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Neck Pain and Arm Symptoms: Evaluation

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The CSPE Care Pathways provide a standardized context for clinical decision making as well as a variety of possible interventions. These pathways are not intended to replace the clinical judgment of the individual practitioner. A practitioner may vary from these guidelines, if in his or her judgment, variance is warranted to meet the health care needs of the patient and the variance remains within generally accepted standards of practice.

CSPE pathways are intended for use within our clinic system. They may be useful as a seed for regional guidelines or guidelines with wider application, but caution must be exercised. The following limitations would have to be addressed. 1) The literature searches employed would need to be more exhaustive; 2) inclusion criteria for published studies would need to be more stringent; 3) a wider pool of subject-matter experts would need to be tapped; 4) the participants of the consensus panel would need to be drawn from a broader cross-section of the profession and perhaps other health care providers as well. Although individual procedures and decision-making points within this care pathway may have established validity or reliability, the pathway as a whole is untested.

SEARCH STRATEGY

Literature searches targeted cervical disc herniations and radicular pain syndromes. References were chosen by the primary author and members of the consensus group. In many cases primary references from these articles were also reviewed. Focused literature searches were done throughout the consensus process relative to topics at hand. Related topics (e.g, Thoracic Outlet Syndromes) did not undergo a thorough search strategy.

ON USING THIS DOCUMENT

This care pathway concerns the evaluation of patients who present with neck pain and arm symptoms. It also addresses patients with a primary neck complaint with concomitant lower extremity symptoms.

The conditions that are highlighted in this document include cervical radicular and myelopathic syndromes in general, and more specifically cervical disc herniations and degenerative changes such as spinal canal stenosis and spondylotic nerve compression. Much of the focus of this care pathway is on differentiating the conditions cited above from other causes of peripheral nerve damage (e.g., thoracic outlet syndromes, peripheral adhesions) and from other conditions which may mimic radicular syndromes (e.g., the deep referred pain associated with joint dysfunction, myofascial pain syndromes, facet syndromes).

This care pathway is currently incomplete. The Background section and Management section will be competed at a later date.

Another slight departure from the usual format of a CSPE care pathway is that the pathway *begins* with the evaluation strategy. Preliminary pages which normally summarize signs, symptoms and ancillary studies were simply incorporated into the overall evaluation strategy section because of the large number of conditions that this care pathway touches upon.

The evaluation strategy is laid out according to 13 clinical issues they should be addressed in patients with neck pain and arm symptoms.

A new feature has been added to this care pathway. “Clinical tips” are placed throughout the document in an attempt to emphasize “best practice” recommendations.

Two appendices deal with management: Appendix VI: Treatment for Thoracic Outlet Syndromes and Appendix VII: Treatment Approach for Patients with Yellow Flags or Nonorganic Signs.

There are three colored summary sheets for quick reference.

Neck pain with arm symptoms

What follows is a list of the conditions/presentations along with ICD codes to be used in the clinic.

Radicular Syndromes

722.0 **Radicular syndromes***

Plus

722.2 **Disc herniation w/o myelopathy***

723.0 **Spondylotic compression/stenosis***

718.88 Other radicular causes: instability, traction injuries, root adhesions, tumors*

Deep referred pain (scleratogenous)

723.97 Cervicobrachial syndrome**

Plus 353.0

739.1 Cervical joint dysfunction/subluxation
724.8 Facet syndrome
729.89 Myofascial pain syndrome
722.90 Disc derangement (disorder)

Multiple lesions along the kinetic chain mimicking radicular syndromes

AC joint dysfunction 955.5
GH joint dysfunction
719.81 specified disorder of joint of shoulder region
719.91 unspecified disorder of joint of shoulder region

Elbow dysfunction
Carpal dysfunction
719.81 specified disorder of upper arm joint
719.91 unspecified disorder of upper arm joint

Other contributing/complicating conditions

721.0 degenerative joint disease/osteoarthritis - cervical
822.6 degenerative disc disease
781.92 postural syndromes (abnormal posture)
718.88 instability, head, neck

Myelopathy

722.71 cervical myelopathy
722.70 disc disorder with myelopathy

Peripheral nerve problems (that mimic radicular syndromes)

TOS/ Brachial plexus syndrome
953.4 Brachial plexus injury

Peripheral nerve injury:

955.9 unspecified upper limb
955.0 axillary nerve
955.1 median nerve
955.2 ulnar nerve
955.3 radial nerve
955.4 muscle cutaneous nerve
cutaneous sensory upper limb nerve
955.8 multiple upper limb nerve

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* Use both the radicular code 722.0 and the appropriate diagnosis code for the *cause* of the radiculopathy. For example: disc herniation (722.2) with C7 radiculopathy (722.0).

** For deep referred pain syndromes coming from the neck, use both the code for cervicobrachial (723.37) and the appropriate code for the cause of the referred pain to the arm. For example, Facet syndrome (724.8) with deep referred pain to right posterior arm (723.37)

NOTES

TABLE OF CONTENTS

Neck Pain and Arm Symptoms

Evaluation strategy

Over the course of evaluating the patient, the following clinical issues should be analyzed and charted.

Clinical Issue 1: Rule Out Fractures and Disease

The majority of patients presenting with neck and arm symptoms will not be suffering from a significant disease process or fracture. However, it is important to rule out these conditions if certain “red flags” are present in the history, physical exam or ancillary studies. In these cases radiographs and basic laboratory screening tests such as ESR (see Appendix I), CBC and occasionally a blood chemistry panel would be warranted.

Red Flags for Suspected Fractures
(Indications for Radiographs in Trauma Cases)

Radiographs should be considered if any of the following indicators are present (Blackmore 1999, Rodgers 1988, Webb 1976). Also see CSPE protocol: Imaging Decision Making: Acute Cervical Spine Injury.

- **High-impact injury** (MVA 60 miles an hour or greater, car vs pedestrian).
- **Head/neck trauma due to fall** (regardless of distance of the fall), especially with tenderness to palpation
- **Age greater than 50 with moderate or low impact injury**
- **Multiple area injuries** (especially head and face)
- **Cervical trauma in patients with impaired mentation** (e.g., head injury, alcohol/drug use/ psychiatric conditions)
- **Patients with special risks** (e.g., fused spinal segments, Down’s syndrome, Marfan’s syndrome, os odontoideum, Klippel-Feil syndromes, or underlying inflammatory diseases such as rheumatoid arthritis)
- **Headache or trauma with focal neurologic deficits** (cranial or peripheral)
- **Significant spasm or tenderness after trauma.**

Other indicators for fracture

- **Sharp, severe, intolerable pain** suggests a fracture.
- **Rust's sign.** Patient stabilizes head when moving from seated to lying, suggests fracture, instability, severe sprain.
- **Significant neck flexor weakness, post traumatic**, suggests fracture or structural instability**.**

RED FLAGS FOR DISEASE (Indications for imaging and laboratory tests)

Red Flags from History

- **Prior history of cancer** (recurrence)
- **Unexplained weight loss, e.g., 10 lbs over 3 months** (cancer, infection, auto-immune/inflammatory disease).
- **Unvarying symptoms**, uninfluenced by rest or activity, same during the day or night (cancer, infection)
- **Diffuse "cape-like" distribution of pain/temperature loss** over one or both shoulders (intramedullary cord lesions/syringomyelia)
- **Horner's syndrome:** pupillary constriction, ptosis, anhydrosis (possible Pancoast or other tumor)
- **Fever/chills** (infection)
- **Recent bacterial infection** or history of recurrent infections. e.g., pneumonia, cystitis, skin infections (spinal infection)
- **Palpable mass** (infection or tumor--75% of non-midline cervical masses in patients over 40 are malignant) (Gleeson 2000)
- **Pain unimproved with a month of treatment** (cancer, infection, inflammatory disease)
- **Neck pain with urinary retention/ incontinence** (cord lesion)
- **Multiple joint involvement** (auto-immune/inflammatory disease)
- **Currently taking anti-coagulants** (bleeding tendency)
- **History of long-term corticosteroid use** (osteoporosis, ligamentous instability, especially in the upper cervicals)
- **Chronic shoulder pain in smoker over the age of 50-60** (Pancoast tumor).
- **Recent infection + fever + neck stiffness** (meningitis)

Red Flags from Physical Exam

- **Mid back, neck or joint pain with fever** (infection, auto-immune/inflammatory disease/cancer).
- **Neck/arm pain with neurological deficits in patients over 50-60** (cancer).
- **Neck pain plus nuchal rigidity** (meningitis).

Red Flags from Ancillary Studies

- **Elevated ESR** (See Appendix I) **or CRP** with neck/back pain
- **Anemia** with neck/back pain.

Clinical Issue 2: Determine If There Is True Neurological Involvement.

It is important to establish the nature of the arm symptoms. Occasionally, they are due to peripheral lesions such as nerve root, brachial plexus, or peripheral nerve damage. Occasionally, they may be due to spinal cord involvement. Most commonly, they are associated with somatic referred phenomenon from injured joints or muscles in the neck or shoulder. Sometimes the arm symptoms stem from concomitant lesions along the kinetic chain in the upper extremity. There will be times when several different types of these lesions co-exist.

The practitioner must sort out each of these various possibilities.

Summary of Differential Diagnoses

1. Radicular syndromes (see p. 9-19)
2. Myelopathy (see p.19-23)
3. Neural compromise at other peripheral locations (see p.24-27)
4. Somatic referred pain (see p.27-30)
5. Multiple dysfunctions in the kinetic chain of the neck and arm (e.g., cervical joint dysfunction, plus GH dysfunction, plus hypertonic pronator teres. (see p.31)

***Strong suspicion of radicular syndrome*:**

Neck pain (may include ridge of shoulder and interscapular area) *plus any of the following*:

- pain radiating into the forearm or hand (especially dermatomal),
- paresthesia to the fingers (especially dermatomal),
- neurological symptoms (subjective numbness, reported weakness).

Weaker suspicion of radicular syndrome:

- intersca pular pain,
- pain radiating past the GH joint but not past the elbow
- moderate to severe trauma to the neck,
- neck and leg symptoms (suggests spinal cord injury; therefore, concomitant nerve root injury must be ruled out),
- suspected diagnosis which has the potential to affect nerve roots (e.g., stenosis, tumor)

Clinical Issue Two: Neuro component? Differential Diagnosis 1: RADICULAR SYNDROMES

Currently there are no universally accepted criteria for diagnosing cervical radiculopathy. (Wainner 2000) However, the following section will offer a clinical profile that can be used to make a working diagnosis.

Radicular pain syndromes are relatively uncommon. The incidence of cervical radiculopathy was found to range from .08% to .20% (83.2 to 202.9 persons per 100,000). The peak incidence of 202.9 persons occurred in the 50-54-year age group. (Radhakrishnan 1994)

►***Clinical tip.*** *Deep referred pain (scleratogenous) is a far more likely cause of neck and arm symptoms than is a radicular syndrome (see pp. 27-30).*

Radicular Symptoms

Note: The following discussion of symptoms are generalized and based on the two leading causes of cervical radicular syndromes--herniated discs and osteophytic spurs in the IVF. For further discussion of these specific diagnoses, see pp. 32.

The typical symptoms of cervical radiculopathy are unilateral neck pain, radiating arm pain, finger paresthesia, sometimes accompanied by neurological complaints.

Below are the most common clinical findings reported in a number of surgical case series.

	Tanaka	Henderson	Heckmann	Dubuisson
# of patients	300	846	60	100
Neck pain	93%	79%	98%	58%
Arm pain	93%	90%		94%
Scapular pain	53%			
Chest pain	18%			
Paresthesia	83%			37%
Sensory loss	86%		88%	74%
Reflex loss	67%		62%	59%
Motor loss	69%		52%	52%

The Neck Pain….

Neck pain includes axial pain, nape pain and pain at the suprascapular, scapular, or inter-scapular region.

Onset. The time interval between the onset of neck pain and the other symptoms in one series of patients averaged 18 days (Tanaka 1998).

Special note: Neck pain may be very mild or entirely absent in some patients. (Gifford 2001, Hubka 1997) A long history of symptoms may result in less severe pain, but these patients may develop long-standing atrophy.

The Arm Pain….

"Classic" Characteristics. The following are the classic characteristics of nerve root pain.

- lancinating or shooting quality (Bogduk 1997),
- radiating into the extremity in a narrow band less than two inches wide (McCulloch 1980),
- often exceeds the intensity of the neck pain (Clark 1998),
- dermatomal,
- easily aggravated by minor movements, coughing, or sneezing. (Bland 1994)

The classic presentation of pain may NOT be commonly seen in practice and may instead appear diffuse, poorly localized and deep, especially if it is chronic in nature (Slipman 1998, Murphy 2000). This can be due to a number of reasons. There may be overlap between dermatomes innervated by one particular nerve, consequently findings may not be isolated to a single dermatome. (Clark 1998). The radiculopathy may be present with its loss of neurological function, even though the nerve root is no longer painfully inflamed. Instead, diffuse deep referred pain patterns from associated injured tissue dominate, obscuring a classic radicular pain pattern.

Henderson and co-workers (1983) reviewed 846 consecutive operative cases of cervical radiculopathy; only 53.9% had symptoms in a dermatomal pattern.

The pain may be more intense at particular sites, for example over the lateral elbow, mimicking tennis elbow, in the axilla, or along the medial border of the scapula. (Gifford 2001)

In one study of patients with EMG confirmed radiculopathy, the shoulder or scapular pain was sometimes the dominant pain (sensitivity 38%) and added to the clinical suspicion of a nerve root problem (LR+ 2.3). (Wainner 2003)

Gifford (2001) reports that patients may describe their pain in a variety of ways: for example, an intermittent deep ache over the triceps or biceps, or localized burning or itch along the medial border of scapula that keeps the patient awake at night, or heaviness of the arm.

The Paresthesia….

- Radicular symptoms are characterized by proximal pain and distal paresthesia in the distribution of the affected nerve root. (Clark 1998) Paresthesia usually develops at an earlier state of neural compression. Later, with subsequent inflammatory reaction, the typical radicular pain ensues. (An 1998)

- Paresthesia may fit more commonly into known dermatomal patterns. (Gifford 2001)

- Numbness in the extremities may develop, with minimal or no pain. (Clark 1998)

Symptom behavior

Radicular symptoms may behave in a variety of ways. Acute nerve root symptoms may be unrelenting 24 hours a day. Pain can seem to be worse at night.

Alternatively, however, the pain may be highly variable with no distinct pattern from day to day. As the radicular syndrome improves, the pain may ease up significantly for a day or two and then return with its former severity. *It is important to alert patients to this possibility*.

The patient's symptoms 1) may be responsive to procedures or activities that open and/or close the IVF; 2) may respond to maneuvers that increase or decrease tension on the nerve root; may have aspects of both patterns with one pattern dominating; or 3) may demonstrate no apparent pattern at all.

1) Pain patterns that respond to closing or opening of the IVF

- Arm symptoms may be aggravated by cervical extension, lateral bending or rotation to the side of arm symptoms.

- Cervical extension narrows the IVFs and may compress nerve roots. Active or passive extension may be significantly limited. Malanga (1997) suggests that reductions in range of motion in extension or lateral flexion to the symptomatic side is suggestive of foraminal stenosis or spurring.

- The quadrant position (extension, lateral flexion and rotation all to the same side of the neck) maximally narrows the ipsilateral IVFs and may increase arm symptoms. (Bland, 1994)

- Arm symptoms may be aggravated by cervical compression procedures during the physical, especially when coupled with lateral flexion or rotation and extension to the symptomatic side (maximum cervical compression).

- Some relief may be experienced with cervical distraction or traction procedures.

- Although cervical flexion is often limited, some particular degree of forward flexion (or lateral flexion away from the symptomatic side) may actually offer a "sweet spot" associated with some symptom relief. There can be an observable flexion antalgia which may vary from patient to patient.

- Even in cases where closing of the IVF is aggravating, relief with flexion is not guaranteed. One reason is that forward flexion may have different effects depending on which root is involved even in the same patient. For example, in one cadaver study, forward flexion increased pressure on the C5 and C7 roots, but paradoxically *reduced* pressure on C6. (Farmer 1994). Furthermore, individual variation may also be associated with the amount of pre-tension on the involved root from a herniation, scar tissue, or an osteophyte as well as the sensitivity of the neural tissue when chemically irritated. (Gifford 2001)

2) Pain patterns that respond to increasing or decreasing tension on the nerve root

- The patient may present with Bakody's sign (shoulder abduction). (See p. 12.)

- The patient may experience relief of arm symptoms with shoulder abduction during the physical exam or when they are holding/cradling and slightly elevating the arm across the abdomen

- Gifford (2001) suggests that a small percentage of patients will get relief with postures and movements toward the side of pain. This may be an attempt to reduce root tension. These patients are more likely to have symptom reproduction with nerve tension tests (see pp. 14-15).

- In some circumstances, cervical flexion may elicit pain down the spine into the extremities or in the mid-back pain. This is because, while the IVF may increase in size taking some pressure off of the nerve roots, the spinal cord and meninges are actually stretched. Stretching of the cord could further irritate symptoms from local disc lesions, dural adhesions, local tumors, etc. In patients with ligamentous instability, neck flexion often exacerbates the patient's pain. (An 1998)

3) No discernible pattern

- Patients may find pain relief positions, but often they are only temporary.
- Patients with more minor root symptoms may not be able to identify any clear postures or movements that relieve pain. (Gifford 2001)

Physical Presentation

The key physical exam procedures for a suspected radicular syndrome can generally be grouped around 1) observation of painful postures and ranges of motion, 2) orthopedic tests seeking to aggravate or alleviate the extremity symptoms, and 3) identifying any neurological deficits.

Special Note: One preliminary study of mild to moderate C6-7 radicular syndromes (based on EMG and nerve conduction studies) has suggested that the following cluster of findings may be of particular diagnostic value: 1) symptom reproduction with one version of Spurling's test (cervical compression with the neck in lateral flexion to the side of pain), (see p. 13); 2) symptom reduction with cervical distraction (see p. 13); 3) symptom reproduction with an upper limb tension test (see pp. 14-15); and 4) cervical rotation reduced to less than 60 degrees toward the side of pain.

