Cervical Spine:
Physical Rehabilitation Program

There is no commonly agreed upon, evidence-based, standardized approach to physical rehabilitation programs for patients with neck complaints. There is, however, low to moderate quality evidence supporting the efficacy of active exercise in the management of these patients. There are also varying degrees of evidence for various components of a physical rehabilitation program. The ideal combination of these components is yet to be identified and so it is up to the practitioner to adopt one of the pre-established programs in current use or piece together individualized programs for their own patients.

Some programs emphasize strengthening of global musculature while others emphasize training motor control with special attention to the smaller intrinsic muscles of the neck. Most programs incorporate rehabilitation of key shoulder and scapular musculature as well. Many incorporate a "multi-modal" approach including some combination of stretching, proprioceptive or position sense training, oculomotor training, and even general aerobic exercises. Roijezon (2015) recommends that the goals of a rehabilitation program should include "pain reduction, normalized range of motion and neuromuscular control, as well as adequate strength and endurance of the cervical spine."

The evidenced-based Canadian Guidelines Recommendations for Neck Disorders (not due to whiplash) simply suggest the following (Bryans 2014):

For Acute Non-Specific Neck Pain

- Home exercise with advice or training is recommended in the treatment of acute neck pain for both short and long-term benefits (neck pain).
- Spinal manipulative therapy or mobilization is recommended for the treatment of acute neck pain for both short and long-term benefit (days to recovery, pain) when used in combination with other treatment modalities such as advice and exercise.

For Chronic* Non-Specific Neck Pain

- Exercise (including stretching, isometric, stabilization, and strengthening) is recommended for short- and long-term benefits (pain, disability, muscle strength, quality of living, cervical ROM) as part of a multimodal approach to the treatment of chronic neck pain when combined with infrared radiation, massage, or other physical therapies.
- Manual therapy is recommended in the treatment of chronic neck pain for the short and long-term benefit (pain, disability, cervical ROM, strength) in combination with advice, stretching, and exercise.

* Chronic neck pain is usually defined as pain lasting 3 months or more.

State of the Evidence

A 2015 Cochrane systematic review offered the following regarding various interventions for chronic neck pain and the evidence supporting them. (Gross 2015)

Chronic neck pain, moderate quality evidence

1) **Cervico-scapulothoracic and upper extremity strength training** can improve pain measured as a *moderate to large* difference compared to controls immediately post treatment [pooled SMD -0.71 (95% CI: -1.33 to -0.10) and at short-term follow-up

2) **Scapulothoracic and upper extremity endurance training** has a *slight beneficial* effect on pain at immediate post treatment and short-term follow-up;

3) **Combined cervical, shoulder and scapulothoracic strengthening and stretching exercises** varies from a *small to large* magnitude of beneficial effect on pain at immediate post treatment [SMD -0.33 (95% CI: -0.55 to -0.10)] and up to long-term follow-up; and a *medium* magnitude of effect improving function at both immediate post treatment and at short-term follow-up [SMD -0.45 (95%CI: -0.72 to -0.18)];

4) Cervico-scapulothoracic strengthening/stabilization exercises can improve pain and function at intermediate term [SMD -14.90 (95% CI: -22.40 to -7.39)];

5) Mindfulness exercises (Qigong) minimally improved function but not global perceived effect at short term.

Chronic neck pain, very low quality evidence suggests

Neuromuscular eye-neck co-ordination/proprioceptive exercises may improve pain and function at short-term follow-up.

Low quality evidence suggests that the following may not be effective as stand-alone interventions: **1) breathing exercises; 2) general fitness training; 3) stretching alone;** and **4) feedback exercises** combined with pattern synchronization may not change pain or function at immediate post treatment to short-term follow-up.

Acute radiculopathy, low quality evidence

For acute radiculopathy, low quality evidence suggests a small benefit for pain reduction at immediate post treatment with cervical stretch/strengthening/stabilization exercises.

The Cochrane review concluded that "No high quality evidence was found, indicating that there is still uncertainty about the effectiveness of exercise for neck pain. Using specific strengthening exercises as a part of routine practice for chronic neck pain, cervicogenic headache and radiculopathy may be beneficial. Research showed the use of strengthening and endurance exercises for the cervico-scapulothoracic and shoulder may be beneficial in reducing pain and improving function. However, when only stretching exercises were used no beneficial effects may be expected." (Gross 2015)

Patient Education

Patient education is an important component of any program. Useful information includes the basic anatomy of the cervical spine, postural advice, and practical demonstrations with instructions for lifting, pushing, pulling, and other daily actions. Basic ergonomic advice includes seated postures, and computer placement, and desk organization. (Evans 2012) ***In addition, patient reassurance and fear avoidance behaviors should be specifically addressed while explaining the difference between hurt (i.e., the discomfort that may accompany activities of daily living or particular exercises) and harm (i.e., actual tissue damage and worsening of the condition).***

Program specific prescriptions

O'Riordan (2014)* suggests that a combination of both resistance and endurance and stretching exercises may offer the best combination of benefits, demonstrating immediate and longer term benefits in increased isometric strength. 50% of the interventions in the O'Riordan review were resistance exercises. The reviewer goes on to recommend that including one or more of the following inventions may also be beneficial: aerobic exercise, proprioception/ head positioning exercises, and craniocervical training regimen.

Likewise, the Canadian Guidelines recommend home-based strengthening and endurance exercises with advice/training/supervision for both short- and long-term benefits (neck pain, cROM) in the treatment of chronic neck pain. In all studies, home exercises were performed daily to 3 times per week.

Anderson (2012) reported that a regime of daily home exercise (6-8 repetitions per day) for 12 weeks with two 1-hour advice/training sessions 1 to 2 weeks apart was effective. Furthermore, even as little as 2 minutes of daily progressive resistance training for 10 weeks results in clinically relevant reductions of pain and tenderness in healthy adults with frequent neck/shoulder symptoms. Home stretching (3-5 times per week) with advice/training is also recommended in the treatment of chronic neck pain for short and long-term benefits in reducing pain and analgesic intake.

Levels of care

Depending on the provider's expertise, practice profile, the body awareness and needs of the patient and practice setting, the following are the options for delivering the rehabilitation program.

- Home-based: Give patient exercises to do at home (no in office instruction)
- Home based: Teach exercise in office, re-evaluate exercise quality and progress on each visit.
- Office based: Patient does exercise routine in office.
- Supervised: Patient does exercise routine under direct supervision.

Length of program

Generally, programs that have been reported in the literature last between 6-12 weeks (O'Riordan 2014). Six weeks appears to be a minimum length for resistance or strength training to provide an opportunity for hypertrophy of muscle fibers to occur. Some patients may benefit from a program lasting 3-6 months. Subsequently a lighter maintenance program should be recommended to maintain gains. ***Note: Long term studies suggest that after the initial interventions are over, these benefits are lost.***

* A limitation of O'Riordan's systematic review was that only one reviewer did the searches and assessments, hand searches were not performed and the search was limited to English. 16 studies were included the majority of them scoring 6/10 on the Pedro scale (range 5-7); none of them reported concealed allocation and blinding was incomplete.

