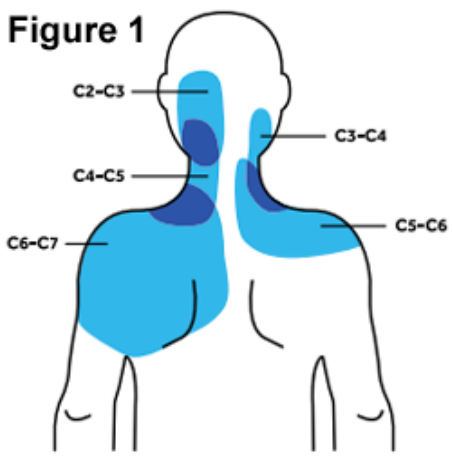
The purpose of this paper is not to provide a comprehensive review of all the conditions that could cause upper limb pain but rather to discuss the epidemiology, pathophysiology, clinical presentation and common provocative tests necessary to provide a framework distinguishing between pain arising in the shoulder and that coming from the cervical spine.

Cervical Pain Syndromes

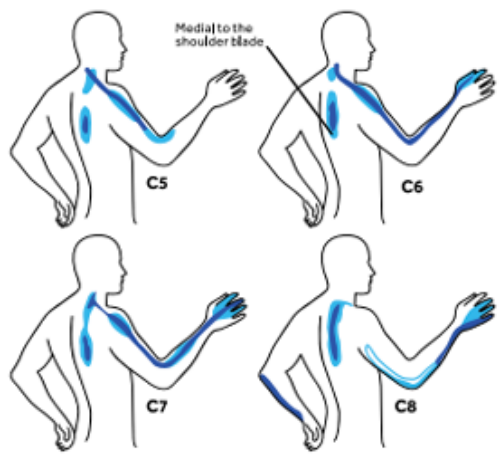
Pathophysiology

Minor anatomical factors are by far the most common cause of neck pain. Mechanical neck pain can remain localized to the cervical spine but may refer to the head, upper thoracic region, trapezius ridge, anterior chest, face and, intermittently, to the forearm. In contrast to radicular pain, somatic axial pain is not associated with nerve root impingement but arises from innervated somatic musculoskeletal structures: bones, discs, zygapophyseal joints, ligaments, and muscles.[11] Nociceptive signals from these anatomical elements are thought to share a common pain pathway with afferents from the head, chest wall, and upper limb leading to the sclerotomal referral patterns (Figure 1).[7,11]

Figure 1



Neck Dominant Pain Patterns



Arm Dominant Pain Patterns

In contrast to the lumbar spine, only 21.9% of cervical radiculopathy, producing arm dominant pain, comes from a herniated "soft disc" protrusion (Figure 2).[12] About three-quarters of cervical radiculopathy can be linked to degenerative changes such as calcified osteophytic tissues at the junction of vertebra's posterior margin and the annulus ("hard disc" herniation).[13,14,15] Nerve root impingement can occur as the nerve exits the intervertebral foramen; posteriorly as facet hypertrophy reduces the foraminal space (Figure 2)[12,16] or anteriorly by an osteophytic uncovertebral joint (Figure 3). Thickening of the ligamentum flavum can also compress the nerve root posteriorly.[16] It is commonly accepted that compression and hypoxia of the neural tissue of the dorsal-root ganglion leads to a painful cascade of inflammatory processes.[17,18]