If ¾ of the above tests were positive, the likelihood of cervical radiculopathy increased from 23% to 65% (LR+ 6.1); when all four were positive the probability rose to 90% (LR+ 30.3). (Wainner 2003)

1. Preliminary Observation: Posture and Range of Motion

- A patient may hold his/her neck stiffly or have a head list away from the affected side. (Malanga 1997)
- **Torticollis** may result from unilateral radiculopathy.
- **Bakody's sign** may be present in acute radiculopathy and is strongly associated with cervical disc herniation. The patient presents with the hand of the affected extremity placed on top of the head to relieve radicular symptoms. (Croft 1995)
- **Palm to chest**. One anecdotal observation suggested that some patients with acute C6-7 disc herniations found pain relief by pressing the palm of the symptomatic arm to the chest. (Schultz 1990)
- **Reduced rotation**. Active rotation to the side of symptoms may be reduced. In one study of patients with mild to moderate cervical radiculopathy (based on EMG studies), reduction to less than 60 degrees of rotation was common (sensitivity of 89%) and had a negative LR of 0.23. (Wainner 2003)
- **NOTE:** In contrast to acute radiculopathy, chronic radiculopathy may be unaffected by neck position or motion. (Clark 1998) In those patients with mild or absent neck pain, neck mobility may be full and pain-free. (Hubka 1997)

2. Orthopedic Tests

Summary of RECOMMENDED exam procedures for suspected radicular syndromes

- cervical compression/ maximum compression
- cervical distraction
- Valsa lva maneuver/Naffziger
- upper limb tension test (ULTT)
- shou lder abduction
- brachial compression test/door bell sign/Tinel's sign

Procedures to open or close the IVF (or change disc pressure)

A series of procedures can be used to either increase or decrease the discal pressure and close down or open up the IVF over a presumably inflamed nerve root. Positive findings could be suggestive of either a herniated disc or degenerative changes leading to spondylotic nerve root compression or stenosis.

Cervical compression tests

Cervical compression should be performed in a step-wise fashion, starting with the neck in neutral, progressing to lateral bending, and finally on to maximum cervical compression, if necessary**.**

- **Cervical compression** attempts to exacerbate nerve root compression with axial loading of the cervical spine, first in neutral. A positive test occurs when axial compression reproduces pain or paresthesia in the arm, forearm, fingers, or scapular region. An exacerbation of neck pain is not considered a positive sign for nerve root involvement. Local pain may suggest joint dysfunction, facet syndrome, or disc derangement.

- **Cervical compression with the neck in lateral flexion** toward the side of symptoms (one version of Spurling's test). In one preliminary study of patients with mild to moderate radicular syndromes based on EMG findings, a positive test (any reproduction of symptoms) was very useful in supporting a C6-C7 radicular diagnosis (86% specificity and an LR+ 3.5), but a negative test was useless in ruling out the condition (50% sensitivity). (Wainner 2003). In this study, lateral bending with compression actually performed better than maximum cervical compression.

- **Maximum cervical compression** is tested with downward pressure on the head while the neck is pre-positioned with lateral bending and some extension to the same side (this has also been referred to as Spurling's test). Rotation to the symptomatic side can be added in an attempt to further close down the IVF (Magee 1997). In cadaver studies ipsilateral rotation and extension are the most root compromising movements. (Farmer 1994, Yoos 1992). A positive test reproduces the patient's arm symptoms, most often on the ipsilateral side. Other variations include holding the compression for 30-60 seconds (Evans 1994) and adding a quick vertical blow through the top of the head (Evans 1994).

  A positive test is very useful in suggesting that a C6-C8 nerve root is irritated and pathologically compressed. Specificity has been reported as high as 93% (Tong 2002) for cervical disc herniations and ranged from 74%-100% for cervical radicular syndromes in general (Wainner 2003, Viikari-Juntura 1989).

  A negative test (i.e., no aggravation of arm symptoms) has no value in ruling out cervical radiculopathy since most patients who have disc herniations and/or degenerative changes will have a negative test. The sensitivity has been reported as 30% (Tong 1997) and even lower (Magee 1997).

Cervical distraction

This procedure attempts to relieve the arm symptoms associated with nerve root compression by tractioning the head while the patient is seated or supine. This procedure can be done for up to 30-60 seconds***. A positive test is considered to be very useful***. In one small study performed supine, a positive test was 100% specific for either the neurological or myelographic signs of C6-C8 root compression. ***A negative test has poor power in ruling out radicular syndromes*** (sensitivity ranged from 26-43%). (Viikari-Juntura 1989). These findings were repeated in another preliminary study of patients with mild to moderate radicular syndromes based on EMG findings. A positive test (any relief of symptoms with up to 14 kg of traction) was very useful in supporting a C6-C7 radicular diagnosis (90% specificity and LR+ 4.4), but useless in ruling out the condition (44% sensitivity). (Wainner 2003)

Distraction relieving arm symptoms or even local cervical pain suggests a role for therapeutic traction.

Tests to increase intradiscal and intrathecal pressure.

- **Valsalva maneuver.** The patient bears down for 2 or 3 seconds as if having a bowel movement in an attempt to increase intrathecal pressure. Exacerbation of symptoms suggests space-occupying lesions, including cervical disc herniations. In one study of patients with mild to moderate radicular syndromes based on EMG findings, a positive test was very useful in supporting a C6-C7 radicular diagnosis (94% specificity and an LR+ 3.5), but a negative test is useless in ruling out the condition (22% sensitivity). (Wainner 2003)

- **Naffziger test**. This test has the same purpose and positive findings as Valsalva, but is accomplished by compressing the jugular veins which, in turn, causes distention of the intraspinal veins. Because of the possible stimulation of baroreceptors, this procedure should not be used in geriatric patients or those with atherosclerotic disease. There is no data on test accuracy.

Procedures to alter tension on the nerve root

Procedures can be performed which either increase or decrease the amount of traction or tension on the nerve root. A change in arm symptoms could result from root irritation or inflammation.

Tests to decrease nerve root tension

- **Shoulder abduction.** Alleviation of radicular pain with shoulder abduction and the arm raised above the head may occur due to a reduction in nerve root tension (Fast 1989) or intraforaminal pressure (Farmer 1994). ***A positive test is strong supportive evidence of C6-C8 root irritation associated with disc herniation or spondylotic changes***. In one retrospective study, a positive test correlated with excellent surgical outcome. (Davidson 1981) Positive tests have been reported as 100% specific for neurological deficits suggestive of root compression and between 80-100% specific for myelographic evidence of root compression (Viikari-Juntura 1989). Another study reported 92% specificity based on patients with mild to moderate EMG findings (Wainner 2003). ***On the other hand, a negative test had poor power in ruling out radicular syndromes.*** Sensitivity has been reported to range from 17-50% (Wainner 2003, Viikari-Juntura 1989). In one other study (retrospective) it was 68% (Davidson 1981).

Tests to increase nerve root tension

- **Upper limb tension test (ULTT).** There are a number of versions of this test usually used to identify peripheral nerve adhesions or entrapments. The version described as the median nerve test is also used to screen for radiculitis. See Appendix II.

  A positive test is considered to be any of the following: 1) symptom reproduction, 2) >10% reduction of elbow extension compared to the asymptomatic side, or 3) symptoms aggravated by contralateral side flexion of the neck and improved by ipsilateral side flexion.

  In one preliminary study of patients with mild to moderate radicular syndromes based on EMG findings, a negative test was very useful in helping to rule out a C6-C7 radicular diagnosis (97% sensitivity and an LR- 0.12). A positive test is not very specific (22% specificity) (Wainner 2003).

The following tests are also designed to produce nerve tension, but they have not been studied for accuracy.

- **Shoulder depression test** attempts to exacerbate nerve root symptoms with downward pressure on the shoulder of the symptomatic side while the neck is stabilized in a position laterally flexed away, thus creating tension on the nerve root.

- **Active brachial tension test. (Bikele's sign)**. Seated patient abducts the symptomatic shoulder to 90 degrees with the elbow flexed. The patient is then asked to extend the shoulder, then fully extend the elbow and reach behind. Some authors have the patient supinate the arm in addition (palm facing up) (McGee 2001); some authors describe the final position with the arm pronated and wrist flexed (Evans 2000). Radiating pain implicates the C8 or T1 roots or brachial plexus.

  (For other procedures which place tension on the nerve roots, brachial plexus, and peripheral nerves in the upper extremity, see NMS I lab notes.)

Procedures to digitally compress the spinal nerve/plexus

- **Brachial plexus compression test.** The practitioner creates firm compression over the plexus with the thumb (just above the clavicle and posterior to the SCM). Pain radiating between the shoulder blades or into the arm suggests cervical neurological involvement. The test had a sensitivity of 74% in patients with mechanical lesions around the nerve root and 69% in patients with lesions of the cervical cord. It has better reported sensitivity than cervical compression. Specificity ranged between 79% and 83%. (Uchihara 1994)

- **Doorbell sign.** ***(AKA, anterior cervical doorbell push button test).*** Pulling the SCM out of the way, with moderate pressure compress the soft tissue along the anterior border of SCM, from about mid-neck to the clavicle for up to 2-3 seconds (Maigne 1996). Local pain is negative; pain referred between the scapular or down the arm suggests that the lesion is of cervical origin. The cause may be simple mechanical joint dysfunction or irritation of a cervical nerve root. Occasionally, scalene myofascial trigger points may give a false positive, mimicking nerve root irritation. Sharp electrical radiating pain presumably would be more suggestive of a nerve root problem.

- **Tinel's sign** for brachial plexus lesions. Tap over the posterior triangle, just posterior to the SCM, along the nerve trunks as the patient laterally bends his/her neck away. It is most useful in trauma cases that suggest the potential for brachial plexus injuries vs. nerve root injury.

  Tinel's sign suggesting nerve root

  ⇒ No response suggests that, if there is neurological injury, it is in the root rather than elsewhere in the cervical or brachial plexus.

  ⇒ A pure tingling sensation (no pain) in the distribution of the nerve trunk suggests damage in the brachial plexus or root. Roots C5 and C6 are the most superficial and are most likely to respond. There is no major anatomical discontinuity in the brachial plexus.

  Tinel's sign suggesting cervical or brachial plexus

  ⇒ Pure local pain suggests an underlying cervical plexus injury which is recovering.

  ⇒ Pain in the distribution of the nerve trunk suggests more severe disruption of the whole trunk.

When combined with the results of the neurological exam, Tinel's sign correctly identified whether the damage was pre-ganglionic or more peripheral in 43/49 roots tested in 120 patients with suspected brachial plexus injuries. The differentiation between partial damage and complete rupture of the plexus was accurate in 14/19 patients. (Landi, 1979)

3. Neurological procedures

Summary of RECOMMENDED neurological exam procedures for radicular syndromes

- sensory testing (light touch, sharp, vibration)
- DTRs (biceps, brachioradialis, triceps)
- manual muscle test (optional: sustained/repetitive)
- measure for atrophy of upper arm and forearm
- dynamometer/pinch gauge (optional)

If radiculopathy is present, *test for myelopathy* (see p. 19-23).

The practitioner must carefully look for any loss of neurological function (sensory, reflex, motor, atrophy) and chart accordingly. These findings are used to bolster the radicular diagnosis, to suggest appropriate treatment (e.g., severe or progressive motor loss may require surgery), and to track treatment response.

►***Clinical tip.*** *In patients with suspected or established neurological involvement, the basic neurological exam should be repeated often to increase its sensitivity and to watch for any deterioration.*

In terms of bolstering the diagnosis, Yoss (1999) reported that surgical findings were often consistent with the neurological loss detected by the physical exam: DTRs agreed 82% of the time with the nerve root that the surgeon found, motor weakness 77% of the time, and sensory loss 65% of the time.

Although deficits are an important part of the clinical profile of cervical radiculopathy, much of this supposition is based on studies of severe radiculopathy that requires surgery (Wainner 2000). ***Deficits may not be as prevalent in milder cases or the types of cases routinely seen in a chiropractic setting.***

Usually one root. In one series of 300 patients with cervical radiculopathy, a single nerve root was compressed in most patients. Only 0.2% had involvement of two roots. (Tanaka) *However, the patient may clinically present with more than one involved dermatome because of individualized patterns of innervation and neurological overlap.*

Absence of neurological deficits does not rule out nerve damage (48% of patients with neck and arm symptoms in one study had positive electrodiagnostic evidence of nerve damage, but no deficits). (Lauder 2000)

Types of deficits. Of 300 surgical patients in Tanaka's series, 86% had sensory disturbances, 69% had motor weakness (either the deltoid, biceps, wrist extensors, wrist flexors, triceps, finger extensors or intrinsic muscles of the hand); and 67% had diminished deep tendon reflexes. (Tanaka 1998)

Sensory testing

- **Sensory changes.** Pain from cervical radiculopathy can often be associated with alterations in sensation along the same dermatome. ***However, severe dermatomal sensory loss is relatively uncommon.*** (Tanaka 1998)

  Larger proprioception and vibration sense fibers are more likely to be affected than the smaller pain fibers. (Lagattuta 1996)

  ►***Clinical tip.*** *Any light touch or pain (sharp vs. dull) deficits should be carefully mapped and periodically re-checked throughout treatment.*

Stretch reflexes (DTRs)

- **Deep tendon reflex abnormalities in the upper extremity** increased the likelihood 2.5 times that there would be a positive

electrodiagnostic study and increased the likelihood of radiculopathy fourfold.

- Subjects with an abnormal biceps reflex were 10 times more likely to have root involvement (Lauder 2000). In one prospective study, a decreased biceps stretch reflex had a 95% specificity and an LR+ 4.9 (Wainner 2003).

- Diminished reflexes may be an early finding of radiculopathy.

► ***Clinical tip.*** *Equivocal reflexes may need to be checked over several visits to determine if they represent a true and clinically significant neurological deficit.*

Muscle tests

- The presence of motor deficits can help in substantiating the presence of a radicular syndrome. In one study of EMG verified C6-7 radiculopathies, weakness of the biceps detected by manual muscle testing, although not sensitive (24%), correlated with radicular syndromes (specificity 94% and LR+ 3.7). (Wainner 2003)

- Typically, muscle weakness is partial (grade 4/5) and affects only one or two muscles innervated by the compromised nerve root. (Hubka 1997)

- Motor deficits may also be useful in identifying the nerve root involved and the severity of the neurological compromise.

► ***Clinical tip.*** *Motor deficits should always be carefully tracked throughout the course of treatment. Progressive motor weakness while under care prompts consideration for further evaluation and a surgical consultation*.

- Patients occasionally present with a motor deficit but without sensory findings (e.g., no pain or numbness). Usually the deficit affects a single nerve root and evolves so slowly that the patient is able to compensate with other muscle groups. Only simultaneous symmetric assessment of arm and hand musculature will detect the motor loss. (Ellenberg 1996) (Clark 1998)

- Another strategy is to perform sustained muscle testing (5 seconds) or repetitive muscle testing (10x) to detect subtle weakness.

► ***Clinical tip.*** *It is important to chart that one of these methods was used. For example, "grade 3/5 weakness at 3 seconds" or "grade 3/5 weakness at 7 reps."*

- **Muscle weakness combined with an abnormal reflex** is a strong predictor of a positive electrodiagnostic study (positive predictive value 94%) and specifically cervical radiculopathy (PPV=86%). (Lauder 2000)

Atrophy

- The principal manifestation of chronic progressive radiculopathy is atrophy. (Clark 1998)

- The forearm and upper arm should be measured at the largest girth (indicate the location of the girth measurement by recording the distance from the olecranon or anterior joint line to the point of measurement).

Differentiating among nerve roots

Roots are best differentiated based on paresthesia distribution and the pattern of neurological deficits. (Bogduk 2002)

Pain distribution is not an effective method of determining which nerve root or spinal nerve might be injured.

There is considerable variation from individual to individual. Proximally there are no distinctive patterns. The dermatomes only separate out in

a meaningful way in the forearm and hand. But even in these cases, there is so much overlap, that the nerve root cannot be confidently identified.

Deficits are more predictive than pain distribution. The pain patterns are often imprecise due to anatomic variation, involvement of multiple levels, and the central sensitization phenomenon which may accompany chronic conditions. Motor, sensory, and reflex deficits are thought to be more predictive in indicating a specific level. In one series, C6 and C7 deficits were diagnostic in 98.7% of the cases (Henderson 1983). However, no other study has reported accuracy this high.

Usually C6 or C7 nerve root are involved. Most reports suggest that C7 roots (C6-C7 disc herniations) are the most commonly involved, although some reports suggest that C6 roots are more common (C5-C6 disc herniations). (Wainner 2000)

For example, in one study, C6-7 disc herniation (49%) with C7 radiculopathy was most commonly involved, followed by C5-6 herniation (43% study) with C6 radiculopathy, then C8 and C5 roots. (Dubois 1998, Tanaka 1998)

In another study, 100 surgical patients with soft cervical disc herniations had the following distribution: 54% occurred at the C6-7 level and 36% of the lesions occurred at the C5-6 level. (Dubuisson 1993)

C2 nerve root

- Pain at the craniocervical junction with radiation to the posterior aspect of the head may suggest C2 radiculopathy and may need to be differentiated from a cervicogenic headache or myofascial pain referral.

C3 and C4 nerve roots

- Irritation of C3 and C4 roots will manifest with discomfort about the posterior neck, occiput, and over the trapezius muscle to the shoulder.
- Occasionally C4 may refer down the anterior superior chest (causing “pseudo angina”).