Length of Sessions

Programs generally range from 12-45 minutes per session. Benefits have been reported for as little as 2 minutes daily (Anderson 2012) and10 minutes a day, 3 days a week. (O'Riordan 2014)

Frequency

Research studies have varied from 3x/week to daily. Positive outcomes in terms of pain intensity, isometric strength, perceived disability and quality of life have been reported to improve with a frequency of 3 times a week. However, there is evidence of improvement with as little as 1-2 sessions a week. Even in programs which target 3 times a week, patient compliance has been reported at only 39% --the rough equivalent of about 1.7 times per week (O'Riordan 2014). Anderson (2012) reported a regimen of daily home exercise (6-8 repetitions per day) for 12 weeks with two 1-hour advice/training sessions 1 to 2 weeks apart.

Cervical Spine Rehab Overview*

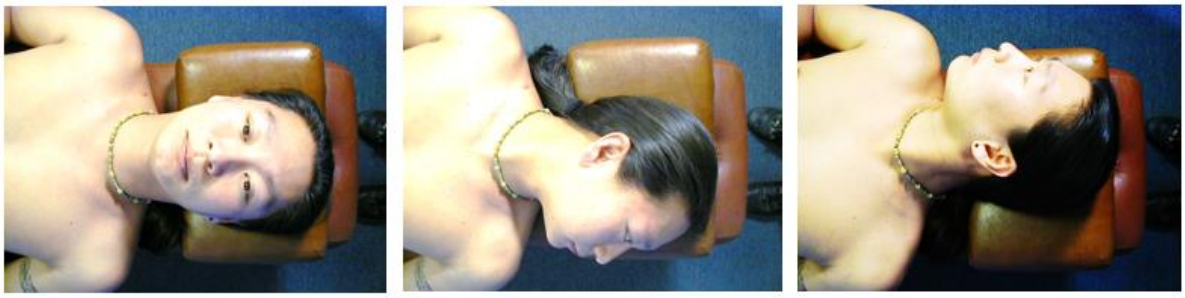
- **Acute Care Interventions**
  - Active ROM
  - Isometrics
  - Directional preference
- **Strategy 1: Evaluate and Train Deep Neck Stabilizers**
  - Assessment: history, observation, Jull's test, craniocervical test
  - Cervical mobilization / manipulation
  - Chin retraction
  - Craniocervical flexion exercises
  - Isometric progression (chin tuck, ball squeeze, ball roll)
  - Neck extensors: prone/quadruped progression (Jull)
  - Quadruped track (Murphy)
- **Strategy 2: Assess and Treat Posture and Respiration**
  - Assessment: posture
  - Anterior head carriage – fixed, habitual, dynamic
  - Thoracic kyphosis exercises
  - Respiration assessments: upright, supine, prone
  - Basic abdominal breathing
  - Abdominal breathing with bracing exercises
- **Strategy 3: Address Muscle Imbalance of Large Torque Producers**
  - Assessment: upper cross syndrome
  - Stretching long and short extensor muscles and general home stretches
  - Re-train scapular stabilizers: wall angels, serratus punch, push-up plus
  - Pec major stretches
  - Strengthen large torque muscles of the neck (resistance training)
- **Strategy 4: Retrain Sensory Motor Response Loop**
  - Assessment: Sensory motor response loop (Revel's and oculomotor testing)
  - Cervical PNF cross patterns
  - Rhythmic stabilization
  - Head repositioning
  - Oculomotor training
  - Balance Training

* Self mobilization/manipulation technics such as neurodynamic self-treatments (i.e., tensioners & sliders) and directional preference exercises are not covered in this rehabilitation protocol.

EARLY INTERVENTION IN ACUTE CASES

In patients with recent trauma or other causes of acute pain, aside from in-office manual therapy procedures, there are three interventions which should be introduced as early as possible: 1) range of motion exercises in a pain-free range 2) isometric activity of the injured muscles or the muscles around an injured joint, and 3) directional preference exercises.

Active range of motion. Active range of motion exercises should generally be given at the first visit. If necessary, these exercises can be non-weight bearing, performed on a pillow or a device such as an occipital float. The key motions for the patient to perform are rotation, chin retraction, and head nodding.



PAIN FREE ROTATION

ROTATION EXERCISE SUPPORTED ON OCCIPITAL FLOAT

PAIN FREE CHIN RETRACTION

In each case, motion must be carefully limited to a pain free range even if that means only a few degrees of movement. The exercises should be done as often as possible throughout the day, preferably hourly. Six to ten repetitions per set would be a reasonable target. Improved cervical ROM is presumed necessary before initiating a cervical "stabilization" exercise program. Patients with relatively full active range of motion from the start can omit this step and proceed to the rehabilitation strategy outlined on page 7.

Isometric contractions. Isometric exercises can be assigned on the first visit provided they do not increase pain. The goal is to delay or slow atrophy and to maintain neurological programming to the muscles. The exercises can be done weight-bearing or lying supine. The patient should focus on using *only the muscles of the neck with little or no recruitment*.

Gentle isometric contractions against finger tip resistance should be performed in each of the cardinal directions. Muscles will be activated with as little as a 10-20% maximum voluntary contraction (MVC).

FLEXION **EXTENSION** **LATERAL FLEXON** **ROTATION**

Six to ten repetitions can be performed frequently throughout the day. The patient may begin with brief contractions and work up to 6-10 second holds. They may also increase the strength of the contraction as long as it does not aggravate symptoms. Isometric contractions should be performed through ranges of motion at about 20 degree intervals (multiple angle isometrics) to activate as many fiber groups within the targeted muscles as possible.

Some authors suggest waiting 24-48 hours (Murphy 2000) in acute cases, especially after trauma such as a whiplash accident. In many cases this delay will not be necessary as long as the strength of the contractions is kept low and the exercises are pain free. If the patient is very acute, one might start with gentle supine isometric rotation exercises since rotation will produce co-contraction of both the deep flexors and extensors. In the case of hyperflexion or hyperextension trauma, it avoids loads in the sagittal plane.

For patients who have more than about 30 degrees of available pain free motion, isotonic exercises can be introduced within the pain free range. (See p 38.)

Directional preference exercises. Another approach that may be introduced as soon as tolerable is repetitive end range loading (see Appendix I), especially with a directional preference emphasis. Edmond in a 2014 study (N=302) reported that 70% of cervical patients presented with a directional preference (most in extension). For more details, see CSPE protocol *Directional Preference Protocol: Centralizing Neck, Shoulder and Arm Pain.*

PRACTITIONER ASSISTED CHIN RETRACTION WITH OVERPRESSURE

REHABILITATION PROGRAM

Once the patient is out of the acute phase, a more complete program can be initiated. Since many patients present already in the subacute phase, the program recommended in the following section can often begin on the first day of treatment.