Figure 2

Axial View of Cervical Vertebra

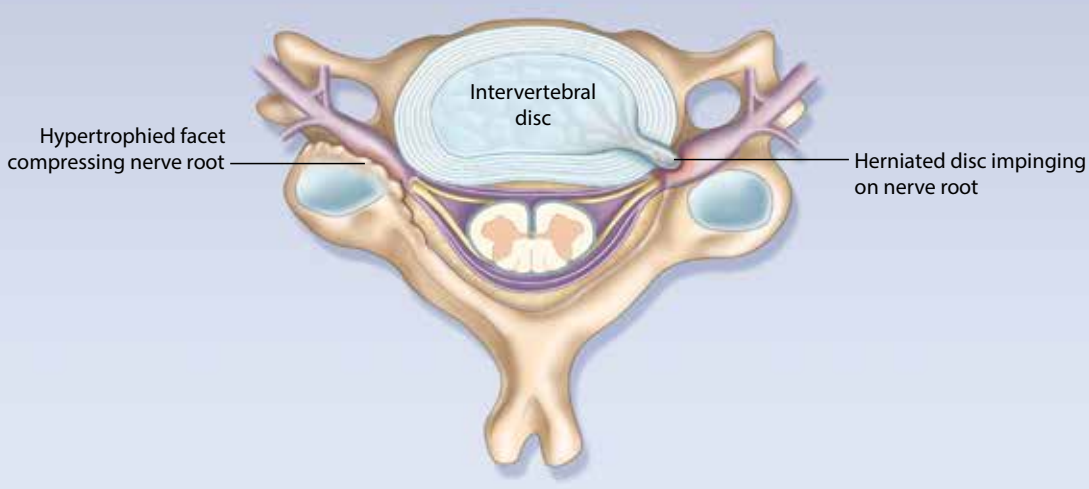
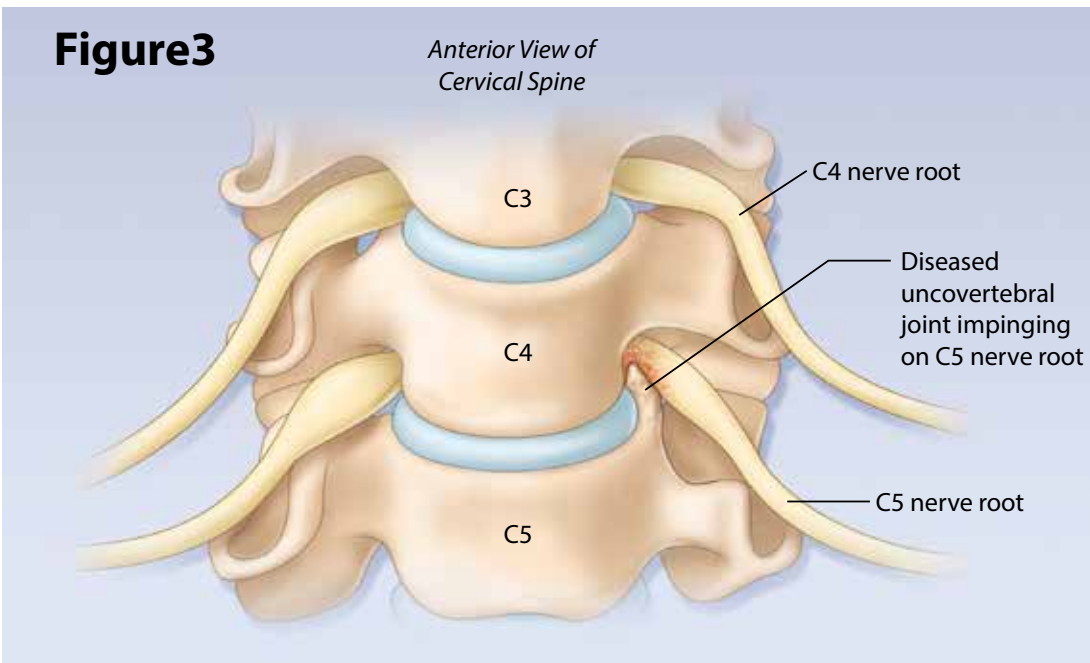


Figure3

Anterior View of Cervical Spine



Clinical Presentation

Cervical radiculopathy presents with a myriad of symptoms including (moderate to debilitating) pain, weakness and paresthesia in the neck and upper limbs (Table 1). Pain usually radiates in a myotomal or sclerotomal distribution (Figure 1).[12,19,20] Sensory symptoms include burning or tingling and the tendon reflexes can be reduced or absent.[21] The C7 or C6 nerve roots are most commonly affected.[12] Neck stiffness and muscle spasms can mimic cervical radiculopathy but do not produce pain beyond the shoulder.[7] Mechanical neck pain is neck dominant while radicular pain is arm dominant.