C5 nerve root

- Pain in the suprascapular region suggests either a C5 or C6 root.
- In general, the deltoid is weaker than the biceps in C5 lesions.
- The biceps tendon reflex diminishes in either a C5 or C6 root lesion, but is more likely to be C5. (Tanaka 1998)
- Subjective paresthesia or objective sensory change in a finger tends to rule out the C5 root (which seldom involves the hand).
- C5 is very unlikely to create pain in the fingers or posterior hand. (Slipman 1998)

C6 nerve root

- C6 root pain can frequently be felt over the anterior or posterior deltoid, posterolateral arm, or dorsal radial forearm. It can sometimes be felt over the dorsal radial side of the hand, back of the thumb and index finger. More rarely, the pain can project to the back of the ulnar side of the hand, and/or dorsal 4th or 5th fingers. (An 1998, Slipman 1998)
- Pain in the suprascapular region suggests either a C5 or C6 root. Additional pain in the lateral aspect of the arm and forearm favors the diagnosis to C6.
- When symptoms are in multiple fingers, suspect C6 involvement if the most severe involvement is in the thumb.
- In general, the biceps is weaker than the deltoid in C6 root lesions.
- Positive likelihood ratios of deficits for C6 radiculopathy (McGee 2001)
  - 14.5 Decreased biceps or brachioradialis reflex
  - 8.5 Sensory loss over the thumb
  - 2.3 Weak wrist extension

C7 nerve root

- Pain in the scapular or interscapular region suggests a C7 or C8 root lesion. (An 1998)
- Pain in the posterior deltoid, posteriolateral arm and even the dorsal radial hand can be from C7 or C6. (Slipman 1998)
- When multiple fingers are involved, it can be difficult to predict what nerve roots are affected. However, when the most severe involvement is the index or long finger, consider the C7 nerve root.
- The triceps tendon reflex diminishes in either C7 or C8 nerve root compression (Tanaka 1998), but will mostly likely be C7.
- Positive likelihood ratios of deficits for C7 radiculopathy (McGee 2001):
  - 28.3 Decreased triceps reflex (C7 or C8)
  - 4.0 Weak elbow extension
  - 2.3 Sensory loss over middle finger

C8 nerve root

- Pain in the scapular or interscapular region suggests a C7 or C8 root lesion. Concomitant pain in the medial aspect of the arm suggests C8.
- When multiple fingers are involved, if the most severe involvement is in the little finger, think C8 nerve root.
- C8 deficits may affect both the triceps and intrinsic muscles of the hand, but the weakness of intrinsic muscles dominates.
- The triceps reflex diminishes in either C7 or C8 radiculopathy. (Tanaka 1998)
- Invariably, C8 root symptoms occur primarily below the elbow, with most dysfunction noted as numbness along the ulnar digits and as a deficit in both abduction and adduction of the fingers and in finger flexion. (An 1998)
- Positive likelihood ratios of deficits for C8 radiculopathy (McGee 2001):
  - 41.2 Sensory loss over little finger
  - 28.3 Decreased triceps reflex (C7 or C8)
  - 3.8 Weak finger flexors

See a nerve root chart, see Appendix III.

Special Topic: Spondylotic Radiculopathy

When secondary to localized spurring or to stenosis in general, symptoms are often chronic and develop insidiously.

Symptoms

- Root pain is proximal, rarely extending below the elbow, involving dermatome, myotome and sclerotome.
- Sensory symptoms are more common than motor.
- Paresthesias are often in the distal territories of the affected roots.

Signs

- Hyporeflexia is one of the more common objective findings.
- There may be atrophy on inspection or by circumference measurements.
- Muscle weakness is progressive, including loss of grip strength.
- However, objective signs are not common in general, since function is often maintained due to multiple innervation.

Clinical Issue Two: Neuro component?

Differential Diagnosis 2: CERVICAL MYELOPATHY

Cervical myelopathy most frequently exists due to a large central disc herniation or severe spondylotic changes with central spinal stenosis. (Matsumoto 1996)

Chronic disc degeneration with osteophyte formation is the most common cause of spinal cord compression in patients aged more than 55 years. (An 1998)

In younger patients, a soft disc herniation is more commonly the cause. In one series of 100 patients with soft disc herniations, about 15% had myelopathy. (Dubuisson 1993)

- Based on experimental trauma, as much as 30% of the cord volume can be lost without affecting the neurologic examination. (Clark 1998)

- In one study the affected level *of the spinal cord* was (in order of prevalence): C5-C6 in 61 patients (58%), C4-C5 in 22 patients (20%), C3-C4 in 17 patients (16%), and C6-C7 in six patients (6%). (Matsumoto 1996)

- The spinal cord segments tend to line up ½ to one full segment superior to the corresponding intervertebral disc. For example, a C5-C6 disc herniation might compress the C7 cell bodies in the cord creating C7 (triceps) hyporeflexia. A C4-C5 disc herniation may compress the C6 cell body causing C6 hyporeflexia while at the same time compressing the secondary neurons in the long track to C7, resulting in a triceps hyperreflexia. (Matsumoto 1996)

General Presentation of Myelopathy

According to Bland (1994), myelopathic findings are actually more common than root symptomatology.

- Cervical spondylotic myelopathy is defined as a neurolgic disorder manifested in its most severe form by

  - spastic gait,
  - clumsy hands,
  - atrophy and sensory impairment,
  - sphincter disturbances.

- Motor and reflex changes are observed more often than sensory changes, and analgesia is more common than anesthesia Arm findings can be unilateral, but leg findings are typically bilateral. (Clark 1998)

Spinal Cord Symptoms

- In contrast to the presentation in cervical radiculopathy, **pain is not a common presenting symptom**. Concomitant pain may be related to the underlying spondylosis of the cervical spine (Clark 1998) or other mechanical dysfunction (e.g., subluxation syndromes, facet syndromes.)

- **Variability.** The symptoms of myelopathy can be vague and variable. Therefore, myelopathy is often not detected on the initial evaluation. (An 1998)

- **The classic presentation** of myelopathy is hand numbness and clumsiness in association with a stiff, spastic gait. (Clark 1998)

- **Clumsy hands.** The involvement of the upper extremities may be an early symptom. Manual dexterity often is impaired (e.g., handling a small object with the eyes closed), with impairment silently progressing until patients are surprised at their inability to complete activities of daily living, such as buttoning a shirt or writing. (An 1998) The hand dysfunction often occurs before there is significant involvement of the lower extremity. (Nakajima 1995)

- **Numb hands.** The distribution of subjective hand numbness may be useful in identifying the level of the cord that is impaired. A retrospective analysis of 106 disc herniation patients with cervical myelopathy found that, although not as accurate as DTRs, “strong numbness” of the hand present at the onset of symptoms was moderately specific and sensitive in identifying the level of lesion. (Matsumoto 1996)

  - numbness in the WHOLE HAND may suggest C3-C4 or C4-C5 cord compression
  - numbness of the RADIAL SIDE of the hand suggests C4-C5 cord compression
  - numbness of the ULNAR SIDE of the hand suggests C5-C6 cord compression.

- **Lower extremity symptoms,** as a result of cervical cord involvement, can include paresthesia, proximal leg pain, even low back pain (often described as burning or aching and aggravated by neck movement).

  Numbness on the soles of the feet and a tight band-like sensation at the midthrocic level were noted in one series of 8 patients with C3-C4 midline herniation. (Nakajima 1995)

- **Bladder involvement** includes urinary retention, frequency, urgency and urge incontinence. History should focus on possible retention or incontinence or unusual patterns of frequency, dysuria, and bladder discomfort. (An 1998) As many as 2/3 of patients may have sphincter dysfunction.

Spinal Cord Signs

Summary of Neurological Exam for Cord Lesions

Procedures are in addition to the basic neural exam for radiculopathy.

Neck flexion (L'hermitte's sign)
Cranial nerve exam (if there are cord signs present)

Upper extremity
observe intrinsic muscles of the hand
finger escape sign
rapid hand opening and closing
Hoffman (dynamic)
scapulohumeral reflex

Lower extremity
gait/tandem Romberg
lower extremity strength
DTRs
Babinski/clonus
position sense
sharp-dull
vibration
run in place/one leg stand
(e yes closed) (see Appendix IV)

General comments

- **Motor loss prominent.** In patients with myelopathy, the cord signs and symptoms generally outweigh any concomitant focal radicular disorder and *motor loss exceeds sensory loss*. (Clark, 1998)

- **LMN/UMN.** Lower motor neuron involvement occurs at the level of the lesion, with atrophy of upper extremity muscles, especially intrinsics of the hands. Upper motor neuron findings are noted below the level of the lesion, with lower extremity spasticity and hyperreflexia. (Clark, 1998) Mixed UMN and LMN signs are common; for example, hyporeflexia at level of herniation, hyperreflexia below.

- **Neck flexion.** Symptoms may be aggravated by sustained flexion of the head. (Vadeboncoeu 1994)

  L'hermitte's sign. This sign is present in approximately 25% of patients with cervical spondylotic myelopathy. Spinal flexion produces sudden, severe, electric shock spreading down through body and often into arms and/or legs, suggesting cord involvement (Parminder 1988) as may also occur with spinal cord tumors or multiple sclerosis. (An 1998)

- **Cranial nerve exam.** If a diagnosis of myelopathy is suspected, a cranial nerve exam may be necessary to help differentiate cord compression lesions from nervous system diseases such as MS, primary lateral sclerosis, or ALS. Positive cranial nerve findings would suggest a more generalized disease process-- but normal findings would not rule out disease. (Siekerka 1992)

- **Superficial abdominal reflexes** may be diminished.

Upper extremity

Reflexes

- **Hoffman's reflex.** The presence of this reflex suggests spinal cord compression. Hoffman's reflex was observed in >80% of patients with a lesion from C3-C4 to C5-C6 but was rare at C6-C7 in one series of patients. (Matsumoto 1996)

  Handal (1998) reported that Hoffmann's reflex and hypereflexia were the most sensitive tests and had the highest accuracy for the diagnosis of cervical myelopathy.

  An asymmetric Hoffman reflex or strong bilateral reflex should alert the practitioner. Bilateral Hoffman reflexes are commonly present. (Clark, 1998) Mild bilateral reflexes are considered a normal variant by some neurologists, although Sung (without making a distinction between unilateral and bilateral) found the presence of the reflex to be very sensitive for at least minimal cord compression.

  Sung (2001) studied 16 asymptomatic patients with a positive Hoffmann's reflex who were then evaluated with radiographs and MRI. He reported the following findings:

  - 14/16 had spondylosis on radiographs
  - 10/16 had foraminal stenosis
  - 15/16 had cervical cord compression from a herniated disc.

  However, none of the patients required treatment.

- A **dynamic Hoffman's reflex** may be elicited by having the patient actively flex and extend the neck while the procedure is repetitively performed. It is thought that the extension phase of the movement might enhance the reflex in cases of myelopathy secondary to spinal canal stenosis.

- **Hypo or hyper reflexia.** Reflex changes may be present and can be used to estimate the location of the cord lesion more accurately than the distribution of sensory loss or muscle weakness. (Matsumoto, 1996)

  Level of cord pressure

  ⇒ Hyperreflexia of the biceps is highly specific to the C3-C4 disc level.
  ⇒ Hyporeflexia of the biceps suggests compression at the C4-C5 disc level.
  ⇒ Hyporeflexia of the triceps reflex suggests compression at the C5-C6 disc level.
  ⇒ Normal upper extremity reflexes suggest that any cord compression would most likely be at or below C6-C7.

- **Paradoxical reflex.** Patients with spinal cord compression at C6 also may exhibit a paradoxical brachioradialis reflex (inverted supinator reflex). In response to tapping the distal brachioradialis tendon, a diminished reflex is elicited with a reciprocal spastic contraction of the finger flexors; this is also known as the inverted radial reflex. (An 1998) ***Note: a common error is to tap the finger extensors rather than the brachioradialis, thereby eliciting a wrist extension response.***

- **Scapulohumeral reflex**. Shimizu (1993) described the scapulohumeral reflex, which correlated well with high (C0-C1) cervical cord compression. 41/225 cases of cervical spine or cord disorders revealed a hyperactive reflex. All 41 cases had structural abnormalities potentially compromising the upper cervical cord, hyperreflexia of other DTRs, or both. The conditions included ossification of the posterior longitudinal ligament, atlantoaxial (medical) subluxation, foramen magnum stenosis, spinal cord tumor, as well as other anomalies and pathologies. Five of 90 normal controls were judged to be positive. The reflex was also present in 11/17 cerebrovascular stroke cases.

  This reflex is elicited by tapping the tip of the spine of the scapula and/or the acromium in a downward direction (best to use a large, well balanced reflex hammer). The test is positive if there clearly is a brisk

scapular elevation and/or abduction of the humerus.

- **Clonus.** Quick sustained stretch of the wrist flexors (hyper extension of the wrist) may cause clonus. The presence of clonus strongly suggests cord involvement. One beat or two-beat clonus is usually considered to be normal.

  ►***Clinical tip.*** *When charting clonus, it is important to indicate if there are more than two beats (e.g., " >2 beat").*

Muscle weakness/clumsiness

- **Dysesthesias and clumsiness of the hands** with inability to open and close the fists 20 times in 10 seconds. A patient with normal function should be able to perform the grip-release motion 20 times in a 10-second period.

- **The finger escape sign** is positive when the patient is asked to squeeze his/her fingers together (adduction) while extending them backwards with the wrist in neutral. A positive test occurs if the two ulnar digits "escape" into flexion and abduction within 30 seconds. (An 1998)

Lower extremity*

Gait and lower extremity strength, sensation, and reflexes should be evaluated to detect weakness, numbness, or upper motor neuron signs that can occur with cervical myelopathy. (Roger 1998)

- **Gait disturbance is an early presenting complaint** and is usually insidious and slowly progressive. Presentations include

  - stumbling
  - an awkward or shuffling gait
  - frequent falls
  - characteristic stooped, wide-based gait of the elderly is a common end result. (An 1998)

  Careful questioning elicits a decreased ability to run or walk confidently**.** To check for subtle signs of myelopathy during the initial evaluation, assess balance and coordination by having patients do a tandem Romberg walk or stand on one leg with eyes closed. (See Appendix IV for normative single leg standing times.) (Clark, 1998)

- **Babinski reflex**. The Babinski reflex may be bilateral (Clark, 1998) or unilateral and suggests cervical cord injury from a central disc herniation or spinal stenosis. (Rodgers, 1998) Babinski's sign usually does not occur unless myelopathy is severe. (Hubka 1997)

- **Hyperreflexia.** Achilles and patellar reflexes may be hyperreflexic (3+/4) as compared with the arms or asymptomatic leg.

- **Clonus.** Quick stretch of the Achilles tendon (hyperextension of the ankle) may cause clonus. The presence of clonus strongly suggests cord involvement.

- **Sensory changes** include lower extremity paresthesia and altered pain, vibration or temperature sensation.

** On the importance of this assessment: "It is my opinion that every patient [with cervical disc herniation or symptoms of radiculopathy] should have at least a brief examination of the lower extremities before treating their neck, whether or not they have lower limb complaints… this should at minimum include myotatic reflexes, plantar response and light touch (with finger tips, looking for reported asymmetry or paresthesia), but should also include whether the patient can perceive vibration at the great toes… I can show you many patients who have no lower limb symptoms who have mild myelopathy and I know of at least two cases where chiropractors did no testing on lower limb before treatment and when these patients were found on examination subsequent to chiro-practic treatment to have signs of myelopathy, were accused of damaging the spinal cord." (Rand Swenson, DC, MD personal communication)*

Clinical Issue Two: Neuro component?

Differential Diagnosis 3: NEURAL COMPROMISE AT OTHER LOCATIONS

When patients have neck pain with arm symptoms, the practitioner must carefully consider a number of possible neurological lesions other than radicular syndromes or myelopathy.

Summary of common causes

3.1 brachial plexus injuries
3.2 thoracic outlet syndromes (TOS)
3.3 peripheral nerve adhesions/ entrapments/ injuries (e.g., radial nerve palsy)
3.4 complex regional pain syndrome (AKA, RSDS)

3.1 Brachial Plexus Injuries

(AKA, brachial plexopathy, brachial plexus neuritis)

Trauma can lead to injury of either the cervical nerve roots or the brachial plexus, resulting in a neurapraxis injury. When this type of injury occurs within the context of sports or recreation, the presentation is often referred to as a "stinger" or "burner." Forced lateral bending of the neck with shoulder depression or a sudden load taking the arm into abduction and extension can place the plexus at risk.

Symptoms include characteristic stinging or burning pain down the arm. Neurological deficits are not usually present or are transitory, except in rarer cases of significant neurological damage or avulsion. Because the plexus is injured rather than the nerve root, neurological symptoms are not dermatomal in distribution.

Supraclavicular tenderness may be present. See also Tinel's sign, on p. 15. Any orthopedic test that places tension on the brachial plexus may reproduce the patient's arm symptoms. (See Bikele's sign p. 15 and the ULLT, Appendix II).

Differentiating "Stingers" and "Burners"
(Kelly 1997)

Root injury	Plexus injury
Compression within IVF	Traction injury
Extension with compression	Lateral bending + shoulder depression
Neck pain common	Neck pain not usually prominent
Associated with stenosis in adults	No spinal stenosis pre-disposition
More common in college sports	More common in high school

"Stingers" and "burners" usually resolve without sequelae. (Levitz 1997) Although, recurrent injuries could lead to muscle weakness.

►***Clinical tip.*** *It is important to counsel athletes who have already had one stinger or burner about the dangers of recurrence.*

3.2 Thoracic Outlet Syndrome (TOS)

(AKA, cervical rib syndrome, scalenus anticus syndrome, costoclavicular syndrome, hyperabduction syndrome, and pectoralis minor syndrome)

Thoracic Outlet Syndromes are a group of syndromes primarily creating arm symptoms. Neurovascular entrapment is caused by compression of the brachial plexus, subclavian artery and/or vein at some combination of the following sites: within the interscalene triangle, between the first rib and clavicle, and between the corocoid process and the tendon of the pectoralis minor muscle. (Liebensen 1988).

Prevalence is reported to range from 3-80/1000. It is more common in women than in men (range of 9:1 to 3:1) (Karla 2002) and is more common in the 20-50 year old age group.