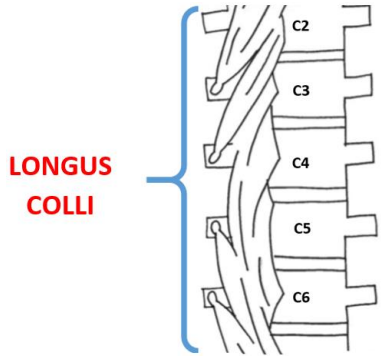
Strategy

1. Evaluate and train deep segmental stabilizers
2. Address postural factors and respiration
3. Address muscle imbalance of large torque producers
   - Stretch short tight cervical muscles
   - Evaluate/re-train scapula stabilizers
   - Strengthen large torque producers of the neck
4. Re-train the sensory-motor response loop

Strategy 1: *EVALUATE* the deep segmental stabilizers

Rationale and Evidence

The deeper muscles of the cervical spine such as longus capitus and longus colli are continuously (or tonicly) active, suggesting a postural, supporting role). This deep muscle activity is required to stiffen or stabilize the segments in functional mid ranges—the zone where ligaments play a minimal role. Based on computer models, when contraction of only the large muscles of the neck was simulated, local segmental instability resulted. That is, due to the normal lordotic cervical curve, sole contraction of the large posterior muscles created a tendency towards buckling of the motion units. (Jull 2000)



Various EMG studies have demonstrated a disturbance in synergistic cervical flexion movement in patients with chronic idiopathic neck pain and in patients who have suffered a whiplash injury (Falla 2003, Jull 2000). In these patients, impairments in the strength and endurance needed by the deep neck flexors for segmental control and support may be compensated by increased activity in the superficial SCM and anterior scalene.

This dysfunction can be improved by retraining and exercise. Improvement parallels a reduction in symptoms (Beeton 1994; Grant 1998). Postural retraining and strengthening of the deep neck flexors may be essential for maintaining proper structural integrity. Muscles of the deep extensor group also appear to play an important role in creating spinal stability in the mid-range zone. These muscles include the suboccipital muscles, semispinalis cervicis and multifidus and the deep suboccipital extensors in patients with chronic neck pain.

Assess the Deep Flexors

Summary of assessment procedures

1. History of trauma, chronic neck pain, headache
2. Observe forward head carriage
3. Static cervical stability tests
4. Head nodding tests with pressure sensor

1. Historical clues

Necks that have been subjected to sudden high forces into extension, as occurs in a recreational injury or motor vehicle accident, potentially have strained anterior structures including the SCM, scalenes and deep flexors. Furthermore, patients whose chief complaint is chronic neck pain or headache (which has a postural or cervicogenic component) may have inhibited deep flexors regardless of the mechanism of injury. (Jull 2004)

2. Observe forward head carriage

Forward displacement of the head, although potentially caused by a variety of factors, may suggest inhibition of the deep flexors. Note that appropriate head alignment does not rule out the possibility of the muscle imbalance. A slightly rotated head may be associated with a number of factors including asymmetrical over activity of one SCM. For more information on forward head carriage, see p 19.

3. Static cervical stability test (Jull test/deep flexor endurance test)

The Jull test is a test of deep cervical flexor muscle endurance (e.g., longus coli, longus capitis) and is thought to reflect functional stability. In cases of whiplash or other trauma, this test should not be performed until the patient's overall neck flexion strength has returned. With the patient supine, place the patient's chin in a retracted position, raise the head slightly off the table, and then slowly release. (See CSPE video *Key Movement Patterns* 2013)

***Clinical tip*:** An optional method to standardize the starting position for the Jull test is for the practitioner to rest hands on the table, cradling the patient's head. The patient is then instructed to elevate his/her head just until there is no contact with the practitioner's fingers.

A commonly accepted threshold for test failure is the inability to hold this position for 10 seconds without chin poking, excessive head shaking, or global flexion or extension (Murphy 2000, 2016). When used purely as an endurance test (shaking allowed), a 2007 (Peolsson) study of 116 asymptomatic subjects (age 25-64) suggested cut points of 56 seconds for men and 23 seconds for women (median times were 150 seconds and 30 seconds respectively but with a wide range).

Failure indicates overall poor functional stability of the cervical spine, inhibited deep flexors, poor endurance, and perhaps overactive SCMs (Murphy 2000, Liebensen 2007).

A variation of this test can be used to qualitatively evaluate the speed of contraction and reaction of the deep neck flexors.

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 their head will be suddenly released in the next few moments, but that meanwhile they should allow the neck to remain relaxed and supported by the practitioner. The head is then released suddenly. The practitioner observes how quickly the patient can recover and how accurately they can return to 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 and perhaps poor kinesthetic awareness.

***!!! Clinical warning*:** This test is only performed when the flexors demonstrate good strength and endurance, and any acute injury has had time to heal.

Rationale and test performance

A 2008 systematic review suggested that the Jull test had adequate test reliability for the endurance component. Most studies contained in the review calculated the intra-observer reliability to be above an ICC 0.85 (deKoning 2008). Test results correlates well with patient's symptoms as measured by the Neck Disability Index (NDI). Validity of this test is unknown. The test variation which assesses speed of contraction has not been studied.

4. Craniocervical test (with pressure sensor)

Using a pressor sensor placed behind the neck as a feedback mechanism, this is a test of the holding capacity of the deep neck flexors as well as motor control.
For details, see Appendix II.

Strategy 1: *REHABILITATE* the deep flexors (& deep extensors)

Low load exercises targeting the deep flexor muscles are recommended to improve neuromuscular control and affect posture (Jull 2015). A number of small studies have supported the use of deep flexor exercises to decrease neck pain and improve function (Kim 2016, Gupta 2013, Chiu 2005). When this approach to rehabilitation is utilized, these exercises generally precede higher load exercises which are applied to more global muscles to build strength and endurance. (Jull 2015)

Treatment options for inhibited deep stabilizers

1. Mobilize/adjust cervical spine to activate deep flexors
2. Chin retractions
3. Craniocervical flexion exercise with biofeedback
4. Isometric holds with chin tuck
5. Ball squeeze
6. Forehead ball roll

Treatment options for deep extensors

7. Quadruped/prone series (Jull)

Combined treatment option

8. Quadruped track (Murphy)

1. Mobilize/adjust the cervical spine

Sterling (2001) found that cervical spine mobilization activated deep flexor activity and decreased SCM EMG activity. This may be used to at least temporally activate the deep flexors, allowing them to engage more effectively during the training exercises.

2. Chin retractions

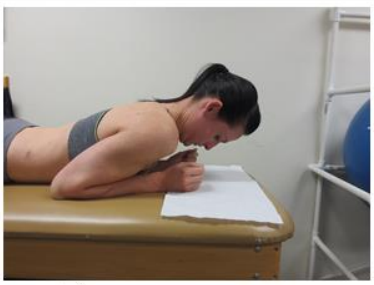
Reported therapeutic effects of chin retraction exercises include

- Increase cervical ROM
- Improve resting posture
- Relieve neck and radicular pain
- Possibly move the nucleus into a more anterior position.