Physical Examination

Perform the examination in the most efficient manner by placing the patient in a series of positions, selecting the optimum position for each test. Observe the head/neck/shoulder posture both sitting and standing. Look for obvious deformity, discoloration or surgical scars. Assess movement into flexion/protraction and extension/

Table 1: Clinical findings associated with cervical radiculopathy

Disc level	Root	Pain distribution	Sensory loss	Motor loss	Reflex loss
C2-C3	C3	Suboccipital, back of the ear	Not detectable		
C3-C4	C4	Neck, shoulder	Lower cervical, upper shoulder	Diaphragm / respiratory dysfunction	
C4-C5	C5	Medial scapular border, lateral upper arm to elbow	"Epaulet" distribution: superior shoulder, lateral upper arm	Deltoid, supraspinatus, infraspinatus	Supinator
C5-C6	C6	Lateral forearm, thumb and index	Thumb, index	Wrist extensors, elbow flexors, forearm supinators	Biceps
C6-C7	C7	Medial scapula, posterior arm, dorsum forearm, third finger	Posterior forearm, third finger	Triceps, wrist flexors, finger extensors	Triceps
C7-T1	C8	Shoulder, ulnar side of forearm, fifth finger	Fifth finger	Thumb flexors, abductors, intrinsic hands muscle	

Adapted from: Rao (2002); Carette et al. (2005); Godbout and Christie (2016)

retraction watching the rhythm of movement and recording the reproduction of the patient's typical pain.

The neurological examination includes both provocative irritation tests and specific conduction tests for the most commonly involved nerve roots, C7 (wrist flexion), C6 (wrist extension) and C5 (shoulder abduction). Test for signs of cervical myelopathy (spastic gait, loss of hand coordination).

Physical Examination: Provocative Manoeuvers

Table 2 shows a list of provocative tests to assess cervical radiculopathy. They either aggravate pain by applying direct compression or tension on the nerve roots or reduce symptoms by reducing irritation.

Spurling and Scoville described the Spurling neck compression test.[22] In the current literature, the test is a passive cervical extension, rotation toward the diseased side and axial compression. A positive test reproduces the radicular symptoms down in the affected upper limb. It is considered negative if there is no change in the arm pain or if the pain is located in the neck.[23] The manoeuver has strong

Table 2: Provocative tests for cervical radiculopathy

	n	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)
Shoulder abduction			
Davidson	22	78 (52-94)	75 (19-99)
Viikari-Juntura	13	46 (19-75)	85 (55-98)
Wainner	82	17 (0-34)	92 (85-99)
Spurling			
Shah	25	65 (49-79)	100 (56-100)
Tong 192	30 (12-54)	93 (88-96)	
Viikari-Juntura	78	50 (28-72)	93 (83-98)
Wainner	82	50 (27-73)	74 (63-85)
Shabat	257	98 (92-99)	89 (77-96)
Valsalva			
Wainner	82	22 (03-41)	94 (88-100)
ULTT			
Viikari-Juntura		97 (83-100)	69 (41-88)
Quintner	45	83 (59-96)	11 (02-29)
Wainner	82	97 (90-100)	22 (12-33)
Apelby-Albrecht	51	97 (83-100)	69 (41-88)
Traction			
Viikari-Juntura	24	44 (14-79)	97 (85-100)
Wainner	82	44 (21-67)	90 (82-98)
Arm squeeze			
Gumina		97 (93-98)	97 (95-98)

Adapted from: Rubenstein et al. (2007) and Wainner et al. (2003)

specificity (93%) but poor sensitivity (30%).[24,25,26]

Elvey proposed the upper limb tension or brachial plexus tension test. It is performed with the patient supine and consists on a successive series of passive movements consisting of cervical side-bending, shoulder abduction, elbow extension, forearm supination and wrist and finger extension. A positive test elicits the typical arm dominant pain. Like the Spurling test, Elvey's test has reported excellent sensitivity (97%), but rather a low specificity (22%).[27]

Shoulder abduction, resting the forearm on the head can alleviate pain from cervical radiculopathy.[28,29]

The neck distraction test consists of axial manual traction of the head in a supine patient. A positive test is reduction in the patient's arm pain. Traction is most effective in slight flexion.[30]

The Valsalva maneuver has also been reported to trigger the patient's pain.[28] Scant data exist on its reproducibility and biomechanics.