A variety of contributing factors have been suggested. Static postures such as forward head carriage, shoulders rolled forward, "drooping" shoulder girdle, prolonged periods of using a computer keyboard, or long periods of hyperabduction or elevation of the arm due to job, recreation, or sleeping postures. Observation of the patient should be done in both the seated and standing posture. Other factors occasionally include a cervical rib, large poorly supported breasts, recent trauma or the delayed effects of trauma (including whiplash).

Diagnosis of TOS is often made based on the clinical symptoms (and excluding other diagnoses) and is not always confirmed by physical exam findings. The dominant symptoms include shoulder and arm pain, paresthesia of the fingers (often the 4th and 5th digit), a sense of heaviness or fatigue in the arm and sometimes pallor in the fingers. Sensory symptoms generally cover more than one dermatome and precede motor symptoms. The hand may also demonstrate loss of grip strength, incoordination, or clumsiness. (Murphy 2000) Other symptoms may include neck pain or headache. Symptoms are usually unilateral.

About 97% of patients have neurological signs and/or symptoms. Patients with significant vascular involvement are considered to be rare. Some authorities suggest that the syndromes can be grouped as following: 1) true neurogenic (neurological deficits demonstratable by physical exam or electrodiagnosis) which is uncommon 2) non-specific (neurological symptoms but no deficits—this type of TOS is sometimes considered to be controversial since there is no gold standard to confirm the diagnosis), which is the most common type and 3) vascular, which represents about 3% of cases.

About 2% have significant venous compression resulting in swelling in the hand or arm, nonpitting edema, cyanosis, ecchymosis or a feeling of heaviness or fatigue in the arm. These symptoms may be aggravated by TOS tests**.** If these symptoms are constant and do not disappear with rest or arm dependency, thrombus formation may have occurred. **Because of the potential of a pulmonary embolism, the patient should be referred urgently (Murphy 2000).**

About 1% have significant arterial compression characterized by mild signs of cramping or fatigue with repetitive use, cold sensation and pallor of the fingertips, Raynaud's-like phenomenon, decreased radial pulse, subclavian bruits, and symptoms that also suggest neurogenic compression.

Summary of physical examination procedures

- Postural analysis (standing and sitting)
- Palpation of the scalenes, pectoralis and other cervical and shoulder girdle muscles
- Neurological evaluation (e.g., DTRs, muscle tests, and sensory testing)
- Vascular evaluation (check upper extremity pulses, nail blanching, temperature, swelling, auscultation for bruit, Allen's test)
- TOS tests (Roos, hyperabduction, etc.)
- Focal stress tests over scalenes and upper portion of pec minor
- Length testing of pecs and scalene muscles
- Static and motion palpation of cervical and thoracic spine, ribs, AC and SC joints.
- Evaluate breathing pattern

Thoracic outlet tests such as Adson's, reverse Adson's, Roos (AKA, EAST test), hyperabduction (Wright's test) or AER (similar to Wright's test), or the costoclavicular test (Eden's) may reproduce neurological symptoms. For more information regarding this orthopedic tests, refer to NMS 1 Lab notes. ***It is very useful to find an arm position that reproduces the patient's symptoms; conversely, tests or arm positions that result only in a pulse reduction but no***

symptom reproduction are likely of no clinical significance since this is a common finding in healthy subjects. Focal stress tests can be performed by applying pressure to the anterior scalene or upper portion of the pectoralis minor muscles for 15-30 seconds in an attempt to reproduce symptoms. Tinel's sign can be elicited over the brachial plexus. (Novak 1993)

The cervical and thoracic spine and ribs should be evaluated for joint dysfunction as well as the joints of the shoulder girdle. Murphy (2003) suggests that dysfunction of the first costo-transverse joint is an important contributing factor especially when the entrapment is in the scalene triangle and that a fixation at the sternoclavicular junction may contribute to entrapment at the clavicle and first rib.

Vascular evaluation may include auscultating the brachial arteries for bruit, checking radial and ulnar circulation by Allen's test and finger blanching test, and checking the upper extremity for swelling or temperature changes.

In one study three out of four of the following findings were present in 97% of TOS cases:

- Arm elevation increases symptoms
- History of C8-T1 paresthesia
- Tenderness over the supraclavicular area or scalene muscles
- Positive Roos test (heaviness and fatigue). (Liebensen 1988)

For decisions regarding imaging, see page 33.
For treatment, see Appendix VI.

3.3 Peripheral Nerve Adhesions/Entrapments/Injuries

It is thought that subtler lesions of the peripheral nerve may cause or contribute to a patient's arm symptoms. The inability of the nerve to glide properly with motions of the arm or neck due to altered muscle tone, adhesions or mild compartment syndromes may "sensitize" the nerve. (Butler 1991)

A number of tension tests have been proposed to evaluate individual peripheral nerves, portions of the brachial plexus, and groups of nerve roots.

Upper Limb Tension Tests (ULTT)

- Median nerve
- Ulnar nerve
- Radial nerve

ULTT might be performed to document evidence of nerve traction or adhesion problems in specific nerves by varying arm position to differentially stretch given nerves. ULTT may also be performed to diagnose cervical radiculopathy. (See p. 14)

In the process of performing the tension tests, the unaffected limb should be examined first in order to appreciate what the "normal" patient response will be. Careful documentation of patient response including symptom reproduction, response to sensitizing maneuvers and side-to-side differences in range of motion up to symptom onset should be considered as criteria for determination of a positive ULTT.

Besides gauging the patient's pain response, the practitioner differentiates a "normal" resistance (as compared to the non-symptomatic side) from a sense of increased tissue end feel, suggesting that the peripheral nerve is not gliding freely (although this may be difficult to differentiate from myofascial shortening by "feel" alone).

The goal is to reproduce symptoms by selectively altering the tension on specific parts of the nervous system to enhance diagnostic accuracy and so that treatment might be directed most effectively.

Sensitizing maneuvers can be used to gain a clearer picture—limbs are moved to the point of aggravating or reproducing symptoms and then backed off to a symptom free position prior to adding a sensitizing maneuver. Sensitizing maneuvers that utilize small movements of distal parts (like the wrist) that result in large changes in symptoms or perceived tension

suggest that the neural adhesion problem is more distal along the course of the nerve. Conversely, if small changes in cervical lateral flexion produce greater symptomatic change, the likelihood of IVF encroachment or other proximal neural adhesion or compression is suggested. (Butler 1991)

For a description of these tests, please consult the NMS 1 lab notes.

3.4 Complex Regional Pain Syndrome (AKA, RSDS, causalgia)

A number of very painful syndromes formerly known as reflex sympathetic dystrophy and causalgia (among others) have been combined under the newer name of complex regional pain syndromes. These are extremity conditions in which the pain far exceeds what would be expected from the initiating injury or event, both in duration and severity. In addition, the patient displays some of the specific characteristics listed below. At one time ascribed to hyperactivity of the sympathetic nervous system, current theories include a role for a hypersensitized central nervous system and sensitized peripheral receptors as well as a modified role for the sympathetics.

A new classification system suggests that there are two types. Type 1: any of the features below are present with no definable nerve damage. Type 2: (formerly called causalgia) a definable nerve injury is present.

There are five main types of symptoms: pain, autonomic dysfunction, edema, movement disorder, and dystrophy/atrophy. (Schwartzman 2000)

- Very severe pain is the dominant feature, often burning, becoming regional, with palmar and plantar dominance. Hyperalgesia and allodynia are present.
- Nails become rigid, thickened, and brittle; the hair darkens, grows rapidly in the affected area, and later may be lost. Other changes in the distal portion of affected extremity include temperature changes (increase or decrease) and diffuse mottling; in about 20% of cases, the affected area is initially painful, warm, and red.
- Spasms, increased reflexes, and muscle weakness are common.
- Movement disorder: the patient has an inability to initiate movement, tremor, muscle spasm, and may have dystonia in the upper extremity. The dystonia starts in the 4th and 5th digits causing flexion contraction and evolves into adduction and flexion of arm and wrist. In the lower extremity the foot is inverted with plantar flexion.

Clinical Issue Two: Neuro component?

Differential Diagnosis 4: SOMATIC REFERRED PAIN (no nervous tissue damage)

When central or peripheral nerve damage has been ruled out, the practitioner should consider that the arm symptoms may be referred somatically from cervical or thoracic joints, ligaments, or muscles. This will be the most common scenario.

Summary of common causes

4.1 facet syndrome
4.2 internal disc derangement
4.3 subluxation syndromes
4.4 myofascial pain syndromes

Specific diagnoses include facet syndromes, subluxation syndromes (cervical, thoracic, rib), internal derangement of the disc, and myo-fascial pain syndromes (e.g., scalene MFTPs).

►***Clinical tip.*** *These diagnoses overlap considerably and differentiation may be very difficult.*

4.1 Facet Syndrome

Facet joints are a common source of local and referred pain. Aprill (1990) performed

anesthetic joint injections in symptomatic patients and confirmed the accuracy of pain charts for predicting the referral pattern of symptomatic zygapophyseal joints. Injections into the zygopophyseal joints produce a fairly discrete and unique referral pattern that can mimic cervical radiculopathy. (Benner 1998)

Facets may be injured by trauma (micro or macro), sustained postural loads, or simple activities of daily living (if the neck is functionally unstable).

In chronic pain from whiplash cases, the facets are commonly involved. In one study 40-68% of patients' pain was from the facets (most common levels were C5-C6 and C2-C3). (Barnsley 1995)

Furthermore, small initial studies have shown that palpation has high sensitivity and specificity to detect the presence or absence of cervical joint dysfunction in neck pain and headache patients (Jull 1988, Sandmark 1995, Jull 1997).

Physical findings for cervical facet syndrome

Palpatory (perhaps the best evidence) (Frontera 2002, Jull 1988)

Tenderness over the facet
Tissue changes around the joint (e.g., spasm)
Joint restriction

Joint loading (may be less accurate)

Local pain with active or passive extension
Local pain with cervical compression (neutral or maximum)
Local pain in the quadrant position (combined extension, rotation and lateral flexion to the same side) or during cervical "Kemp's" test

4.2 Internal Disc Derangement

Intervertebral discs can cause local and referred pain *even if there is no herniation into the canal*.

Radial tears or local swelling can stimulate nociceptors. In the lumbar spine nerves penetrate into the outer 1/3 of the annulus and often proliferate after injury, sometimes penetrating as far as the nucleus pulposis. Common speculation is that the cervical discs are similarly innervated.

Radial tears appear in the annulus fibrosus due to biomechanical stress and may allow for migration of the nucleus pulposis into the fissures. However, discogenic pain seems unlikely to come from posterolateral fissures because there are very few fibers there to begin with. The source of pain may more likely be from the pressure of discal material against the posterior longitudinal ligament or from tears in the thicker anterior annulus, especially after hyperextension trauma (Mercer 1999).

Disc derangement: clinical presentation

Neck pain with or without referred pain
Self-limiting episodes in younger people
of acute torticollis (Bland 1994)
Intermittent scapular pain (Bland 1994)
May co-exist with facet syndrome
May be aggravated by cervical compression
Less likely to have tenderness localized just over the facets (conventional wisdom)
Somatic referred pain into the arm may be improved by repetitive movements into chin retraction, neck extension, or some other direction (e.g., McKenzie protocol)
Often very difficult to differentiate from facet syndrome

Disc swelling without protrusion may also occur due to inflammatory changes. This may produce more constant symptoms in older patients.

A central disc bulge/herniation without myelopathy or radiculopathy may irritate the posterior longitudinal ligament and dura mater, causing scleratogenous diffuse bilateral neck pain. This phenomenon is more common in geriatric patients. (Bland 1994)

4.3 Subluxation Syndromes/Joint Dysfunction

Joint dysfunction/subluxation syndromes, because of their relationship to the facets and discs, are considered capable of creating local and radiating symptoms*.* In this regard, they may either mimic radicular syndromes or may be superimposed on an existing radiculopathy (e.g., cervical joint dysfunction associated with a disc herniation and radiculitis). (See Clinical Issue 4, p. 35.)

Pain referral patterns include thoracic or interscapular pain, sometimes referred to as cervicogenic dorsalgia (Terrett, 2002). Maigne (1996) speculates that up to 70% of common interscapular pain may originate from the lower cervical joints.

The interscapular pain may be well localized (especially along the medial scapular border) or diffuse; it may be a burning, pressure or cramping sensation; or it may be a deep seated intrathoracic pain. This condition is associated with activities in which the hands are held at the level of the chest without support (e.g., sewing, typing, carrying packages).

The key physical exam findings include

- reproduction of the dorsal pain with head rotation to the symptomatic side (sometimes requiring some additional extension while rotated) (Terret 2002),
- sometimes a positive doorbell sign (Maigne 1996) (see p. 15),
- palpable joint dysfunction in the lower cervicals,
- symptom relief with cervical manipulation.

Concomitant findings may also include a tender point about 2 cm lateral to the spinous process of T5 or T6. (Maigne 1996)

Clinical criteria for joint dysfunction/ subluxation syndromes

Generally, practitioners look for two or more of the following to be present (Peterson 2002).

- Altered motion by palpation (loss of joint play, reduced palpable segmental range of motion, altered end feel, hypermobility)
- Tenderness or dysesthesia elicited by static or motion palpation
- Palpable spasm or change in tissue texture near joints (e.g., positive skin rolling, temperature change, visible tissue changes)
- Reduction of tenderness with joint challenge
- Palpable malposition (e.g., “prominent” articular facet, deviated spinous process, prominent transverse tip of atlas)

Although it cannot be entirely ruled out, it is doubtful that a subluxation can actually pinch a nerve or cause radicular signs. “Bone out of place” is probably an “inappropriate” explanation except in a few limited cases. (Leach 1994). Subluxation *plus* anatomical changes (stenosis, other degenerative changes) *may* trigger ischemia to the roots resulting in radicular signs and symptoms. On the whole, arm symptoms associated with neck subluxations are more likely due to a somatic referred phenomenon.

4.4 Myofascial Pain Syndromes

Myofascial trigger points can cause referred pain, numbness, or paresthesia along the arm Mense 2001), mimicking a radicular syndrome.

►***Clinical tip.*** *Vernon suggests that in some cases, MFTPs can co-exist with radicular syndromes and may need to be addressed. (Conley 1994)*

Trigger points in most rotator cuff muscles (e.g., supraspinatus, infraspinatus, sub-scapularis), scapular stabilizers (e.g., serratus anterior, latissimus dorsi,) and some neck muscles (e.g., scalenes) can project pain into the arms.

Recommended Criteria for Identifying MFTP (Simon 1999)

►***Clinical tip.*** *A sensitive spot in a muscle that refers pain does not alone identify an MFTP. (Mense 2001)*

Essential criteria for MFTPs

- Exquisite spot tenderness of a taut band or a nodule within a taut band. (If the spot tenderness is intense, the patient may sometimes exhibit a "jump sign").
- Pressure on the trigger point reproduces the patient's pain and the patient *recognizes* the tenderness as the same pain they are complaining of.
- Painful limitation to full stretch of the muscle.

Confirmatory observations for MFTPs

- Local twitch sign (seen or felt)— sensitivity is thought (based on expert opinion) to be poor, but specificity is very high.
- Referred pain or altered sensation in an area that the patient recognizes as reproducing the symptoms that he or she presented with (thought to be a very useful confirmation).
- Pain or altered sensation in an expected referral pattern that the patient doesn't recognize may suggest a more latent trigger point.
- Electromyographic evidence of spontaneous electrical activity is present in the area of a tender nodule within a taut band.

Note: The muscle harboring the trigger point may also be weak. (Gerwin 1997)

Further evaluation

When a myofascial pain syndrome has been identified, additional evaluation steps should be taken:

1) other muscles within the same functional unit should be evaluated for dysfunction (e.g., weakness or muscles that are short and tight), such as assessing the entire rotator cuff group in the case of an infraspinatus myofascial pain syndrome;

2) identify activities that may have led to the development of the syndrome;

3) identify any other structural or functional causes that may result in *persistence* of the trigger points, such as chest breathing (especially in patients with scalene trigger points), leg length inequality, pelvic distortions, etc. (Gerwin, 1997)

►***Clinical tip.*** *In addition to the possibility of a patient's arm symptoms radiating from trigger points located in the neck and shoulder muscles, a patient may actually have two separate lesions -- e.g., a cervical facet syndrome responsible for the neck pain and pronator teres trigger points resulting in forearm and hand symptoms.*

Clinical Issue Two: Neuro component?

Differential Diagnosis 5: MULTIPLE JOINT LESIONS ALONG THE KINETIC CHAIN

(no nervous tissue damage)

When patients have symptoms extending into the arm, it is a good clinical strategy to evaluate the key joints and muscles that comprise the kinetic chain along that extremity.

In some cases, extremity symptoms may be the result of local lesions in the shoulder or arm rather than actually radiating from the neck, even when neck pain is present. In other circumstances, these lesions may co-exist with actual radicular or somatic referred pain coming from irritated spinal tissue.

Finally, they may represent additional sites where the peripheral nerve is "hung up," irritated or mildly compressed, giving rise to a "double crush" syndrome.

Regardless of the proposed mechanism of involvement, addressing any evident distal biomechanical lesions may be very useful in managing the patient's extremity symptoms. The following joints should be evaluated, primarily by motion and static palpation**.**

- First and second rib
- Acromioclavicular (AC) and sternoclavicular joint (SC)
- Glenohumeral joint
- Elbow joint
- Carpal bones, distal radial-ulnar joint

Any dysfunction should be treated according to findings. Restoration of normal tone and function may resolve some or all of the arm symptoms.