Chin tucks can be performed beginning in the seated or supine position and progressing to the prone position as the deep flexors become more active. The patient is instructed to tuck the chin as far as possible focusing on posterior translation. Although not visible, this results in the upper cervical spine maximally flexing and the lower cervical spine maximally extending.

SEATED CHIN RETRACTION

SUPINE CHIN RETRACTION



PRONE CHIN RETRACTION

Note: chin retractions are often part of a directional preference treatment approach (AKA McKenzie) for pain control. For this approach see the CSPE document *Directional Preference Protocol: Centralizing Neck, Shoulder and Arm Pain.*

Quadruped chin retraction

Caution: Habitual chin retraction may be relatively contraindicated in patients with TMD because the flattening of the cervical lordosis and distorting the hyoid muscles may change the dynamic function of the TMJ.

When retraction is done in a prone position, the position can be attained by either resting up on the elbows or in a quadruped stance. It can then be incorporated into a series of quadruped exercises. See Appendix III. (Murphy 2000, Murphy 2016).

Chin retraction in the Brügger relief position

This relief positon incorporates chin retraction. It is useful if anterior head carriage or other postural deficiencies are observed or the patient sits and works in a hunched over posture or long periods.

Brügger relief position

The overall position consists of multiple components designed to counteract a typical “closed up” sitting posture. Not all of the components may be equally important in addressing a neck problem.

Brügger relief positon checklist:

- sit upright
- the lumbar spine comfortably hyperlordotic (short of end range)
- the sternum elevated up and out (which should automatically result
- in the shoulders drifting backward)
- the neck upright (holding a “long neck”)
- the chin mildly retracted
- the upper extremities externally rotated
- palms up and fingers splayed.
- lower extremity moderately abducted
- if possible, sitting on a higher chair to allow the hip flexors to open up.

Having the patient adopt the Brügger relief position at regular intervals throughout the day is thought to help improve overall posture while also activating the deep cervical flexors. For patients who sit for long periods, they can attain and hold this posture for 30 seconds every 30 minutes.

If repetitive active chin retractions are incorporated, a common formula is to perform sets of 10 chin retractions several times a day.

3. Craniocervical flexion exercise.

Liebensen (2007) and Jull (2008) suggest a craniocervical flexion exercise as part of an initial training program to activate the deep flexors of the neck (e.g., the longus capitis and longus colli). The exercise is performed in the supine position using a stabilizer cuff under the head. This is similar to the craniocervical flexion test but is used as a rehabilitation exercise for improving motor control and muscular endurance. See Appendix II.

4. Isometric holds with chin tuck.

In the acute phase, chin retraction should be done with the head fully supported. But in the post-acute phase, endurance can be promoted by having the patient practice holding a supine chin retraction while holding the head off the edge of a mattress or, more simply, while raising the head slightly from the surface. The exercise can be performed twice a day, working toward 10 or more seconds without shaking. For example, it can be done in the morning and night while the patient is lying in bed.

The static holds can be prescribed on a 6 X 6 (6 second holds, 6 repetitions) and then a 10 X 10 basis. In either case, the patient has to stop the hold whenever s/he begins to shake. This exercise will build endurance of the deep flexors. This activity can also be done in a quadruped position, which requires chin retraction against gravity.

A chin tuck with the neck in slight flexion is another option for exercising the deep neck flexors.

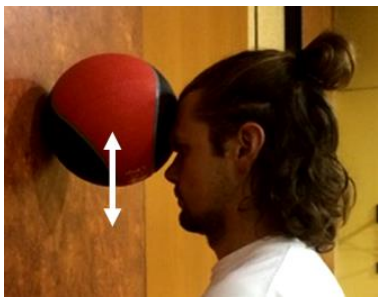
5. Ball squeeze

The patient can hold a small ball (or his/her fist) between the chin and the chest and squeeze. Sets of isometric contractions can build deep flexor endurance.

This should be done twice a day. One can prescribe 6 seconds holds, six repetitions (6x6) or 10 second holds, 10 repetitions (10x10). Note: this exercise may be relatively contraindicated in patients with temporomandibular disorder (TMD).

6. Forehead ball roll

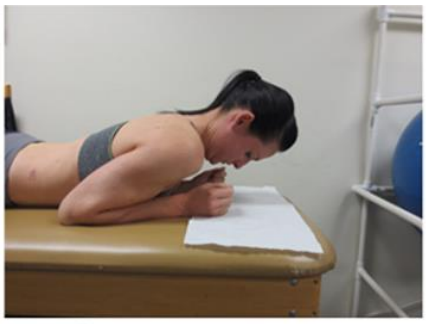
The deep flexors can be activated and endurance can be built by having the patient use his/her forehead to roll a small ball up and down against a wall, using short nodding movements. Once a patient has good AROM, diagonals can be added to this exercise.



This can be done twice a day. One can prescribe 2-3 sets of 8-10 repetitions.

7. Training the neck extensors (Jull)

The exercises are performed in the quadruped position or prone with the trunk supported on the elbows. (Jull 2008)



When using the quadruped position, the patient assumes a postural “set” in which the curves of the low back as well as the thoracic and cervical spines are held in neutral position. The patient should be facing the floor and the scapulae are stabilized in a “down and in” position.

Exercise 1 (Craniocervical flexion, return to neutral): The patient performs a head-nodding motion (as if nodding "yes") starting from neutral into flexion and then back again. All of the motion is *focused into the craniocervical region*, with the rest of the cervical spine held in neutral.

ROTATION IS CO ON C1 WITH LITTLE TO NO FLEXION IN THE REST OF THE SPINE

Exercise 2 (Upper cervical rotation): The patient rotates their head (indicating "no"), limiting the movement to less than 40° (again focusing the rotation to the craniocervical region) in an effort to activate the obliquus capitis superior and inferior muscles.

If the patient finds it difficult to limit the movement to atlas, the provider can gently grip and block movement of C2 to help the patient consciously focus on the vertebra above.

Exercise 3 (Cervical extension): This exercise shifts to extension and reverses the focus of the first two, encouraging movement *in the rest of neck rather than the upper cervical joints*. It is similar to a low back stabilization approach where the spine is held in neutral and the torso is flexed by hip hinging. In this case, the craniocervical region is maintained in a neutral position, and the patient extends the rest of the cervical spine (focusing on the semispinalis cervicis/multifidus

groups to produce the motion). The goal is for the deeper extensor muscles and the deep cervical flexors to stabilize the upper cervical joints in a neutral position (i.e., limiting movement) while the more superficial cranial extensors initiate the movement. Exercise 3 training can go through the following steps:

- **Step 1 (Supine isometrics):** First the supine patient practices neck extension with minimal craniocervical extension by performing an isometric contraction (about 20% of a maximum contraction) by pressing the back of the head against the table/bed while visualizing a curling-back action. The patient is instructed to concentrate on avoiding either lifting the chin (which would activate the multifidus/semispinalis muscle group in the upper cervical region) or chin retraction (activating the deep flexors). When the patient can demonstrate satisfactory control, they can progress to doing ROM exercises.