Squeezing the muscles in the upper arm compresses the radial, median, and musculocutaneous nerves. According to one study this triggers pain in patients suffering from C5 to T1 radiculopathy.[31]

Shoulder Pathology

Pathophysiology

The pathophysiology of shoulder disorders is complex and not well understood.[32] Lacking a clear,

Table 3: Clinical syndrome of shoulder pain based on history and physical examination

Pattern of shoulder pain	Pain location	Mechanism	Aproximate age (years)
Pattern 1	Deltoid	Traumatic or non-traumatic	35+
Pattern 2	Acromioclavicular joint	Traumatic or non-traumatic	Any age 50+
Pattern 3			
Frozen shoulder	Glenohumeral joint	Traumatic or non-traumatic	40-60
Glenohumeral arthritis	Glenohumeral joint	Gradual	50+
Complete cuff tear	Glenohumeral joint	Recognized event	60+
Subscapularis tear	Glenohumeral joint	Traumatic, event-forced external rotation	40+
Painful laxity	Glenohumeral joint	Minimal but recognized trauma	10-30
Post-traumatic instability	Glenohumeral joint	Following traumatic dislocation	10-30
Internal derangement	Glenohumeral joint	Repeated throwing motion	18-30

Adapted from: Carter et al. (2012)

comprehensive anatomical diagnosis, Carter and his group proposed a classification system based on the location of the dominant pain, patient age, mechanism of injury, and clinical presentation.[33] Shoulder pain is divided into three main groups or patterns (Table 3): Pattern 1 or Impingement Pain describes symptoms felt primarily at the tip of the acromion over the deltoid muscle. Pattern 2 or Acromioclavicular Pain is pain at the acromioclavicular joint. Pattern 3 represents shoulder disorders in and around the glenohumeral with the site of the dominant pain described as "in front, in back or inside the shoulder". This pattern covers rotator cuff tears, frozen shoulder, subscapularis tears, painful laxity, gleno-humeral arthritis, internal derangement and post-traumatic instability. These complex pathologies share a common characteristic pain location somewhere over the anterior or posterior aspect of the gleno-humeral joint. Of the 205 subjects included in their study, pattern 1 was seen in the majority (67.8%) of the patients. Pattern 2 and pattern 3 represented 9.7% and 22.4%, respectively

Clinical Presentation

Pain from shoulder disorders does not usually radiate distal to the elbow.[34] A limitation of overhead activities is often associated with rotator cuff problems or internal

derangements such as labral tears. A blow to the point of the shoulder can dislocate the acromioclavicular joint; AC problems are endemic in professional hockey players. Generalize joint laxity can lead to painful shoulder laxity while dislocation can lead to chronic instability. Bony erosions are observed in autoimmune disorders. Thyroid dysfunction and diabetes are associated with an increased incidence of adhesive capsulitis.[35,36] Age is an important factor since several pathologies occur almost exclusively within certain age groups. Post traumatic shoulder instability or labral defects are more common in the first two or three decades of life. Rotator cuff tears and adhesive capsulitis occur most frequently in middle age. Glenohumeral arthritis is found in older individuals.[37,38,39,40]

Physical Examination

Start with inspection looking for signs of previous injuries, trauma, surgical scars, swelling, or muscle wasting. Chronic rotator cuff failure frequently produces a marked loss of the supraspinatus and infraspinatus. Palpate for masses, crepitus, temperature changes and deformities. Point tenderness, particularly at the AC joint, can indicate arthritis. Anterior tenderness may suggest biceps tendinitis. Lateral tenderness might be a subacromial bursitis.

Test both active and passive ranges of motion. There are four main functional arcs of motion: forward elevation, external rotation, abduction, and internal rotation.[41]

Physical Examination: Provocative Manoeuvers

Over the years authors have described more than 150 provocative tests for shoulder pathologies. These tests should be an adjunct to the examination and not used as the sole diagnostic determinant. They are best employed once a particular diagnosis is suspected and can help to "rule in" or "rule out" conditions already under consideration. Table 4 lists some of the more commonly used.