►***Clinical tip.*** *When tenderness is found within the territory of the patient's radiating pain or paresthesia, the practitioner must consider still another explanation. As Gifford explains, "Physically testing or pressing on a particular structure and reproducing the pain that the patient complains of does not therefore mean that the definitive source of the problem has been found." The hyperalgesia may actually be secondary to nerve root irritation or, in the case of somatic referred territories, due to central sensitization at the cord level. (Gifford 2000). This possibility will be strengthened if the practitioner finds no improvement with therapy directed at the tender peripheral joints or muscles.*

Clinical Issue 3: Diagnosis--Identify the Pain Generator or Determine the Cause of A – Radiculopathy or B – Myelopathy

In cases where a radicular syndrome or myelopathic syndrome is strongly suspected based on history and physical exam, the cause of the neurological lesion should be elucidated, that is, a specific working diagnosis should be formulated and recorded.

Clinical Issue 3A: Diagnoses for a radicular syndrome

Differential Diagnoses for a Radicular Syndrome

1. disc herniation *
2. spondylotic compression*
3. stenosis
4. traction injuries (whiplash, "burners")
5. root adhesions/fibrosis
6. tumors
7. fracture
8. instability
9. infection (of bone, disc, meninges near root)
10. "chemical irritation" of nerve root

*** Most common causes.**

►***Clinical tip.*** *The two most common causes of radicular pain syndromes are 1) disc herniation or 2) spondylotic spurs and osteophytes. (Tanaka 1998)*

While in Lunsford's surgical series (1980), the frequency of disc herniation (34%) was lower than that of compression secondary to spurs (66%), in another series (Tanaka 1998) of 82 surgical cases the causes were more evenly distributed (disc herniation, 54%; spur, 46%). A typical herniated cervical disc is sometimes referred to as a "soft disc." Chronic disc degeneration with osteophyte formation, especially if there is hard material including portions of the vertebral end plate associated with the herniation, is sometimes called a "hard disc." (An 1998)

1. Cervical disc herniation

A herniation of the nucleosis pulposis may cause the abrupt onset of unilateral radicular pain which develops over minutes to days, sometimes with no history of neck or arm pain. The larger the volume of the herniation *relative to the size of the canal*, the more severe the nerve root compression and the more extensive the radicular symptoms are likely to be.

►***Clinical tip.*** *A provisional diagnosis of disc herniation is the first consideration in all patients with a strong radicular presentation (especially with deficits) who are under 60 years old, especially when there is not better evidence for a competing diagnosis*.

Although not necessary, the presence of any of the following would further strengthen the clinical suspicion (based on conventional wisdom and some research evidence):

- Neck pain and decreased active cervical range of motion
- Arm pain centralizes with repetitive or sustained neck positioning (AKA, McKenzie evaluation)
- Bakody's sign or positive shoulder abduction test
- Positive Valsalva maneuver (can also be positive with tumors)
- Positive cervical compression/distraction tests (may also be positive with spondylotic compression)
- Decreased biceps reflex (or other deficits)
- No evidence of significant osteophytes or spurring around the IVF on radiograph.

2. Spondylotic compression

Among the various pathologies which affect the nerve root, degenerative processes of the spine are one of the most common. Joint degeneration can cause intervertebral foramen trespass secondary to spur formation in either the Luschka or zygoapophyseal joint.

Note: In the literature, we see the following terms used essentially as synonyms: spinal osteoarthritis, spondylopathy, and degenerative disc disease. (Gorman 1997)

►***Clinical tip.*** *In older patients, consider spondylotic spur/stenosis as the first differential, especially in the absence of more compelling evidence for a competing diagnosis.*

Findings that would <u>cast doubt</u> on the diagnosis:

- Little evidence of degenerative changes on a radiograph. (Radiographic assessment is required.)
- Arm pain centralizes with repetitive or sustained neck positioning (AKA, McKenzie evaluation); this is more suggestive of a herniated or deranged disc.
- Bakody's sign or positive shoulder abduction test is more suggestive of a disc herniation.
- Positive Valsalva maneuver is more suggestive of a disc herniation or tumor.

►***Special note.*** *The format for writing a cervical disc herniation diagnosis is standardized in WSCC clinics. Consult Appendix V.*

3. Cervical stenosis

See discussion on pp. 34 and 40.

4. Direct trauma/traction to a nerve root

The nerve root can be directly injured by a single episode of traction or a pinching compression within the IVF. Whiplash injuries, especially rear-end collisions can cause radiculitis, as can any compressive force applied to the top of the head or forehead, especially if the spine is already in extension. Traumatic shoulder depression with cervical side bending in the opposite direction is more likely to injury the brachial plexus, but can cause damage to the nerve root. See stingers and burners on p. 24.

5. Nerve root adhesions/fibrosis

Scar tissue may form around the nerve root from surgery, trauma, or microtrauma. Fibrotic changes can also occur within a nerve root from mechanical disuse of the arm or neck. This diagnosis is very subtle and is often partially based on exclusion. Some of the findings that would suggest nerve root adhesions follow:

- Nerve root adhesions (NRA) tend to produce intermittent arm pain. When the pain is constant, either there is significant acute inflammation present or a different diagnosis should be considered.
- With adhesions, increased arm pain with forward cervical flexion is generally brief, *resolving rapidly after the tension is released*. This also happens at times with side bending, rotation and extension. In a patient with disc derangement or herniation, neck flexion usually aggravates the symptoms for a longer period or until extension or some other pain-relieving directional movement is introduced.
- NRA symptoms are produced at end range of nerve root stretch. (Butler 1991)
- Patients with root adhesions may exhibit deviation toward the arm pain during forward flexion of the neck. This also happens at times with extension.
- NRA usually have no significant improvement in cervical range of motion with repetitive movements, unlike a disc herniation or derangement.

►***Clinical tip.*** *Patients who experience an increase in pain from the stretching of fibrotic tissues need to be told that this pain is associated with the desired therapeutic outcome.*

6. Tumors

Although not common in the cervical spine, any tumor near the nerve root, originating from the bone or cord could cause nerve root irritation or compression. The chances of a malignancy increases with age. See red flags for disease on p. 9.

7. Fractures

Fractures of the vertebral body are rare causes of radicular damage. See p. 7 for indications for radiographs.

8. Cervical instability

Cervical instability (An 1998) is a relatively rare cause of radicular syndromes. Significant structural instability at end range (e.g., > than 3-4 mm of listhesis on flexion-extension radiographs) can cause a “dynamic” form of stenosis, compromising the IVF and irritating and intermittently compressing nerve roots. The damage may be secondary to high load trauma or, less commonly, to degeneration of the middle and lower cervical spine.

9. Infection of bone or meninges near root

Infections of the cervical disc, vertebra, or meninges are uncommon. They are usually associated with greater age (patients over 60) or immunological compromise (e.g., diabetes, chemical dependency, etc). Infections of the spine are usually associated with an elevated ESR, especially over 50 mm/hr.

10. "Chemical irritation"

It is speculated that inflammatory products from a significantly inflamed facet or degenerative products from an aging intervertebral disc may cause chemical irritation of the nerve root (a true radiculitis). Irritation signs (e.g., pain) would be more likely than neurological deficits. These diagnoses would be almost completely dependent on exclusion of any of the above diagnosis.

Clinical Issue 3B: Diagnoses for a myelopathic syndrome

For the most part, the same conditions that cause radicular syndromes can also damage the spinal cord.

►***Clinical tip.*** *Patients with a suspected radicular syndrome must be evaluated for signs and symptoms of myelopathy.*

Differential Diagnoses for a Myelopathic Syndrome

1. disc herniation*
2. spinal canal stenosis *
3. tumors
4. instability (structural)
5. neurapraxis injury
6. fracture
7. cord/menningeal adhesions/fibrosis
8. infection (of bone, disc, meninges near root)

*** Most common causes.**

1. Disc Herniation

Cervical disc herniation and spinal canal stenosis are the two most common causes of cervical cord compression. Diagnosis requires advanced imaging, usually an MRI. **Significant cord involvement is usually considered a contraindication to manipulative therapy.** For more information, see management section of this care pathway when it becomes available.

2. Spinal Canal Stenosis

Stenosis may be congenital or degenerative in nature. In the cervical spine, it usually affects the central canal (as opposed to the IVF). It may be the primary cause of radicular or cord symptoms or may instead be a local complicator, amplifying the symptoms associated with another lesion, such as a herniated cervical disc.

Cervical extension *narrows* the diameter of a stenotic canal further and shortens and *thickens* the spinal cord. With extension, because of the inclination of the plane of the facets, there is also development of retrolisthesis and further canal-diameter narrowing. (Benner 1998)

Summary of effects of spinal stenosis

Motor deficits more likely
Myelopathy more likely
Post-traumatic symptoms more likely

- **Motor deficit more likely.** A significantly smaller sagittal diameter of the bony cervical spinal canal was found in patients with motor disturbances (whether of radicular or medullary origin) than in those patients without motor disturbances. The smallest diameters were found in the group that had motor disturbances with cord compression. (DeBois 1999)

- **Myelopathy more likely.** Patients with cervical spondylotic myelopathy have a smaller sagittal diameter of the cervical spine than do patients who have cervical spondylosis without myelopathy. (DeBois 1999)

  Cervical radiculopathy is rarely associated with developmental canal stenosis (antero-posterior diameter of the spinal canal of 12mm or less). It is, however, a fundamental factor for cervical myelopathy. Only 5% of stenosis patients in one study had nerve root involvement. (Tanaka 1998)

- **Postraumatic symptoms more likely.** Petterson (1997) found that among patients with persistent symptoms from a whiplash injury, the spinal canal was significantly narrower than in the asymptomatic group. Traumatic injury and spondylotic changes have a far greater impact on the spinal cord and nerve roots if the sagittal diameter of the bony cervical canal is small. (DeBois 1999) Acute injuries such as a whiplash or a fall may initiate or exacerbate cord symptoms in a patient. (Cates 1995)

3. Tumor

See discussion on p. 33.

4. Instability

Instability at C1 due to attenuation of the transverse ligament is an important cause of instability. Causes include the following:

- Down's syndrome,
- Marfan's syndrome,
- os odontoideum,
- inflammatory diseases such as rheumatoid arthritis, sacroiliitis (ankylosing spondylitis, psoriatic arthritis, Reiter's syndrome, enteric arthritis), SLE and other auto-immune diseases.

The same traumatic and degenerative changes of the spine that can lead to a radicular syndrome may also cause myelopathy (see discussion on p. 33).

5. Cervical cord neurapraxia

Cervical cord neurapraxia is a transient (lasting several minutes to several days) disturbance in neuronal function that may be associated with motor paresis involving both arms, both legs or all four extremities after cervical cord hyperextension, hyperflexion, or axial loading. (Boockvar 2001). During hyperextension the sagittal diameter of the spinal canal is compromised by as much as 30% indentation of the ligmantum flavum and laminar ligaments. Sensory changes include burning pain, numbness, tingling, and loss of sensation. It does not seem to be related to pre-existing stenosis.

6. Fracture

Refer back to p. 33.

7. Cord adhesions

Refer back to p. 33.

8. Infection

Refer back to p. 33.

Clinical Issue 4: Identify Pain Generating Biomechanical Lesions

Regardless of the Pathoanatomical cause or whether or not there is nerve involvement, routine evaluation should include a screen for joint dysfunction (subluxation syndromes) and myofascial changes in the neck, upper extremity, and upper thoracic spine. ***Part of management will often focus on normalizing the function of these structures.***

High pay-off areas to screen for myofascial and joint dysfunction include

- the upper cervical spine (including the occiput and suboccipital muscles)
- the lower cervical spine
- the upper thoracic joints and ribs
- muscles originating from the shoulder girdle (including the SCM, the scalenes, levator scapula and upper trapezius).

Clinical Issue 5: Determine Pain Relieving Strategies

In addition to the traditional orthopedic and neurological exam and chiropractic evaluation for joint dysfunction and soft tissue problems, the patient can be taken through a number of procedures to identify loading (or unloading) strategies that may centralize the symptoms out of the extremity or offer relief of neck pain.

- In the acute phase of a radiculopathy, some patients may get relief with significant flexion, lying supine with 2-3 pillows beneath their head to maintain the neck near end range flexion. (Gifford 2001)

- The patient can be tested to see if cervical traction will relieve symptoms. (See p. 13)

- The practitioner may explore repetitive or sustained end range loading of the cervical joints in a variety of positions and directions in an attempt to centralize the symptoms. For a systematic approach, see CSPE protocol: McKenzie evaluation of the neck. This evaluation is usually done on the first or second visit.

- Caution should be exercised when exploring movements or positions that cause centralization because sometimes nerves respond in a delayed manner, especially to repetitive movements or movements that cause root compression (e.g., extension, rotation or lateral bending toward the painful side). The flare up may be later and the patient and clinician should be aware of this possibility. (Gifford 2001)

One author suggests that if all else fails, the most common method of relief for a suspected radicular syndrome may come from supporting or limiting movements of the upper extremity. (Gifford 2001)

Clinical Issue 6: Determine Phase of Injury

Acute

In the broadest sense, the acute phase of injury can be considered to be the first 6 weeks of symptoms. Conventional wisdom suggests that during this period the pathoanatomical investigation for a specific pain generator (e.g., a disc herniation in the case of radicular syndrome or a facet syndrome in the case of deep somatic referred pain) is most successful. In more chronic presentations, the analysis is sometimes more problematic. (See "chronic" below.) Any factors that suggest that the acute problem may have a longer or more complex course than usually expected should be identified. (See Yellow Flags p. 45 and Prognosis, p. 52.)

In a more narrow sense of the term "acute," there may be a period when the patient's condition appears to be very inflamed, with significant range of motion limitation or antalgia. These acute flare ups can also occur in patients with chronic presentations.

►***Clinical tip.*** *In severe cases, the patient may not be able to initially tolerate a classic orthopedic exam. Early evaluation should emphasize neurological, palpatory, and pain relief assessments. During these periods, investigation of posture, movement patterns, and other contributing factors will also have to be postponed until the patient settles back into his or her more habitual modes of sitting, standing and movement.*

Recurrent

Patients with multiple episodes of neck and arm pain may represent a disc herniation in evolution, but may also suggest the possibility of underlying instability. During acute flare ups, investigation of aberrant movement patterns, posture, and other contributing factors will have to be postponed. However, these patients are good candidates for aggressive physical rehabilitation.

Chronic

Patients with more or less continual symptoms for 2 or 3 months and longer can be classified as chronic.

Chronic cases immediately present the practitioner with four key clinical issues that will affect both evaluation and management strategies.

1. Chasing the pain generator. The practitioner will still attempt to identify the pain generating tissue and direct therapy towards it. However, the longer and more severely disabling the patient's pain has been, the less successful such a search may be. Due to central and peripheral sensitization, the patient's nervous system may be so irritable that minimally noxious stimuli or even non-noxious loading may continuously trigger the patient's symptoms. It can appear as if nearly every pain provocation test is positive or that the symptoms and tissue sensitivity migrates from office visit to office visit. Chasing the pain around the body may be a particularly frustrating exercise for both practitioner and patient. *A better strategy is outlined below.*

2. Inefficient biomechanics and weak links in the kinetic chain. Subtle inefficiencies in the patient's posture and movement patterns may create enough adverse stress and tissue load that, coupled with an overly sensitized nervous system, a continuous pain cycle is maintained. These inefficiencies can take the form of abnormal joint function (subluxations), muscle imbalances, poor movement coordination (synergistic substitution, altered movement patterns), and/or a poorly functioning deep stabilization system. Evaluation is directed toward identifying the biomechanical problems as opposed to simply finding the pain generators. Management is aimed at optimizing the mechanics and reducing the "burden" on the sensitized nervous system to below threshold levels. Consequently, these patients are excellent candidates for physical rehabilitation and functional capacity examinations. Postural and movement assessment is possible in the very first visits.

3. **Deconditioning**. These patients often have a level of deconditioning so significant that it can be seen as a separate additional problem which must be addressed in the management plan. Key muscles in the kinetic chain often have poor endurance and the patient's overall aerobic capacity is compromised to the point that the activities of daily living can have the same impact on the body as classic overuse syndromes.

4. Psychological burden. This group of patients should be carefully assessed for the "yellow flags" of biopsychosocial risk factors. They may be suffering from clinical depression, pain avoidance behavior, competing secondary gains, or other factors that can impede recovery.

See Clinical Issue 10 on p. 45.

►***Clinical tip.*** *Questionnaires such as the Cornell Medical Index may be used.*

In summary, in these cases, a functional approach to care, emphasizing restoration of joint function, appropriate muscle balance, and good motor control, may be more effective than focusing on pain reproduction as an assessment objective and immediate pain relief as a therapeutic goal. See Appendix VII.

Clinical Issue 7: Determine Severity of the Condition

The severity of the patient's condition can be assessed in the context of the global impact on the patient's ability to function as well as estimates of the seriousness of any neurological compromise.

Assessing global impact on patient

Assessment of the global impact on the patient is best done in terms of effect on activities of daily living (ADLs) and the patient's pain intensity.

Activities of daily living. ADLs can be assessed informally while taking the chief complaint history, but in cases of patients with radicular syndromes or other significant presentations, a formal questionnaire such as a Neck Disability Index (NDI) is suggested for use at WSCC.

The Neck Disability Index (NDI) can be used to establish minimal, moderate and severe impact. (See CSPE protocol: Questionnaire: How to Score the Neck Disability Index. See also the CSPE protocol on Severity.)

A DASH questionnaire can also be used to establish the affects of the condition on the patient's ability to perform tasks with their upper extremity. (See CSPE protocol: Questionnaire: How to Score the DASH.)

Pain. Pain can be quantified with a visual analogue scale or verbal pain scale. The WSCC clinics preferentially use a mechanical slide algometer (mVAS). (See CSPE protocol: mVAS). Pain drawings can also be used to gauge the degree of peripheralization of the patients symptoms into extremities.

Assessing severity of nerve root/peripheral nerve damage

Severity of neurologic damage is usually based on the type and degree of the deficit. Significant muscle weakness or atrophy would usually be thought of as severe; milder muscle weakness, absence of reflex or sensation would be considered moderate; diminished sensation or reflex would be considered mild. The following approach to assessing the severity of the radiculopathy associated with lumbar disc herniations may be useful for cervical radiculopathy as well. (Saal 1996)

- Mild loss: sensory deficit, with or without a loss of one motor grade; with typical improvement in 6-12 weeks.
- Moderate loss: absence of deep tendon reflex (DTR) with more than one grade of motor loss; typically with complete recovery within 3-6 months; gradual recovery of muscle strength over that time. (Note: a grade 0 DTR will rarely return).
- Severe loss: motor loss to a Grade 3 or below; with full recovery often taking a year, and occasionally with only partial recovery.