CORRECT
NO/LITTLE CHIN MOVEMENT

INCORRECT
CHIN FLEXES

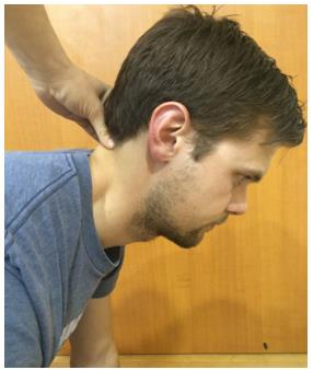
INCORRECT
CHIN LIFTS

- **Step 2 (Quadruped extension curl from flexion to neutral):** Initially, the extension ROM exercise is limited to starting from a flexed position and extending back to neutral. Avoiding full extension may be more tolerable for patients in an acute state. The instruction is to "curl" the neck backwards without lifting the chin. *The provider may stabilize the C2 spinous process to encourage the patient to initiate the movement from the lower cervical spine*. There should be as little head nodding or chin retraction as possible. To help attain the neutral cervicocranial set, patients should be instructed that at the start and the end of each repetition their eyes and face should be looking straight down between their hands (as opposed to looking out ahead of their hands).

NO MOVEMENT IS ALLOWED
AT THE CRANIOCERVICAL JUNCTION

- **Step 3 (Fuller cervical extension, maintain craniocervical neutral).**
  Next the exercise progresses to a fuller range of extension while still in the quadruped position. The patient still focuses on minimizing craniocervical extension.

  The range is progressively increased as the patient is able to demonstrate adequate control (i.e., minimal chin lifting or retraction) over wider and wider a range of extension.



NO MOVEMENT IS ALLOWED
AT THE CRANIOCERVICAL JUNCTION

An example of an initial prescription would be a set of five repetitions each of craniocervical flexion, rotation, and cervical extension. If a patient cannot perform one the exercises with adequate control, that exercise should be delayed until done properly. The patient is eventually progressed to three sets of five repetitions and then to three sets of 10.

8. Quadruped Track

A five step Quadruped track (Murphy 2000) can be used that incorporates deep flexor training with scapular training, neck-arm coordination and a motor control component. For details, see Appendix III.

A general treatment strategy for rehabilitating the deep stabilizers.

One can progress patients through the exercises recommended in the previous section by following an “ACE approach” (i.e., first **A**ctivate, then teach **C**ontrol, then build **E**ndurance).

In order to improve muscular endurance and motor control, corrective exercises should first focus on facilitation and later strengthening of the deep stabilizer muscles.

Mobilizing and manipulating the cervical spine along with chin retractions and the first two exercises of the extensor sequence (p 14) may help to activate deep stabilizers. Exercise options that both activate and provide neuromuscular control training include the craniocervical flexion exercise progression with biofeedback, isometric holds with chin tuck, and isometric contraction against a tennis ball. Endurance training would include isometric holds with chin tuck of progressively longer duration and forehead ball roll (which is a relatively demanding exercise).

Murphy also suggests that along with targeting the cervical musculature, a cervical stabilization program should also include scapular, lumbar and pelvic stabilization exercises as needed (Murphy 2000). (See CSPE Protocol Lumbar Rehabilitation Program). Murphy has created a progressive, quadruped exercise track which emphasizes activation, motor control and endurance (Murphy 2000, 2016). (See Appendix III.)

Strategy 2: Posture & respiration, assessment & treatment

Forward head posture has been implicated in neck pain, radicular pain, and certain types of headaches, such as tension-type headaches associated with MFTPs. (Fernandez-de-las-Penas 2006, Diab 2011). Evidence demonstrating a strong link between certain postures and neck pain is mixed, with systematic reviews finding both no correlation (Silva 2010, Straker 2009) and a positive correlation (Silva 2009, Lau 2010). Jull (2008) postulates, for example, that whereas the evidence linking cervicogenic headache with a "fixed" posture is weak, a sustained loaded posture (e.g., cervical extension loading in a seated posture) might present a more promising approach to postural analysis. Furthermore, Jull (2015) points out that there is some evidence that postural training itself can improve neck muscle function.

Anterior head carriage causes stress on the structures of the cervical spine that theoretically could contribute to joint dysfunction or myofascial pain syndromes. Postural analysis may be useful in constructing a rehabilitation program. The most common postural cues for muscle imbalance are forward head carriage and shoulders rolled forward. Another risky posture may be sustained neck flexion.

Some small studies have found that exercises targeting the deep flexors and sometimes general strengthening exercises of the cervical muscles as a whole can improve forward head carriage. (Diab 2011, Gupta 2013, Kim 2016).

Postural Assessment

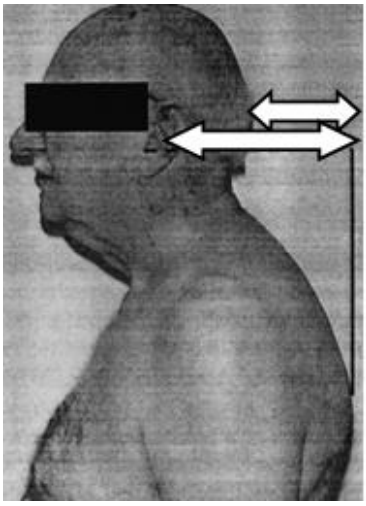
Assessment tool	Finding	Comments
Observation	Forward head carriage	May be associated with an upper cross syndrome; postural re-training may be necessary.
Observation	Rounded/anterior shoulders	May be associated with tight pectoralis (and other internal rotators of the shoulder) and inhibited middle/lower trapezius.
Observation	"Gothic" shoulders (angular rather than curved contour of side of the neck)	Overactive upper trapezius/levator scapula.
History	Work or recreational postures with prolonged holding the neck in a flexed position (as can occur with reading, working on a computer and texting)	Behavioral or ergonomic changes should be made.
Palpation and observation for diaphragmatic breathing	Vertical chest breathing with little movement of the belly or paradoxical breathing (i.e., the abdomen retracts with inspiration and expands with expiration)	Abdominal breathing is taught as an exercise and as an adjunct to all other exercises the patient is given.

Posture: Anterior Head Carriage

Anterior head carriage is present when the external auditory meatus is drawn forward past the glenohumeral joint. This forward head position can be fixed, habitual, or dynamic.

1. "Fixed" head position

A fixed head position can be seen with the patient either seated or standing. One can measure the distance between the EOP or external meatus and the wall to establish a baseline for forward head carriage.



The next step in assessment is to try to determine the cause of the forward head.