Neer first described the subacromial impingement syndrome.42 Symptoms result from compression and abrasion of the anterior part of the supraspinatus under the coracoid process and the coracoacromial ligament. Two diagnostic tests are commonly used: the Neer test and the Hawkins-Kennedy test.[42,43,44] In both tests the examiner passively forwardly elevates the patient's arm. The Hawkins-Kennedy adds internal rotation at 900 of forward elevation, which forces the humeral head under the coracoacromial ligament or anterior acromion.[45] A positive test in both tests is the reproduction of the patient's typical pain.[46] An injection of xylocaine to relieve the pain offers confirmation.[47]

There are many other tests for rotator cuff disorders. A pain-

Table 4: Provocative tests for shoulder pain

	n	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)
Speed			
Calis		68.5	55.5
Park		38.3	83.3
Hawkins			
Calis		0.92	0.25
Park		71.5	66.3
Toprak		67 (53-78)	47 (26-69)
Painful arc			
Calis		32.5	80.5
Park		73.5	81.1
Neer			
Calis		88.7	30.5
Park		68.0	68.7
Toprak		80 (67-89)	52 (30-73)
Drop arm			
Calis		7.8	97.2
Park		26.9	88.4
Cross-body abduction			
Calis		82.0	27.7
Park		22.5	82.0
Yergason			
Calis		37.0	86.1
Supraspinatus			
Park		44.1	89.5
Toprak		92	41
Infraspinatus			
Park		41.6	90.1
Toprak		33 (6-79)	66 (54-76)

Adapted from: Park et al. (2005) and Thoomes et al. (2018)

ful and restricted active lateral elevation between 600 to 1200, described as the "painful arc test", is linked to rotator cuff weakness and tears.[48,49] In the Jobe or "empty-can" test, the patient actively abducts the arm to 90° in the scapular plane then internally rotates. The test is positive if it reproduces the typical pain or if the patient fails to maintain the abduction against a downward force.[50,51]

The "lift-off test" tests the integrity of the subscapularis muscle. With the arm internally rotated behind the back, the patient is asked to lift the hand away from the body.

External rotation tests for weakness in teres minor or infraspinatus indicative of tendinopathy or tear. The patient holds the arms beside the body with the elbows at 900 flexion and actively externally rotates against resistance.

The drop-arm rotator cuff test, for a complete cuff tear, is performed by passively elevating the arm to 1600 and letting it drop.[52] The test is positive if the patient cannot maintain the elevation.

For a diagnosis of bicipital tendonitis the Yergason and Speed

tests tears may be helpful. In the former the patient actively supinates against resistance. Tenderness in the bicipital groove is a positive test.[53] In the latter the patient forward flexes the arm against resistance with an extended elbow and supinated forearm. Again positive is pain in the bicipital groove.[49,54]

Acromioclavicular joint pain is aggravated by cross-body adduction with the shoulder maintained at 900.[55]

Shoulder instability is assessed with the anterior apprehension test. With the patient's elbow at 900 and the forearm supinated the examiner abducts and externally rotates the shoulder eliciting the sensation of incipient dislocation. A positive Jobe relocation test would further confirm the instability where the examiner applies a posterior pressure over the humeral head to relieve the apprehension.[34]

Value, Reliability, and Diagnostic Accuracy of the Physical Tests

Cervical radiculopathy

Provocative tests have been widely used for cervical radiculopathy with minimal evidence regarding their reliability and accuracy. The lack of consensus on what constitute positive results makes reproducibility and accuracy difficult to achieve.[56]

The reported sensitivity of the Spurling test ranges from 50 to 90%.[30,57] Studies on the reliability and diagnostic accuracy of the provocative tests for cervical radiculopathy have strongly supported the idea that a "test item cluster was more useful for diagnosis than any single test item".[28,58,59]

Shoulder disorders

The same lack of specificity or generalizability applies to the most provocation tests for the shoulder. A study of 120 patients with subacromial impingement syndrome found the highest sensitivity values for Hawkins (92.1%), Neer (88.7%), and cross-body adduction (82%) tests with accuracy at 72.8%, 72% and 66.4% respectively. These maneuvers are suggested as "rule in" tests.[47] Park's research team explored the relationship between rotator cuff tear severity and diagnostic values of the common provocative tests. They found positive Hawkins, infraspinatus, and painful arc (80.5%) tests were best at confirming an impingement syndrome, while the painful arc, drop arm (97.2%) and infraspinatus tests were most reliable for full-thickness cuff tears.[46] Gumina used the arm squeeze test to differentiate cervical root compression from shoulder pathologies. The maneuver was positive in 96.7% of cases with radiculopathy but was found on average in only 3% of patients with shoulder disorders.[31] Combined with a negative upper limb tension test it rules out nerve root irritation as a source of pain.[59]