Assessing severity of cord damage

In the case of cervical cord compression secondary to stenosis or other degenerative changes, the following classification system can be used (Montgomery 1992). Although designed for the slower changes that usually accompany spondylotic myelopathy, it is offered here as a general guideline for cord involvement.

Disability Classification of Cervical Spondylotic Myelopathy

- Grade 0: Root signs and symptoms, no cord involvement
- Grade I: Signs of cord involvement, normal gait
- Grade II: Mild gait involvement, able to be employed
- Grade III: Gait abnormality, able to be employed
- Grade IV: Able to ambulate only with assistance
- Grade V: Chair bound or bedridden

Clinical Issue 8: Determine Need for Imaging or Neurophysiological Testing

Summary

Most cervical radiculopathies are due to either disc herniation or degenerative disease of the spine. Since most of these cases respond to conservative care, radiculopathy is not considered to be an absolute indication for imaging early in patient management.

Although plain radiographs are usually not necessary to confirm the working diagnosis, practitioners may sometimes elect to employ them* in cases when the type or application of manipulative therapy might be influenced by the presence of spurring or degree of degeneration. However, radiculopathy should be considered only a relative indication, since there is currently little evidence that initial films would have any significant effect on outcomes or side-effects.

Imaging modalities may provide useful case information in a number of specific situations.

Imaging is *strongly indicated* prior to a trial of conservative care in the following situations:

- traumatic onset: risk of associated fracture or dislocation, or risk of avulsive injury to nerve (See CSPE protocol, Imaging, acute cervical spine injury.)
- suspected associated myelopathy
- suspected infection or neoplasm
- suspected or known inflammatory syndromes which could cause structural instability (e.g., RA, AS, etc.)
- severe neurologic deficits or severe, disabling radicular pain upon initial presentation
- based on overall clinical judgment.

Imaging is indicated in the course of case management of the patient in the following scenarios (Yonenobu 2000, Wainner 2000):

- progressive neurological deficits, especially motor deficits
- failure to respond to conservative care within the first few weeks
- inadequate response to conservative care within 2-3 months
- in preparation for a possible surgical consult (if a surgical consultation is a certainty, the surgeon may wish to order the imaging modalities)

►***Clinical tip.*** *A surgical consultation is indicated if neurologic signs are worsen-ing (especially motor), or if they are posi-tively correlated with degenerative changes or disc herniation and conservative care has failed. (McClure 2000)*

*WSCC faculty disc and radiculopathy survey: 17/20 of the licensed DCs felt that x-rays should be taken. The WSCC radiology department (Drs. Harger, Taylor, Hoffman, et al.) recommended films and commented that the "minimal three views" should be performed first. The majority agreed that it is appropriate to "order obliques" in most patients imaged for cervical radiculopathy.

1. Plain Radiography

Plain film is typically the first imaging performed for patients with suspected cervical radiculopathy. It is more appropriate when degenerative changes are a suspected cause or complication than in cases of suspected disc herniation. It is also usually the first imaging choice in cases of traumatic injury. (Ahlgren 1996)

Plain radiographs may reveal the presence of osteophytes or degenerative listhesis which may be compressing nerve roots, spinal canal stenosis, or instability.

Degenerative changes: Osteophytes and spurring

In general, only a weak association exists between the presence of diffuse degenerative changes and clinical signs and symptoms. Degenerative changes are seen routinely on radiographs, especially in older patients. Cervical spondylosis is seen in 80% of patients over 55 years of age. (McClure 2000) Careful correlation must be made between radiographic changes and clinical findings. Plain film does not reflect inflammation or ligamen-tum flavum hypertrophy or buckling that may be associated with degenerative disease and which may add to compressive syndromes. (Bell 1992, McClure 2000, Wainner 2000)

- In patients with degenerative spinal disease, oblique plain radiographs may show osteophytes projecting into the intervertebral foramina. The C5-6 level is the most common site for degenerative changes in the cervical spine followed by C4-5 and C6-7. (McClure 2000)

- Beak-like osteophytes involving the uncovertebral (Luschka) joints are frequently found at asymptomatic levels. Thus, only osteophytes at the involved nerve root level or levels can be assumed to be contributing to the production of symptoms.

- An osteophyte of the superior articular process is more likely to be a compressive factor because it always grows at the entrance of or just medial to the foramen where the nerve root is most vulnerable to compression (Tanaka 1998). However, plain film radiographs cannot adequately demonstrate the orientation of the osteophyte or spurring relative to the nerve root nor will they reveal the true size of the osteophytes since the presence of cartilaginous caps cannot be detected. Furthermore, plain film does not reflect any associated inflammation or ligamentum flavum hypertrophy that may be associated with degenerative disease and which may add to compressive syndromes. (Bell 1992, McClure 2000, Wainner 2000)

- Multiple levels of degeneration have been associated with poorer response to conservative care (Saal 1996)

- Disc herniations cannot be detected by plain film radiographs. (Hubka 1997)

- Anterolisthesis or retrolisthesis associated with degenerative disease may contribute to stenosis. (McClure 2000)

Stenosis

Spinal stenosis is defined as narrowing of the anteroposterior diameter of the spinal canal at C5 to 13 mm or less. (Gorman 1997) The normal mean midline sagittal diameter of the bony cervical spinal canal is 17 ± 5 mm. The lower limit of this diameter is between 12 and 14 mm. This diameter decreases gradually from C2 to C4, and remains nearly constant from C4 to C7. (DeBois 1999)

- The diagnosis of stenosis CANNOT be made by plain films alone because the size and effect on the spinal cord itself cannot be adequately judged. Several causes of stenosis may be evaluated on plain film, but a reduced central canal diameter on plain film warrants evaluation with MRI or CT (usually with myelography). These modalities can assess the diameter of the

canal as well as the "functional reserve." (Malanga 1997)

- A sagittal diameter of 13-15 mm at C4-C7 is considered relative stenosis; 10-12 mm is often associated with neurological damage; and less than 10 mm is considered absolute stenosis. A spinal canal with an AP diameter less than 10 mm is more vulnerable to acute spinal cord injury when the spine is sufficiently hyperextended. (Clark 1998).

- Pavlov's ratio is the width of the canal (measured from posterior body to the laminar line) over the diameter of the mid-vertebral body. A ratio less than 0.82 is suggestive of stenosis. (Cates 1995) According to Yochum (1996), this method is unaffected by image magnification and is more accurate than simply measuring the sagittal diameter.

- Anterolisthesis or retrolisthesis associated with degenerative disease may contribute to stenosis. (McClure 2000)

- Central canal stenosis has been associated with poorer response to conservative care in patients with disc herniations and cervical radiculopathy. (Saal 1996)

Instability

Dynamic forces may influence symptoms. Both referred pain and a true radicular syndrome may be associated with spinal instability. Flexion-extension studies may reveal hyper-mobility at levels in which there is more than 3 mm of listhesis as compared to neutral. (Ellenberg 1994)

►***Clinical tip.*** *In cases of chronic or non-responsive whiplash, delayed instability may not be detected until dynamic films are repeated weeks or months after the injury due to initial muscle guarding.*

Beware of false (clinically meaningless) positives.

- Cervical spine degenerative changes, including osteophytes in the area of the intervertebral foramen, are quite common in asymptomatic patients. Gore demonstrated that 70% of asymptomatic women and 95% of asymptomatic men between the ages of 60 and 65 years had at least one of three degenerative changes. These included disc space narrowing, osteophyte formation, and endplate sclerosis. (Gore 1986)
- Cervical stenosis can appear radiologically at age 30; patients may never develop symptoms.
- Radiologic cervical stenosis may be seen in 75-85% of patients over 60 years old, "almost all" past 70 years old.

2. Advanced Imaging

In certain circumstances in which imaging is appropriate for evaluation of cervical radiculopathy, plain film will be followed by advanced imaging, such as MRI or CT. Preceding advanced imaging with plain film radiographs can be helpful in evaluating MRI results because MRI does not detail bone well. In cases where simple, uncomplicated disc herniation is strongly suspected, initial plain films may be omitted. The decision may ultimately depend on whether the practitioner suspects disc herniation versus DJD. The features of interest include disc herniation, bony canal stenosis, ligamentum flavum hypertrophy, and nerve root and cord effacement or compression. Soft tissues are demonstrated best by MRI; dense, cortical bone is demonstrated best by CT. The addition of myelographic contrast to CT allows the evaluation of mechanical pressure on the dura and neural structures.

The two most common choices for evaluation are MRI or CT with myelography. Evaluation of all clinical factors in conjunction with the results of plain film findings and consultation with a radiologist is recommended in order to choose the most appropriate imaging. If surgery is being strongly considered, then consultation on imaging choices with the surgeon is also recommended. (Bell 1992)

When to order advanced imaging

An algorithm for the use of MRI with cervical disc herniations or radicular pain has not been developed or tested. Practice profiles and expert opinion suggest three possible strategies from which to choose:

⇒ **"Low tolerance" threshold: radiculopathy.** Ellenberg (1996) suggests MRI should be ordered for those patients with suspected cervical radiculopathy.

⇒ **"Moderate tolerance" threshold: neurological deficits.** MRI does not have an early role in evaluating patients unless there are neurological deficits (Pettersson 1997)

⇒ **"Higher tolerance" threshold:** Advanced imaging should be ordered only in the following circumstances (Hubka 1997) :
   1) a suspicion of myelopathy,
   2) progressive neurological deficit while under care (especially motor),
   3) as part of a presurgical examination, (e.g., arm pain or neurological deficit that does not respond to conservative treatment),
   4) severe radiculopathy.

Croft's survey of 3,511 chiropractors in the U.S: 26% reported low tolerance, ordering such tests at the first indication of herniation; 67% displayed higher tolerance and would order CT or MRI only after a trial of conservative therapy had failed. 7.3% reported that they never order such tests. (Croft 1996)*

* **WSCC faculty survey:** 17/20 respondents thought that in most situations an MRI should NOT be done initially, but should be delayed until the results of a trial of therapy become apparent. WSCC radiology (Drs. Harger, Taylor, et al.) agreed with these recommendations.

2.1 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) has become the preferred imaging modality for the evaluation of disc degeneration and herniation, as well as spinal nerve, thecal sac, or spinal cord compression. (Humphreys 1998) MRI has been shown to correlate more closely with operative findings than myelography or CT. (Rodgers 1998)

MRI is the best imaging modality for visualization of the spinal cord and nerve roots. It also demonstrates the disc, ligamentum flavum, joint capsules, synovial cysts and other soft tissue structures well. It does not display osseous changes well. MRI is subject to several artifacts in the cervical region which can make small details, such as structures in the IVF, difficult to evaluate.

- **Intervertebral disc changes:** Boden (1990) and associated orthopedists differentiated a herniated nucleus pulposus from a bulge. A bulge is a diffuse, usually non-focal protrusion of a non-osseus material beyond the normal disc space. Unless it contributes to spinal stenosis, it is not likely the cause of a radicular presentation (while nerve root inflammation secondary to degenerative changes of the disc has been hypothesized, this should remain a provisional diagnosis by exclusion). A herniated nucleus pulposus is an extension, usually focal, of disc material beyond the osseus confines of the vertebral body, resulting in displacement of extradural fat, nerve root or thecal sac. (Gorman 1997) Herniated discs have been further divided into contained versus noncontained, indicating whether or not the disc material is central or peripheral to the annular fibers.

- **Beware of false (clinically meaningless) positives.** The low specificity (high false-positive rate) of MRI is underscored in one study that used a 1.5 Tesla imaging system in asymptomatic subjects.

⇒ In subjects under the age of 40, 10% were noted to have cervical disc herniations and 4% had foraminal stenosis.
⇒ In subjects over the age of 40, 8% had disc bulging or herniation and 20% had foraminal stenosis.
⇒ In subjects over the age of 40, almost 60% had evidence of disc space narrowing and degeneration, spurs, or spinal cord compression.
⇒ By age 60, 12% of individuals showed indentation of the spinal cord.

Therefore, MRI abnormalities must be correlated with information obtained from the history and physical examination before assigning clinical significance. (Rodgers 1998)

Disc lesions may or may not decrease in size with successful treatment. (Maigne 1994)

2.2 Computed Tomography

Computed tomography provides better information about osseous changes than MRI. CT may be indicated for evaluation and surgical planning when osseous degenerative changes are likely to play a considerable role in compression. (McClure 2000) CT with myelography may be most appropriate for these patients. In some patients, both MRI and CT with myelography may be performed. (Shafaie 1999, Wainner 2000) In many cases, CT provides better detail of tissues in the IVF. (Ahlgren 1996)

CT may be appropriate in the following scenarios:

- significant degenerative changes
- suspected fracture
- patient contraindications to MRI (intracranial surgical clips, metallic foreign body, etc.)
- MRI findings do not support strong clinical findings.

3. Myelography

Myelography is more useful as an adjunct to CT. Along with the superior bone imaging of CT, the contrast medium illuminates the subarachnoid space which may be indented by disc lesion, osteophytes, etc. Cord compression may be appreciated as well. However, since this procedure is more commonly done as a pre-surgical investigation, it is not often ordered by non-surgical practitioners.

4. Discography (Murphy 2000, Schellhas 1996)

- **Indications:** A discogram can be ordered when disc derangement is suspected to be the pain generator. It is considered to be more sensitive than MRI for painful discs. It is not typically used to evaluate the impact of the disc or other material on neural structures.

- **Methodology.** Contrast material is injected into the disc in an attempt to 1) reproduce the patient's symptoms and 2) detect displacement of nuclear material within or from the disc. Sometimes the procedure is followed by injection of an anesthetic to relieve the symptoms.

  Although most cervical disc morphology is abnormal and some discomfort is felt by most patients, proponents claim that there is a definite painful response that mimics symptoms in symptomatic patients that does not occur in asymptomatic patients. This is generally for sclerotogenous rather than radicular pain.

  Drawbacks: The test is expensive, uncomfortable, and controversial. It is often not very accessible to practitioners. It may have a significant number of false positives. Interpretation of the findings is highly operator dependent.

5. Neurophysiological studies

Neurophysiological studies (NPS) have frequently been used in addition to neuro-imaging in the evaluation of patients with cervical radiculopathies. (Ellenberg 1994, Wainner 2000) These studies typically include nerve conduction and electro-myographic studies.

- MRI has been shown to be more sensitive (93% MRI to 42% NPS). They have similar positive predictive values, but MRI has a higher negative predictive value (25% MRI to 7% NPS).

- Neurophysiologic studies may provide little additional information in patients with clinical and MRI evidence of cervical radiculopathy. A higher correlation between MRI and radiculopathy was seen than between NPS and cervical radiculopathy. This finding may be more remarkable in patients with severe symptoms. (Ashkan 2002)

- The routine use of NPS is not likely to provide significant patient management information. (Ashkan 2002)

NPS may be useful in the following scenarios:

- To rule out differential or concomitant diagnoses, especially peripheral neuropathies (Malanga 1997, Dillingham 2002)
- When neurologic signs are equivocal (Dillingham 2002)
- To provide further correlation with clinical findings and neuroimaging
- To evaluate the severity of neurologic changes and axonal recovery (Dillingham 2002)
- To predict surgical outcome (Better surgical outcome is seen in patients with initially positive NPS changes than in those with initially negative studies.) (Dillingham 2002, Wainner 2000)
- NPS may be useful in "double crush" cases, when clinical findings are unclear or when there is a discrepancy with imaging. (Ashkan 2002)

Cautions with NPS

- NPS studies may not add significant clinical information when clinical neurologic findings are mild. (Nardin 1999)
- The timing of NPS tests is important. Detectable NPS changes occur after 1-3 weeks of symptoms and may be negative after 3-6 months. (Malange 1997)
- NPS detects primarily ventral root compression and may be negative in cases of dorsal root compression. (Ashkan 2002) Radicular pain may originate from changes at the dorsal root ganglion.
- Patients without clinical signs of motor or reflex change may show changes on NPS. (Dillingham 2002)
- NPS studies are strongly operator dependent. (Ellenberg 1994)
- NPS studies have been shown to be less specific for the C6 nerve root. (Dillingham 2002)
- The contribution of evaluating H-reflexes and F-waves is controversial. Dillingham (2002) reports that they are typically not helpful in the evaluation of cervical radiculopathy. On the other hand, Miller et al. report H-reflexes are as sensitive and specific as MRI with sensitivity 72% and specificity 85%. They also report them as particularly helpful in patients with only one clinical sign of radiculopathy. (Miller 1999)

Clinical Issue 9: Identify Any Local "Complicators"

For the purpose of this document, local "complicators" are physical factors in or around the spine that, while not being the primary pain generators themselves, may affect either the prognosis or overall case management. These factors pre-exist the injury and may continue to be present even after the patient is returned to pre-injury status. They include degenerative joint and disc disease, spinal anomalies, instability and a relative degree of stenosis.

Degenerative Joint Disease

Spinal degeneration may be related to a case several ways.

1. It may be entirely incidental to symptom production. While symptomatic patients have a higher incidence of degenerative changes on x-ray and MRI, the cause and effect relationship in any given patient can be problematic. (Wainner 2000)

►***Clinical tip****. In most situations degenerative disc or joint disease of the cervical spine should not be cited as the patient's primary diagnosis. Rather, it can be cited as a local complicator.*

2. It may directly create radicular symptoms either by forming specific osteophytes in the IVF or by contributing to overall stenosis (see pp. 34 and 40).

3. It may create both local and referred symptoms as part of osteoarthritis or due to secondary instability which can occur in the lower cervical spine. See below.