Site	Cause	Management
The head is forward in an otherwise upright body.	Possible imbalance between cervical flexors and extensors.	Treatment requires activating the deep flexors, relaxing overactive SCMs, and relaxing the extensor muscles; chin retraction exercises for postural training may be useful.
The head is drawn forward because of anterior rounded shoulders.	Tight pectoralis muscles and inhibited middle/lower traps; there may be the full expression of the upper cross syndrome.	Special attention is paid to stretching the pectoralis muscles and training the lower trapezius; postural exercises such as Brügger relief position are indicated
The head is drawn forward due to hyperkyphosis	The hyperkyphosis may be secondary to an upper cross syndrome, thoracic joint dysfunction, or thoracic disease (e.g., AS, thoracic compression fractures).	In addition to the treatment cited above, include manipulating the thoracic spine and supine extension exercises over a ball or cylinder.
The head is drawn forward because of flexion from the waist	Tight psoas as part of a lower cross syndrome (or perhaps rectus abdominis) may be the cause.	Rehabilitation exercises will have to also target the low back and pelvis.
The whole body is leaning forward from the ankle.	Poor proprioception and balance issues may be involved. Tight calf muscles may result in over compensation in forward lean.	Consider stretching tight calf muscles and giving balance work teaching patients to distribute their weight more evenly over the foot.

Patients with structural limitations such as hyperkyphosis secondary to osteoporotic compression fractures and ankylosing due to AS present a more difficult challenge. But even for these patients some soft tissue changes and improvement may be possible.

From the outset, the patient must be taught how to assume a correct neutral upright spinal postural position. This position can be practiced repeatedly during the day as part of a motor skill retraining program. Any other exercises performed should be performed with this postural set.

Treating a kyphotic thoracic spine and chronic segmental extension restrictions

Rehabilitation activities can be used in conjunction with in-office manipulation and mobilization of the thoracic spine into extension.

Lying on a Cylinder

The cylinder is used as a fulcrum in different orientations to open joints and induce sustained muscle relaxation.

Horizontal placement: The patient lies over the styrofoam cylinder which is positioned horizontally just inferior to the vertebra targeted for extension. They are instructed to relax, allowing the spine to extend over the cylinder. The hands cradle the head for support, but cervical flexion is avoided. The patient will raise into a bridge with the pelvis held off the floor. The spine is held in neutral while the patient performs abdominal bracing and abdominal breathing.

Parallel placement: The cylinder can be place along the length of the spine. While aligning the spine with the cylinder, the patient should make contact with their EOP, the TLJ, and sacral base. The backs of the hands lie against the floor; the arms can be held at various degrees of abduction as if performing a wall angle. The starting position is with the arms nearly by their sides and is eventually advanced to 90 degrees of abduction while still maintaining good form. The patient then simply relaxes and performs abdominal bracing and breathing.

While deep breathing and allowing their shoulders drop to the floor under the influence of gravity, the patient can lie still or gently rock in place. Each position is held from 30-60 seconds and preferably performed twice a day.

Lying on an Exercise Ball

The patient relaxes into a back stretch over the ball, head supported by their hands. This position is sustained for 30-60 seconds, either holding still or with gentle rocking. Slow, deep diaphragmmatic breathing is encouraged. As the patient is able to progress, the arms are outstretched and the patient arches further and further back over the ball. This advanced position may cause dizziness because of the cervical extension and should be monitored carefully in older patients and patients with dizziness or balance problems.

BEGINNER

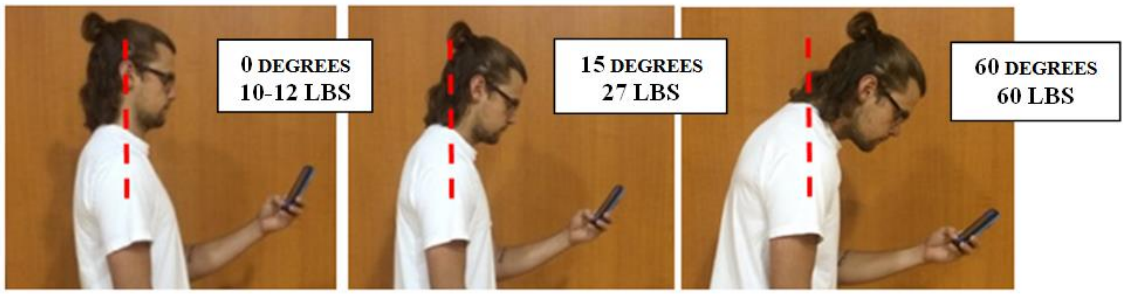
INTERMEDIATE

ADVANCED

2. The "habitual" forward head

In this case, the patient may slip into forward head carriage only in certain situations. Sitting may be one such situation and so it is important to observe the patient sitting in the practitioner's office.

"Text neck" is a phenomenon associated with sustained postures held while texting or with the head bent over any electronic device. Cervical flexion especially if coupled with chin protrusion create substantial loads on the spine.



Similarly, the problem may occasionally be a “rest” position adapted after exercising. Patients sit and lean forward, resting their arms and upper body on their thighs.

Another cause may be ergonomic issues at the work place or at home such a computer placement In this case, assessment will usually take the form of asking a series of questions about the work environment (see below).

Checklist for problems in the environment

The following situations might promote unwanted chin poking, forward head carriage, or prolonged flexed postures.

⇒ Is the patient’s computer screen at the proper height (nose approximately at mid screen)?
⇒ Is there unwanted glare on the screen?
⇒ Does the patient have the proper eye glass prescription?
⇒ Is reading material upright in a stand?
⇒ Does the patient have proper back support for the chair?

Treatment in these cases consists of patient education, recommended changes made in the patient’s environment, and periodic postural exercises such as Brügger seated rest position performed each hour for several weeks.

3. Dynamic forward head carriage

The practitioner should carefully watch the patient as he or she gets up out of a chair or rises from an adjusting table. The patient may lead with the chin. In this case, the patient should be made aware of this habit. The patient may need to practice retracting the chin just before moving until a new behavior is formed. In these cases, it is important for the practitioner to reinforce the new behavior whenever the patient is in the office.

Even more commonly, the patient may chin poke whenever engaged in a strenuous activity, including exercises. Below is a checklist for patients.

Checklist for problems with exertion

The following situations might promote unwanted chin poking.

⇒ Lifting heavy objects off of the ground
⇒ Performing sit ups* or crunches
⇒ Performing pull downs
⇒ Rowing
⇒ Performing butterflies (for pecs)

*Generally patients should be dissuaded from doing full sit ups because of the load penalty on the lumbar discs.

Respiration and abdominal bracing

Breathing mechanics and breathing pattern disorders are recognized as playing a potentially important role in a wide variety of physical and emotional health problems. (Chaitow 2004) Currently there are many different approaches, with very different therapeutic goals and few clinical outcome studies. It is beyond the scope of this protocol to provide an overview of the many systems of breath education or to provide a detailed description of a large variety of assessment and treatment techniques.