Table 5: Differential diagnosis of cervical radiculopathy and shoulder pain

Neurologic	Shoulder
Cervical radiculopathy	Impingement syndrome
Cervical myelopathy	Rotator cuff tears
Brachial plexopathy	Adhesive capsulitis
Thoracic outlet syndrome	Biceps tendinitis
Brachial plexitis (Parsonage-Turner syndrome	Glenohumeral instability
Herpes zoster	Glenoid cyst
Pancoast tumor	**Elbow**
Peripheral mononeuropathy	Medial epicondylitis
Multiple sclerosis	Lateral epicondylitis
Syringomyelia	**Wrist/hand**
Elevated intracranial pressure	Tendinitis (ex: DeQuervain's tenosynovitis)
Intracranial tumor	Muscle or connective tissue disease
Cardio-Vascular	Myofascial pain syndrome
Thoracic outlet syndrome	Fibromyalgia
Aortic arch syndrome	Polymyalgia rheumatic
Vertebral artery dissection	**Other**
Cardiac ischemia	Dental pain
Myocardial infarct	Neck-tongue syndrome
Adapted from: Lauder (2002)	

"Putting it All Together"

Differentiating between neck and shoulder pain can be a challenge. Considering their overlapping innervation patterns and musculature, cervical radiculopathy and mechanical neck pain often mimic shoulder pathologies and vice versa. Moreover, with aging, degenerative joint changes may produce both symptomatic shoulder and cervical pathology.[2,60]

The place to start is with the history. The physical examination and particularly the provocative manoeuvers are best used to confirm or refute the conclusions reached on history.

History begins by determining the dominant site of pain. This can be located by inquiring about the

SUMMARY OF KEY POINTS

1. Sinister pathology is rarely produces completely intermittent pain.
2. Neck pain is frequently associated with psychosocial stress and heightened emotional response.
3. The first step in taking the history is to establish the site of the dominant pain.
4. A neurological examination should include tests for spinal cord involvement causing cervical myelopathy.
5. Neck dominant pain can include pain felt in the face, upper back, top of the shoulder, anterior chest and headache.

site of the most severe and bothersome symptoms. Neck dominant symptoms are somatic referred pain and can include headache from occipital to retro-orbital, interscapular or trapezius ridge pain, facial pain along the jaw line and anterior chest pain, easily confused with a cardiac event. Recognizing all of these locations as potentially referred neck dominant pain may be difficult. Constant arm dominant pain is probably radicular but distinguishing shoulder pain, which is most often located over the deltoid but can also be at the acromioclavicular or poorly defined in front or behind the gleno-humeral joint adds complexity. Disorders of both neck and arm can affect the shoulder (Table 5).

Next determine if the pain is constant or intermittent. Completely intermittent pain is less likely to indicate sinister pathology and is more apt to be mechani-

CLINICAL PEARLS

The best way to differentiate between the neck and the shoulder as the source of upper limb pain is to assess the effect of movement in each area on the patient's typical pain.

The provocative tests should be chosen to confirm a suspected diagnosis. By themselves they are not a reliable guide to the specific pathology.

Neck and shoulder problems may coexist particularly in older patients and the examination of one should always include a screen of the other.

Radicular arm pain is more often caused by boney foraminal nerve root entrapment than by a new "soft" disc herniation.

CME

Post-test Quiz

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cal. Acute radicular, arm dominant pain, is always constant.

Particularly for shoulder pain the patient's age and the mechanism of injury offer significant clues to the diagnosis.

The physical examination consists of inspection, assessment of head/neck/shoulder posture, range of motion, neurological evaluation, and the use of provocative tests. Signs of upper motor neuron lesions, such as abnormal gait, loss of fine motor control, positive Hoffman or Babinski signs, sustained clonus or hyperreflexia must be checked to rule out myelopathy.

Differentiating between neck and shoulder pain on the physical examination frequently relies on reproducing the patient's typical pain with movement. Cervical flexion will usually increase symptoms, both referred and radicular, arising from the neck.[61] Pain felt most acutely over the deltoid calls for a more thorough shoulder exam beginning by assessing pain production in the four main functional arcs of motion and including the appropriate provocation manoeuvers.

Constant arm dominant pain suggests a radicular etiology and requires further neurological evaluation incorporating provocations such as the Spurling test.

The new CORE Neck Tool contains an excellent summary of the essential history and physical examination.[62]

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