Presentation of osteoarthritis (An 1998)

- painless stiffness with relative sparing of flexion usually indicates osteoarthritis
- may be predisposed by chronic forward head position and cervical hyperextension posture
- intermittent aggravation of aching and stiffness that often is worse with activities that involve neck movement
- symptoms may increase upon waking in the morning or at night from sleep

This temporal relationship of the pain syndrome to sleep, position of neck, and activity that exacerbates symptoms is of importance.

Other symptoms include

- **Dysphagia**. In cases of advanced degenerative disease, dysphagia may be the only aspect of neck pain noted by the patient. At times it is related to large anterior vertebral osteophytes compressing visceral structures in the anterior neck. (An 1998)
- **Pupillary signs** due to irritation of cervical sympathetics, intermittent blurring of vision, or retro-ocular pain may be present.
- **Ear symptoms** (such as tinnitus) may be relieved by cervical traction.
- **Facial pain, jaw pain** may be present.
- **Vertigo** may be due to cervical proprioceptor and/or irritation of the autonomic nervous system.
- **Pseudoangina** may occur due to pain referral from autonomic nervous system irritation. (Brodsky 1985)

Clinical Issue 10: Identify Yellow Flags for Psychosocial Issues or Other Predictors of Chronicity

Summary of Yellow Flags

1. Psychological factors
2. Worker's compensation issues
3. Litigation
4. Job environment
5. Education
6. Cervical nonorganic signs

The practitioner should be aware of any "yellow flags" indicating psychological or social factors that may affect treatment and prognosis. They may indicate 1) significant psychological distress and abnormal illness behavior (either with or without a clinically significant underlying physical pathology or dysfunction), 2) the possibility of a poorer treatment response, and 3) a change in emphasis in treatment approach (see Appendix VII).

Evaluation may be based on initial history, certain "nonorganic" signs displayed during the physical exam, or a trend of behavior during therapy.

The following conclusions are based on a review of the literature on back pain in general. Most of the research in this area has focused on low back pain, although a review by Bongers (based on 15 studies reporting on neck pain, 5 of which were prospective) found that the psychosocial influences on back, neck, and musculoskeletal pain appear to be surprisingly similar. Linton (2000) concluded a review of the literature with "there is strong evidence that psychosocial variables are strongly linked to the transition from acute to chronic pain and disability (level A evidence)."*

Linton further stated "there is strong evidence that psychosocial variables generally have more impact than biomedical or biomechanical factors on back pain and disability." This evidence was also "level A evidence."*

1. Psychological factors

Burton's study (1995) suggests that "psychological status of the patient at the time of presentation has a much stronger influence on outcome than does conventional clinical information." Turk's review also concluded that "Psychological factors are better predictors of chronicity than are clinical or physical factors."

The following are some of the factors that have been shown to have a strong correlation with more difficult and chronic cases.

1.1. Catastrophizing. This is a mental attitude whereby patients think the worst about their situation (e.g., they will never be able to work again), consistently misinterpreting bodily symptoms in the most negative light. Catastrophizing is strongly related to pain and disability (level A evidence)* (Linton 2000). In one study, catastrophizing was seven times more useful in predicting outcomes than the most predictive history or physical examination findings. (Burton 1995)

1.2. Fear avoidance behaviors. Some patients believe that their pain is so harmful or damaging that they consequently develop guarding and fear of movement. It can be associated with the belief that all pain must be abolished before attempting to return to work or normal activity. Linton's review (2000) states that "there is strong evidence that attitudes, cognitions, and fear-avoidance beliefs are strongly related to the development of pain and disability (level A evidence)."* In one study, fear avoidance behaviors were the best predictors of pain and disability at 12 months. (Klenerman 1995) In a population-based study on low back pain, the presence of kinesophobia was positively correlated with future pain and disability. (Picavet 2002)

1.3. Depression and anxiety. There is strong evidence that depression, anxiety, distress, and related emotions are strongly related to pain and disability (level A evidence)* (Linton 2000). However, there is no support for a "pain prone" personality as such. (Linton 2000)

1.4. Self-perception of poor health. There is evidence that poor self-perceived health is moderately related to chronic pain and disability (level A evidence)* (Linton 2000)

1.5. Sexual abuse. "There is limited evidence that sexual and/or physical abuse may be related to chronic pain and disability." (Linton 2000) There is some evidence that sexual or physical abuse is related to the development of more pronounced or chronic problems in women. This has not been clearly demonstrated in men. (Linton 2000)

1.6. Other factors. Other factors that interact and should be considered include substance abuse, perceived stress, coping resources, and social support. (Turk 1997)

2. Worker's compensation issues

There are many socioeconomic factors associated with worker's compensation cases such as work demands, work environment,

* Level A evidence was based on support from a meta-analysis or systematic review of good quality of two or more studies.

availability of modified work, income, job security, advancement and career potential, pension, natural job attrition, job availability, and compensation. To what extent any of these factors affect clinical outcomes or management is debated.

Researchers can arrive at strikingly different conclusions. Some studies and experts contend that there is no clinical difference between those patients who are receiving compensation and those who are not. At the other end of the spectrum, some medical legal experts imply that, in fact, many claimants are malingerers. One problem is that studies examining the influence of compensation on chronic back pain and recovery are generally poorly designed and often compare groups of patients that lack sufficient similarities to be included in the same study. Compensated patients usually have other confounding characteristics such as heavier physical jobs, lower social class and less education. Research bias may account for the tendency of economists to play down the role of psycho-social factors in their studies and health care providers to overlook economic issues.

According to Waddell's review of the literature (mostly low back), the outcomes for conservative treatment, back surgery, and chronic pain rehabilitation programs are consistently poorer in compensated patients. There is, however, conflicting evidence on the magnitude of the effect, with estimates ranging from 0-30%.

Although the specific amount of compensation probably has only a small effect on the time-table in which patients return to work, other related socioeconomic issues may have greater influence. An injured worker may experience a secondary gain from being off the job. A secondary gain is an economic, physical, or emotional "reward" which results from an injury or illness.

However, it is important to remember that secondary gains are often counter-balanced by secondary losses which include loss of the social benefits of working, financial or social status, and the change from a working role to a sick role. The majority of injured workers receiving compensation (75-95%) do recover and return to work rapidly. True malingering, that is, complete fabrication of symptoms, is thought to be extremely rare.

3. Litigation

It is often assumed that litigation has a negative impact on patient response to care. While a number of studies have attempted to determine the effects of litigation on treatment and/or prognosis, they have not satisfactorily controlled for variables. They have tended to overlook what may be significant differences in the type of accident, claim, insurance, work, severity, disability or patient that result in some cases being litigated and others not. Waddell (2000) performed a literature search and reviewed 14 studies which he judged to be the best designed of the pool. Only four studies dealt with neck pain specifically. The majority of these studies show no impact of litigation on outcomes. (A chart listing the studies he reviewed is in Appendix VIII.) Ultimately, however, there is insufficient evidence to assess whether, or to what extent, litigation may be associated with any differences in clinical outcomes, disability, or return to work.

4. Job environment

There is a relationship between pain and job demands, job control, monotonous work, perceived workload, and work under time pressure. Lack of social support can also be a factor. (Bonger 1993)

Poor satisfaction with social relationships at work were risk factors for pain and physical findings (including neck pain) For blue collar workers, additional factors include work content, work control, and "mental overstrain." Physical load was not identified as a risk factor or predictor of chronicity. (Linton 2000)

5. Education

Waddell (2000) reports that most of the evidence on strictly social influences is of low scientific quality, is cross-sectional, and demonstrates only associations, rather than necessarily causal relationships. Most of the

evidence is for low back pain, with much less research on neck pain, although in principle the findings are likely to be similar.

Some studies have found a correlation between lower education attainment (less than 13 years of school) and poorer treatment outcomes. The correlation, however, rarely remains when other factors are controlled for such as the amount of heavy work, control over the work environment, income, etc.

Although not all studies are in agreement, most do suggest that lower educational attainment (less than 13 years of schooling) is related to poorer outcomes, including increased disability or poorer response to rehabilitation. Possible explanations include occupational factors (e.g., greater likelihood of heavy work, work stress, work injury), psychological factors, or poorer health access. (Waddell 2000)

6. Cervical nonorganic signs

The presence of nonorganic signs or symptoms can suggest 1) significant psychological distress and abnormal illness behavior (either with or without a clinically significant underlying physical pathology or dysfunction), 2) the possibility of a poorer treatment response, and 3) a change in emphasis in treatment approach.

The following signs and symptoms are reported to have acceptable reliability (an average of 84.6% inter-examiner agreement in one study). The validity has not yet been established but is speculated to be similar to the nonorganic signs for the low back (Waddel's signs). (Sobel 2000)

The presence of only one or two of these *non*organic signs can be consistent with some organic diseases* or biomechanical dysfunction and further investigation may be warranted. It is believed that, parallel to Waddel's signs in low back pain patients, three or more signs are considered necessary to draw a clinical conclusion about abnormal illness behavior. The presence of nonorganic signs, on their own, should not be misinterpreted as faking or malingering, or used as a justification to refuse adequate or appropriate treatment**.** (Main 1998) However, relative to prognosis, Gaines (1999) observed that the presence of *even one* of Waddel's signs in patients with low back pain correlated with a fourfold increase in return to work delay, and this may be true for these signs as well.

There are 7 nonorganic signs and symptoms:

1. The patient complains of pain with superficial palpation of the cervical or upper thoracic region.

2. The patient complains of widespread tenderness to deep palpation outside of the cervical and upper thoracic region.

3. The standing patient complains of neck pain when his/her whole torso is rotated from the pelvis (the practitioner must be sure that no rotation occurs at the neck or shoulders).

4. The patient has a decrease of 50% in active cervical rotation to both the right and the left.

5. The patient reports diminished response to sensory testing in a pattern not consistent with a nerve root or peripheral nerve.

6. The patient responds to manual muscle testing with nonanatomical weakness, especially with sudden "give-way weakness" or demonstrates weakness during formal muscle testing but normal strength during informal observation.

7. The patient displays over-reaction during the examination, characterized by any of the following: movements that are moderately or extremely stiff, rigid or slow; rubbing, clutching, grasping, or squeezing the affected area for more than 3 seconds; grimacing due to pain; sighing.

*Individual nonorganic findings could be accounted for by a true organic disease processes. Organic diseases are usually associated with a pathoanatomical lesion, such as infection, inflammatory disorders, cancers, degenerative disorders etc. For example, superficial or widespread sensitivity could be due to combined regional disease (see p 27) or primary fibromyalgia; significant symmetrical decrease in cervical rotation may be secondary to advanced cervical degeneration.

Clinical Issue 11: Identify Contributing or Sustaining Factors

This step often must wait for subsequent visits when patients are not suffering an acute flare up of their condition.

Summary

Posture (standing and seated)
Upper (proximal) cross syndrome
Functional instability

Posture

Posture should be evaluated with the patient standing and after the patient has been sitting for a while and assumes a habitual body attitude.

Optimally, the patient's ear should be in a vertical line with the glenohumeral joint and lateral malleolus. Forward head carriage can be associated with sustained postural end range loads on the discs and the motion units. Janda speculated that the upper cervical spine sustains an extension load and the cervicothoracic junction or T4-T5 area of the spine is loaded in flexion. There is also stress placed at the C5-C6 motion unit. McKenzie also suggests that this type of posture should be corrected. Forward head carriage can be associated with cervicogenic headache, the upper cross syndrome (see below), thoracic outlet syndrome (see p. 24), and T4 syndrome.

Upper Cross Syndrome

This pattern of muscle imbalance is thought to contribute to a variety of neck and shoulder conditions by creating abnormal loads across joints, inefficient movement patterns and postures (such as forward head carriage), and tension in muscles resulting in myofascial pain syndromes. (Janda 1988)

The following muscles may be involved in the upper cross syndrome. (Liebenson 1996)

- Overactive neck extensors (including upper traps, levator scapulae and suboccipital muscles)
- Inhibited/weak deep flexors (including longus capitus, longus colli and scalene muscles)
- Overactive pectoralis
- Inhibited/weak middle and lower trapezius
- Sometimes overactive SCMs

For more information on assessing this muscle imbalance, see the Management section of this care pathway when it becomes available.

Functional instability

Stability of the cervical spine, especially in the neutral zone (i.e., stability in joint positions that are not loaded at end range) is dependent on adequate proprioceptive function, good muscle integrity, and appropriate motor control.

Although solid clinical research is still wanting, a reasonable *clinical strategy* would be to anticipate that patients with a history of recurrent or chronic neck pain may be suffering from underlying functional instability.

Winters & Peles (1990) found that when only the large muscles of the neck contracted (as simulated in a computer model) regions of local segmental instability resulted. Deep muscle activity was required to stiffen or stabilize the segments in functional mid ranges. Because of the normal lordotic cervical curve, contraction of the larger posterior muscles creates a tendency towards buckling of the spine. (Jull 2000)

The deeper muscles including longus capitus and longus colli are continuously active, further suggesting their importance in a postural and stabilizing role. The stabilizing role of these deep muscles has also been confirmed by Vitti (1973) and Mayoux-Benhamou (1994).

Poor endurance, motor control, and contraction speed can be assessed by performing the cervical instability test (Jull test), along with its variations, and the neck flexion movement pattern. See below.

- **Cervical instability test (Jull test).** With the patient supine, passively retract the patient's chin and raise the head slightly off the table (approximately 1 or 2 cms). The patient should be able to hold this position for 10 seconds without chin poking, excessive head shaking, global flexion or extension. Failure indicates overall poor functional stability of the cervical spine, inhibited deep flexors, and perhaps overactive SCMs. (Murphy 2000)

  A variation of this test can be used to qualitatively evaluate the speed of contraction of the deep neck flexors. This test is only performed when the flexors demonstrate good strength and any acute injury has had time to heal. The practitioner raises and positions the patient's head as described in the cervical stability test above. In this variation, the patient is warned that his/her head will be suddenly released in the next few moments, but that meanwhile he/she should allow the neck to remain relaxed and supported by the practitioner. The head is then released suddenly and rapidly. The practitioner observes how quickly and accurately the patient can recover the starting head position. Excessive overshooting, slow response, or inability to return to roughly the same starting point indicates poor control and speed of contraction.

- **Using a blood pressure cuff.** An inflatable air filled pressure sensor (Stabilizer, Chattanooga South Pacific), positioned suboccipitally behind the neck is used as a biofeedback device.

  This procedure tests the holding capacity of the deep neck flexors. The head is in a neutral position and the pressure sensor is placed suboccipitally behind the neck and inflated to 20 mmHg. The patient is instructed to very slowly flex the upper cervical spine with gentle nodding action and hold the position steady for 10 seconds. This should occur with minimal activity in the superficial muscles. An ideal response is that the patient can increase pressure by 10mmHg. Most neck pain patients' initial performance is an increase of 2-4 mmHg and they demonstrate an inability to hold the position steady. (Jull 1997)

Neck flexion movement pattern

The patient is asked to slowly raise his or her head from the table. If the deep neck flexors (scalenes, longus colli) are weak or inhibited and the SCMs are overactive, the chin will poke forward at the beginning of the movement (first 10 degrees). Slight finger tip resistance on the forehead may be used to emphasize the abnormal pattern. (Janda 2002)

Clinical Issue 12: Set Outcome Measures

The following are examples of common symptoms and methods for measuring symptom improvement.

►***Clinical tip****. It is helpful to utilize outcome measures for <u>all three goals</u> whenever possible. The most useful is generally considered to be monitoring effects on activities of daily living, work or recreation.*

GOAL: Decrease effect of neck problem on ADL's/ work/ recreation

- Use Neck Disability Index (NDI) (available in clinics).
- Use DASH questionnaire to assess activities using the upper extremity (available in clinics).
- Have patient report pain severity (mVAS) <u>while performing a specific activity.</u>

- Have patients report their ability (measured by frequency or duration) to perform a specific activity.
- Observe repetitions of a specific activity which is/was aggravating for the patient (tracking number of repetitions/degree of pain/quality of movement).

GOAL: Symptom relief

DECREASE pain

- Measure with VAS or m-VAS (required in clinics, see CSPE protocol).
- Use verbal numerical pain rating scale (NRS: 0-10).
- Track use of analgesics (dosage and frequency).
- Use McGill pain questionnaire.

DECREASE TERRITORY of pain

- Track pain centralization (patient report or pain diagram).

DECREASE DURATION OF SYMPTOMS

- Monitor percentage of the day that the patient is symptomatic (by patient recall or diary).
- Monitor length and/or the number of symptom-free periods (by patient recall or diary).

DECREASE RECURRENCE RATE of symptoms or RECURRENCE RATE of peak intensity

- Monitor frequency, duration of episodes/peak intensity (by patient recall or diary).
- Monitor length, number of symptom-free periods (by patient recall or diary).

GOAL: Improve physiologic measurements

IMPROVE cervical AROM

- Use inclinometer or visual estimate.

Note: the following are the ranges of motion most likely associated with activities of daily living (Bennett 2002) :

⇒ backing up a car requires an average of 67.6 degrees of rotation;

⇒ tying shoes requires an average of 66.7 degrees of combined flexion and extension;

⇒ washing hair in the shower requires an average of 42.9 flexion-extension.

See Appendix IX.

IMPROVE DEEP FLEXOR STRENGTH

- The neck flexion test (Janda) can be used to assess endurance or speed of contraction; can be used with blood pressure cuff.
- Use the cervical instability test (Jull test) (hold for 4-10 seconds)

IMPROVE STRENGTH/ENDURANCE OF LARGE TORQUE PRODUCERS.

See Appendix X.

IMPROVE GRIP STRENGTH

- Use Jamar dynamometer (see CSPE protocol).
- Monitor number of grip repetitions of a standardized object (e.g., squeezing a balloon filled with flour, a hand ball, etc.).

INCREASE DEEP FLEXOR CONTRACTION SPEED

- Perform Jull test with quick release (pass/fail).
- Observe response to wobble board push (pass/fail based on being able to maintain a chin tuck).