The focus of this section will be on basic assessment of the movements of breathing, identifying common breathing pattern disorders, training the patient in basic abdominal breathing, and coordinating breathing with abdominal bracing during exercises.

The rationale for these interventions is that respiration is associated with scalene activation. Neck muscles, once thought of as accessory muscles of respiration, are now considered to be involved even in normal respiration. (Perri 2007) The respiratory diaphragm is also thought to play a role in maintaining posture (Kendall 1993). There are also important relationships between breathing mechanics, abdominal bracing, and core stability that should be considered. (Liebenson 2007)

Breathing assessment

Determining a patient's basic breathing strategy should not take long and should be done as soon as the patient is out of intense pain. It is best to do this observation when the patient is not aware that their breathing is being assessed. Often one can make these observations while doing other procedures. Patients, however, can be formally observed in a variety of positions which include sitting or standing, supine, and sometimes prone.

Checklist for assessing breathing pattern

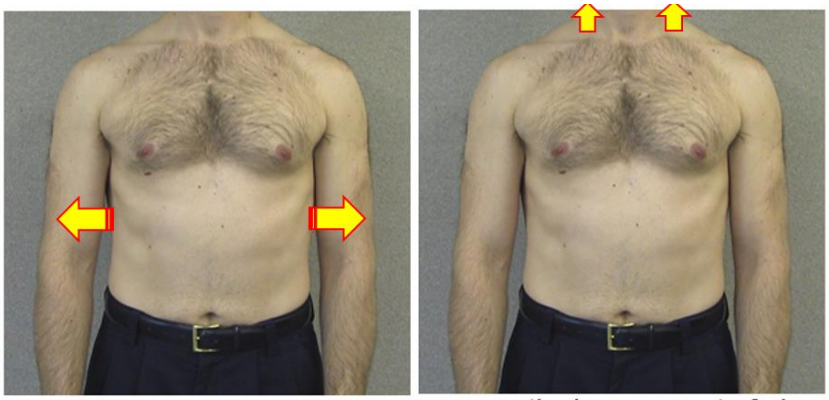
⇒ Abdominal vs chest breather
⇒ Lateral vs vertical breathing
⇒ Improper rib positon
⇒ Paradoxical breathing

SITTING/STANDING ASSESSMENT

The practitioner focuses on a few key observations:

- Breath should be initiated from the abdomen.
- Abdominal motion should be more prominent than that of the chest.
- There should be lateral (i.e., horizontal) movement of the rib cage. There should be little vertical movement of the chest. This is often easier to see in the seated or standing position. Another option is to place the hands lightly on the lateral rib cage and feel the amount of excursion.

OPTIMAL PATTERN



lateral movement of rib cage *no vertical movement of chest*

A. SUPINE ASSESSMENT

The supine position is the easiest position in which to observe the degree of abdominal movement. If needed, the practitioner can ask for a “slow, relaxed, full breath,” rather than “take a deep breath,” but be aware that this may change the patient’s movements from his/her habitual pattern to a more conscious breathing pattern. (Perri 2007)

The practitioner can place his/her hands on the patient’s sternum and belly. *Initiating* the breath from the chest or observing that chest breathing *dominates* are sub-optimal patterns that should be corrected.

In addition, if the patient’s breathing seems to be associated with excessive A-P movement (i.e., the sternum and anterior ribs positioned too anterior), this positon should be corrected whenever the patient practices proper breathing. To re-enforce the proper rib positon, the practitioner can place his/her hand underneath spine at the thoracolumbar junction and instruct the patient to press the spine against the hand.

Alternatively, the patient can be required to hold down the end of an elastic band at the level of the thoracolumbar junction while practicing proper breathing mechnaics.

Another option is to have the patient rapidly blow air out of the mouth like attempting to blow up a balloon. This will usually result in the rib cage settling into a more posterior position.

Finally, there should be no evidence of paradoxical breathing (i.e., abdominal movement *in* during inhalation and *out* during exhalation). The presence of paradoxical breathing indicates a much more significant breathing error and a pattern more difficult to re-train.

B. PRONE ASSESSMENT

The spinous processes should separate during inspiration and approximate during expiration when the patient is lying prone. If there is restricted movement at a particular segment, that motion unit may be amenable to manipulative therapy.

***Clinical tip*:** *Some patients may demonstrate marked deviation from normal mechanics. Those who cannot perform predominantly abdominal breathing even with instruction and after appropriate manual therapy, should be considered for specific breathing pattern training either before or concurrent with their rehabilitation program.*

Basic abdominal breathing exercises

Patients who have minor variations in the proper breathing pattern which can be easily corrected with instruction can immediately begin working on abdominal breathing.

Patients can be taught to correct and self-monitor with their eyes shut, using their own hands on sternum and abdomen. They are instructed to practice breathing into the belly. The patient is to practice in lying, seated and standing postures.

Their homework is to practice a deep, slow, steady breathing rhythm, dropping their diaphragm to the very bottom of the abdomen. Good form includes the following:

- Avoid sighing.
- Neck muscles should remain as relaxed as possible.
- Relaxed breathing during inspiration and expiration should be through the nose.

Abdominal breathing with bracing and exercises

Initially, breathing plus bracing is easier to learn in the supine position. Patients are instructed to tighten their abdominal muscles (i.e., abdominal bracing) while practicing their correct breathing pattern. During abdominal bracing, patients should breathe with normal abdominal movement while holding 10% of maximum contraction of the abdominal muscles. For some patients, initially a better option is to lie prone and breathe into the table (i.e., pressing their belly against the table).

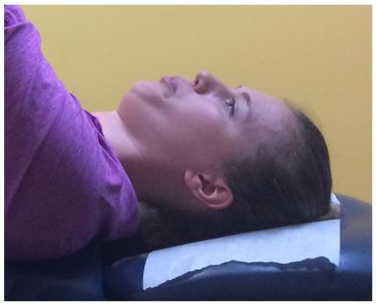
After the patient has demonstrated good control and proper movement, the following advanced breathing exercises can be prescribed:

SUPPORTED DEAD BUG

Lying supine, the patient rests his/her legs on a chair, maintaining hip and shoulders at 90 degrees of flexion. While performing abdominal bracing, proper breathing is practiced.

UNSUPPORTED DEAD BUG

A more advanced exercise can be performed with the legs held in an unsupported positon. Practicing blowing out an imaginary candle while maintaining the core bracing augments the training. As a progression, arm motions (e.g., extending the arms backward toward the floor) can also be incorporated.