Clinical Issue 13: Establish a Prognosis

The prognosis for patients with uncomplicated mechanical neck pain or neck pain with deep referred arm pain is generally considered be good.

Hansen (1994) suggests that the presence of any of the following findings may increase recovery time by 1.5 to 2 times: preconsultation duration of symptoms greater than 8 days, severe pain, more than four episodes, pre-existing structural or pathologic conditions.

Significant yellow flags may also adversely affect recovery time. See Clinical Issue 10, Identify yellow flags, p. 45.

Cervical Radiculopathy

Most studies reporting prognosis of cervical radiculopathy are limited by significant methodological shortcomings. However, the general sense is that the natural history of cervical radiculopathy is favorable for patients who undergo nonoperative treatment. (Wainner 2000)

Two large epidemiological studies suggest that the majority of patients (up to 90% in one study) will improve with conservative treatment. (Radhakrishnan 1994, Sampath 1999)

Severity of neurological deficit, age, and duration of symptoms may have some prognostic value. (Wainner 2000)

One large randomized controlled trial of 468 patients showed that the following factors tended to suggest a poorer outcome at six months: history of episodic occurrences for more than 5 years, more than 3 cervical radicular episodes, bilateral paresthesia, women over the age of 50, and symptoms that were worse than those of the controls at the time of presentation. However, again due to methodological flaws, validity of the conclusions is unknown. (British Association of Physical Medicine 1966)

"Typically, the worst period is the first one to three weeks, but may be as long as 4-5 weeks" and usually improves with longer symptom-free periods and the gradual return to normal activities. (Gifford 2001)

Authors such as Gifford and Croft suggest that the complete course may take 3 months or longer. (Gifford 200, Conley 1994) Some patients become chronic pain sufferers.

Disc herniation

Cervical disc regression in patients with radiculopathy appears to be common. (Maigne 1994, Sampath 1999). In one study 40% of patients with cervical disc herniation experienced regression of discal material (Mochida 1998). Bush (1997) prospectively evaluated 13 patients with MRI evidence of a posterolateral disc herniation associated with radicular symptoms and positive neurological signs. At one year follow-up, all patients had "satisfactory" recovery. Repeat MRI demonstrated disc regression in 12 of 13 patients at an average of 12 months following nonsurgical treatment. This suggests that disc regression by one year is typical. Symptoms may also improve even without disc regression. (Maigne 1994)

- Central canal stenosis has been associated with poorer response to conservative care in patients with disc herniations and cervical radiculopathy. (Saal 1996)
- Saal (1996) in a longitudinal cohort study followed 26 patients with disc herniations and cervical radiculopathy, who were treated nonsurgically. No patients had concomitant myelopathy and most had neurologic losses. Twenty had "good to excellent" outcomes with conservative care.Outcomes were slightly better for noncontained versus contained HNP. **Myelopathy associated with disc herniation.**

Myelopathy secondary to cervical disc herniation may also have an overall favorable prognosis for a slight majority of patients, at least in mild forms of the condition. In Matsumoto's series of 17 patients with mild cord symptoms who could walk on flat ground without the aid of a cane, 10 of the patients had symptom improvement and spontaneous regression of the herniated mass at an average of nine months. More diffuse herniations with a broader base were more likely to resorb than smaller focal lesions. Patient's with disc herniations that were more likely to avoid surgery were those that had a more lateral orientation. (Matsumoto 2001)

Myelopathy associated with stenosis

Roberts studied 24 patients with cervical myelopathy for up to 6.5 years and found that approximately a third improved, a third remained the same, and a third deteriorated. Motor symptoms tended to be much more progressive and less likely to improve than sensory abnormalities. (Benner 1998)

Dillin (1992) suggests that the likelihood of clinical improvement is better for disease that presents with signs and symptoms of less than one year.

In one study, the most useful indicators for poor prognosis for this condition were the following (Benner 1998):

- duration of symptoms for longer than 6 months at time of presentation,
- a vertebral canal/body ratio less than 0.8,
- a cord compression ratio after surgery that remains below 0.4. This measure is obtained easily from axial slices on contrast computed tomography or MRI and is derived by dividing the smallest anteroposterior diameter of the outlined cord by its maximum transverse diameter.

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APPENDIX I: Erythrocyte Sedimentation Rate (ESR)

"The relative sensitivity of the ESR suggests that it might be useful as a screening test, as long as its poor specificity is acknowledged, that is, most patients with underlying infection or malignancy will have an abnormal ESR, although the majority of elevated ESRs will not be found to result from these conditions." (Deyo 1991)

ESR DECISION MAKING (for patients under 50 years old)

- ***ESR BELOW 20,*** *contributes to a decision supporting a trial of conservative care*
- ***ESR ABOVE 50,*** *seek significant underlying disease process*
- ***ESR 20-50****, check for red flags / consider trending results*

ESR increases over the age of 50. "As a rough guide, the ESR in men should be half of the patient's age and in women, half of the patient's age plus 10." (Sacher)

Disease such as multiple myeloma and polymylagia rheumatica can cause ESR levels above 100.

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APPENDIX II: Upper Limb Tension Test (ULTT)

This tension test is sometimes referred to as ULTT 1 or ULLT- median nerve.

With the patient supine, the practitioner rests the symptomatic arm against his/her thigh to provide support and control, and then takes it through a series of passive movements, progressively increasing the tension on the neurological contents of the neck and upper extremity.

- ⇒ First, the shoulder is stabilized to prevent hiking and the arm is abducted to about 90 degrees with the elbow flexed to about 80 degrees.
- ⇒ Next the forearm is supinated (so the patient's palm is facing outwards) while the wrist and fingers are passively extended.
- ⇒ Still maintaining this tension, the practitioner next externally rotates the patient's shoulder until there is pain or increased tissue resistance is felt.
- ⇒ Then the elbow is slowly extended which adds further tension on the neurological tissue.
- ⇒ Finally the neck is laterally flexed away and then toward the symptomatic side.

Final position

A positive test is considered to be any of the following:

1) symptom reproduction,
2) >10% reduction of elbow extension compared to the asymptomatic side, or
3) symptoms aggravated by contralateral side flexion of the neck and improved by ipsilateral side flexion.

In one preliminary study of patients with mild to moderate radicular syndromes based on EMG findings, a negative test was very useful in helping to rule out a C6-C7 radicular diagnosis (97% sensitivity and an LR- 0.12). A positive test is not very specific (22% specificity). (Wainner 2003).

APPENDIX III: Nerve Root Chart

Lesions (modified after Rodgers 1998 and Slipman 1998)

Root	Pain*	Sensory	Motor	Reflex
C1	Retro-orbital and frontal	No dermatome	Cervical flexion, cervical extension	None
C2	Medial suboccipital to vertex	Medial suboccipital to vertex	Cervical flexion, cervical extension	None
C3	Periauricular; pinna; jaw; upper neck	Periauricular, pinna, jaw, upper neck	Cervical lateral flexion	None
C4	Postero- & antero-lateral neck; posterior shoulder	Base of neck, shoulder	Scapular elevation	None
C5 (C4-C5 disc)	Posterior neck & shoulder; peri-clavicular	Lateral arm	Shoulder abduction, external rotation, elbow flexion	Biceps Brachioradialis
C6 most common (C5-C6 disc)	Shoulder; postero-lateral arm; ventroradial fore-arm; dorsal thumb	Lateral forearm, thumb, index finger, radial side 3rd finger	Elbow flexion, forearm supination, radial wrist extension	Brachioradialis, Biceps, Pronator teres
C7 2nd most common (C6-C7 disc)	Post. neck & shoulder; postero-lateral arm; dorsal forearm, hand (radial), middle & index finger	Dorsal hand/forearm, second, third and fourth digits	Elbow/wrist/finger extension, wrist flexion, pronation	Triceps
C8 (C7-T1 disc)	Post. shoulder; postero medial arm, dorsal (ulnar) forearm, dorsal 5th finger	Fourth and fifth digits Medial forearm	Finger flexion, finger abduction, thumb opposition	Finger flexors

*Not considered a very reliable indicator of nerve root level.

APPENDIX IV: Single Leg Stand

The patient is asked to stand on one leg and is timed with eyes opened and with eyes closed. The patient gets one practice trial.

Balance can be compared to normative tables. (Below from Bly, 1992)

AGE (years)	EYES OPEN (seconds)	EYES CLOSED (seconds)
20-59 29-30		21-28.8
60-69 22.5		10
70-79 14.2		4.3

Charting
Document patient compliance and timed ability to stand on one leg in static balance.

Reliability and Validity
Good interrater reliability but low on test retest based upon time.

Follow-up Testing
To rule out basic balance problems, Romberg, tandem Romberg, for coordination problems finger to nose test.

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APPENDIX V: Charting Cervical Disc Herniation in WSCC Clinics

(adapted from CSPE Lumbar Disc pathway, revised 1/31/06)

Please chart cervical disc herniations exactly as described on this page.

RADICULITIS

"Probable/Presumed herniated C5-6 disc *[name level by citing the vertebra above and below]* **with C6 radiculitis** *[name involved roots]* **to left lateral hand."**

Use "*radiculitis"* in cases with no neurological deficits but only irritation signs (e.g., dermatomal pain or dermatomal hyperesthesia or paresthesia, arm symptoms aggravated or relieved by orthopedic tests, subjective numbness or weakness).

Use **probable** when the diagnosis is based on history and physical exam (clinical grounds). Use **presumed** when clinical findings are confirmed by advanced imaging findings (MRI, CT, myelography).

Indicate the greatest distance the patient's subjective symptoms extend (pain or paresthesia, or reported numbness).

RADICULOPATHY with SOFT NEUROLOGICAL SIGNS

"Probable/Presumed herniated C7-T1 disc *[name level by citing the vertebra above and below]* **with C8 radiculopathy** *[name involved roots, e.g., c8]* **into right posterior forearm and soft neurologic signs."**

Use *"radiculopathy with soft neurologic signs"* in cases with soft neurologic deficits (hypoesthesia, mild muscle weakness, and/or diminished reflexes).

RADICULOPATHY with FIRM/HARD NEUROLOGICAL SIGNS

"Probable/Presumed herniated C4-C5 disc with C5 radiculopathy into left lateral arm and firm neurologic signs."

Use this in cases of significant motor weakness (grade 3 or worse), significant muscle atrophy, severe intractable pain and/or documented nerve damage (e.g., positive nerve conduction study).

MYELOPATHY

"… with myelopathy"

Add this to the "probable" when the diagnosis of cord involvement is based on clinical grounds alone. Add this to the "presumed" diagnosis based on agreement with advanced imaging.

5 steps to standardizing diagnosis: *step one*—decide root level and likely disc level; *step two*—if there are no deficits call it radiculitis, if there are deficits call it radiculopathy; *step three*—decide whether the neurological signs should be categorized as "soft" or "firm"; *step four*-- indicate the greatest distance the patient reports pain, paresthesia or numbness from the history (include side of body and surface area or part of hand); *step five*-- if there is advanced imaging evidence, call the diagnosis "presumed," otherwise call it "probable." Note: A *confirmed* diagnosis would be based on clinical findings confirmed at surgery.

Appendix VI: Treatment for Thoracic Outlet Syndromes

- Increase mobility of tissues around the thoracic outlet
  - ✓ Adjust the cervical and thoracic spine, ribs, acromioclaviclar and sternoclavicular joints as needed.
  - ✓ Apply therapeutic stretch, post-isometric relaxation, or myofascial release techniques to the scalene, pectoralis, levator scapulae, and suboccipital muscles as needed. *

- Passive modality options.
  - ✓ Consider preceding soft tissue therapy with ultrasound or moist heat. (Sucher)
  - ✓ Consider TENS for pain management. (Liebensen)

- Correct postural alignment.
  - ✓ Correct forward head carriage.
  - ✓ Correct rounded/drooping shoulders.
  - ✓ Correct the upper (AKA, proximal) cross syndrome.

- Avoid postural triggers/activity modification.
  - ✓ Adapt job, sport or environment to decrease the risky posture.
  - ✓ Find alternate ways to carry packs, bags.
  - ✓ Assess need for proper bra support and width of bra straps.
  - ✓ Consider avoiding long bike rides, swimming, long periods of driving.

- Develop endurance to maintain posture.
  - ✓ Activate and strengthen middle and lower trapezius, shoulder external rotator, thoracic extensor, and deep cervical flexor muscles.

- Train diaphragmatic breathing.

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* Sucher recommends a very aggressive self-stretching program requiring a few minutes of stretching 5-10 times every day for 2-4 days. The stretch is held for 15-30 seconds and is vigorous enough to cause local discomfort even with extremity symptoms, but this aggravation of symptoms should subside within seconds or minutes after the stretching. The stretching can then be reduced to 1-2 times per day.

Appendix VII: Treatment Approach for Patients with Yellow Flags or Nonorganic Signs

In cases where yellow flags or nonorganic signs are present, the practitioner should consider emphasizing the following strategies:

1) Unless the prognosis is unfavorable, stress the positive expectation that the individual will return to work and normal activity.

2) Monitor improvements in function rather than frequent pain monitoring.

3) Focus the patient on self-responsibility and self-management. Encourage the patient to recognize, from the earliest point, that pain can be controlled and managed so that a normal, active or working life can be maintained. Provide encouragement for all “well” behaviors-- including pain-relieving postures and alternative ways of performing tasks.

4) Emphasize active care over passive care. Once the patient is out of any acute phase, emphasize that the discomfort associated with active care does not necessarily equal harm to the body. Note: this message may need to be communicated a number of times over many visits before the patient gains the insight that activity can be safe and is very important for recovery.

5) Focus on short term goals and achievements (e.g., step by step progression through an exercise track or incremental improvement in performing a particular activity in daily living).

6) Working with the patient, examine the patient's life situation identifying barriers to treatment and/or adherence to active care. Help the patient find concrete, effective and realistic ways to overcome these barriers. Examples may include brainstorming about how to fit exercises into a hectic life schedule (chin retractions can be done in a car at red lights); communicating with an employer who is resistant to a needed ergonomic change; or encourage the inclusion of family members in a report of findings to support a patient in exercising or performing physical activities.

7) For patient’s who are on sick leave, it may be of particular importance to try to arrange early return to work, sometimes with modified duties. To facilitate this consider contacting, as appropriate to the case, the “Return to Work Specialist” at the worker’s compensation insurance company or, with the patient's permission, the human resources department of the employer, the employer personally, or the attorney in a personal injury case.

8) Passive care may need to be moderated. In some cases, less intensity in application (e.g., force of thrust, electro- modality setting), less frequency of passive treatments, and overall lower dosage may lead to better response.

9) Consider referral for counseling and/or psychological evaluation.

Appendix VIII: Studies of Effects of Litigation

This chart is based on 14 studies chosen and summarized by Waddell (2000) with data specifically about litigation. Four studies were on neck injuries, 5 on low back pain and 5 were general injuries. Also cited is a literature review by Mendelson.

Authors	# Subjects	Area of Injury	Effect of litigation
Gallagher 169		Low back pain	No Effect
Gore & Sepic	Waddell did not cite	Neck No	Effect
Guest & Drummond	Waddell did not cite	Waddell did not cite	Unclear from Waddell if study dealt with compensation vs litigation or controlled for severity
Hohl 146		Neck	No Effect
Mayou et al	Waddell did not cite	Auto injury	No Effect
Mendelson 80	47 litigation 33 controls	Low back pain	No Effect
Mendelson	Review of other studies	Waddell did not cite	No miraculous cures after litigation resolved
Norris & Watt	Waddell did not cite	Neck	More serious injuries more likely to sue and poorer prognosis
Peck et al	208 105 litigation 103 controls	General injuries	No Effect
Sanderson Waddell did not cite		Back Pain	No significant effect
Schutt & Dohan	67 Neck		No Effect
Solomon & Tunks	127 80 litigation 47 controls	General pain mostly spinal	No effect on outcome but greater likelihood of depression
Tait, et al	201 49 litigation 152 controls	Back Pain	Increased pain and disability
Talo 60		Chronic Pain	No statistical effect
Trief & Stein	81	Low back pain	Decreased response with “behavioural measures” and resolution of psychological distress

Chart created by Karen Petzing, DC

Appendix VIII: Studies of Effects of Litigation (continued)

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Appendix IX: Cervical range of motion for functional tasks

Task	Side Bending	Rotation	Flexion/extension
Pouring from pitcher	5.7	11.5	18.3
Glass to mouth	1.5	7.4	6.5
Cutting w/knife and fork	2.9	9.0	15.7
Holding telephone	8.6	9.3	5.1
Reading newspaper	2.2	11.4	19.9
Writing at table	9.6	16.5	26.2
Tying shoes	3.0	26.3	66.7
Rising from chair	4.2	11.8	16.1
Opening a door	3.4	11.1	7.9
Reaching for objects overhead	1.6	4.3	4.3

Values are mean degrees of motion. Data is based on 28 healthy subjects.

J Spinal Disord & Techniques, Vol. 15, No. 4, 2002

Appendix X: Outcome Measures for Strength/Endurance of Cervical Muscles

Neck Strength. In athletes, neck strength should be approximately 30% of body weight to decrease chance of injury.

Functional Strength Testing of the Cervical Spine

Test	Results	Interpretation
Supine neck flexion (lift head keeping chin tucked in)	6 to 8 repetitions 3 to 5 repetitions 1 to 2 repetitions 0 repetitions	functional fair poor non-functional
Prone neck extension (lift head backward)	Hold 20 to 25 seconds Hold 10 to 19 seconds Hold 1 to 9 seconds Hold 0 seconds	functional fair poor non-functional
Side lying neck lateral flexion (pillows under head so head is flexed; lift head sideways away from pillow)	Hold 20 to 25 seconds Hold 10 to 19 seconds Hold 1 to 9 seconds Hold 0 seconds	functional fair poor non-functional
Side lying neck rotation (lift head off bed, rotate to one side)	Hold 20 to 25 seconds Hold 10 to 19 seconds Hold 1 to 9 seconds Hold 0 seconds	functional fair poor non-functional

Time and repetitions will decrease in older patients.

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