EXERCISE PRESCRIPTION

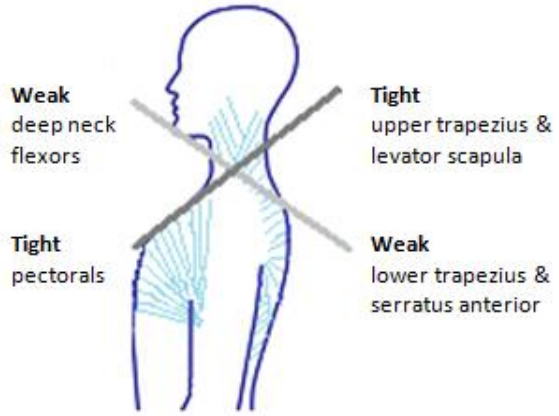
To gain facility with diaphragmatic breathing as outlined above, the patient can be asked to practice twice a day for 10-20 breaths.

Additionally, the patient should practice once per hour for two to three breaths (Perri 2007). This breathing strategy should be utilized whenever the patient is performing abdominal bracing, especially during rehabilitation exercises or activities of daily living. It may take three months of daily training to create a new habit.

The patient should also consciously engage proper breathing patterns while performing the other exercises in this protocol.

Strategy 3: Address muscle imbalance of large torque producers

Deep flexor inhibition may be a part of a larger muscle imbalance referred to by Janda as an upper cross (or proximal cross) syndrome. (Janda 1994) The patient may have all or part of the pattern. The pattern includes an imbalance comprised of short tight cervical extensor muscles (suboccipitals, upper trapezius and levator scapula) and inhibited flexors (longus colli and longus capitis, sometimes the scalenes are included). An associated finding can be overactive sternocleidomastoid muscles. The lower half of the imbalance is comprised of short tight pectoralis muscles and inhibited middle and lower trapezius. Sometimes associated with this will be inhibited serratus anterior. Although the lower traps and serratus are commonly thought to be inhibited (Janda 1987; White1994), there is little research to support this observation (Beeton 1994).



This pattern is seen as a possible cause or perpetuating factor in chronic recurrent neck pain, headaches and shoulder problems.

Lower trapezius activity and endurance is evaluated by isometric testing of the scapula. The practitioner places the scapula in an adducted and depressed position, leaving the upper extremity by the side. The patient is asked to hold this positon for 10 seconds. Inability to hold the position or excessive shaking indicates a weak or inhibited lower trapezius. Recruitment of latissimus dorsi, levator scapulae or upper trapezius is also noted.

Assessing Upper Cross Syndrome

Assessment tool	Finding	Significance
Observation	Forward head carriage	May be associated with part or all of the upper cross syndrome; postural re-training may be necessary
Observation	Rounded/anterior shoulders	May be associated with tight pectoralis and inhibited middle/lower trapezius
Observation	Gothic shoulders (angular rather than curved contour of side of the neck)	Overactive upper trapezius and/or levator scapula
Static stability test (Jull test)	Inability to hold for 10 seconds without chin poking, shaking, or neck movement	Inhibited or weak deep flexors
Head nodding with pressor sensor	Inability to hold steady head nod at various intervals up to at least 26 mmHg for 10 repetitions of 10 second holds	Inhibited or weak deep flexors, poor motor control, perhaps poor kinesthetic awareness.
Supine active neck flexion (Janda test)	Early chin poking	Inhibited deep flexors and/or overactive SCM
Active shoulder abduction	1) Hiking of the shoulder in the first 60 degrees of abduction; 2) asymmetrical lateral movement of scapula; 3) winging of inferior tip of scapula	1) inhibited lower traps and/or overactive upper traps/levator; 2) inhibited middle traps 3) inhibited serratus anterior
Push up	Winging of inferior tip of scapula or collapsing of scapula toward midline	Inhibited serratus anterior
Length testing of pectoralis, upper trapezius, and levator scapula.	Hard end feel, poor joint excursion	Short, tight or overactive muscles
Lower and middle trapezius (static isometric hold in shortened position)	Inability to hold position for 10 seconds without shaking, recruitment or significant asymmetry in endurance	Inhibited or weak muscles
Difficulty performing wall angel	Scoring method: 0 if they have pain; 1 if head cannot touch the wall with eyes held horizontal, 5 fingers cannot touch wall, decreased external shoulder rotation, no control of anterior rib flair; 2 if wrists are not flat on the wall or T/L lordosis is > 1cm form wall; 3 (passing score) if head, TL and sacrum touch wall, eyes horizontal, wrists and fingers touch wall without pain.	Tight pecs/internal rotators, poor core control, hyper kyphosis/forward head carriage

Managing the Upper Cross Syndrome

Exercises for an upper cross syndrome

1. Cervical deep flexor exercises
2. Stretching exercises for long and short extensors
3. Re-train scapula stabilizers
4. Pec major stretches.

1. Cervical deep flexors exercises

See section on previous pages, Rehabilitation Strategy # 1 (pp. 10-13) and Appendix II.

2. Stretching exercises for long and short extensors

Commonly short tight muscles include the pectoralis muscles, the SCMs, and the cervical extensors such as the suboccipital muscles, levator scapular, and upper trapezius.

In the case of the scapular muscles, one initial strategy is to start by activating the weak scapular stabilizers (i.e., lower trapezius and serratus anterior) rather than stretching levator scapula and upper trapezius. Likewise, strengthening the deep neck flexors may result in reflexive relaxation of the short tight suboccipital and extensor muscles. Even when following this approach, it may be that pectoralis major will have to be stretched as part of the preliminary treatment plan. (Jull 2008) Even when this strategy is employed restoration of muscle balance and proper motor control may still require stretching/relaxing these muscles. One might avoid early aggressive stretching in the acute phase of a cervical radiculopathy.

In cases of muscles with trigger points or reactive muscle spasm, post-isometric relaxation is a good technique choice. For tissue where more substantial connective changes have occurred, contract relax, antagonist contract (CRAC) technique or a post-facilitation stretch may be preferred.

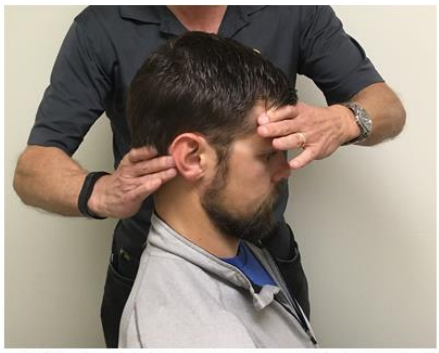
***Clinical tip*:** *Generally, when short tight muscles are in opposition to inhibited muscles, short tight muscles may be best to stretch or relax first. The theory is that by restoring their normal tone, or length, any potential reciprocal inhibition to the inhibited muscle group will be minimized, allowing these muscles to function without a "neurological brake" on them. An exception might be the upper trapezius and levator scapula. It may be more effective to first initiate a training program to activate the lower trapezius before spending time trying to stretch the shoulder elevator muscles.*

Relax the suboccipital muscles

These muscles are often short and tight. Adjusting the upper cervical joints, direct pressure work or post-isometric relaxation (PIR) can be used to relax these muscles.

Home chin retraction exercises with overpressure will stretch these short extensors. Self stretches in cervical flexion can also be used, but the patient must retract the chin while doing the stretch. Pressing the occiput back against a properly set automobile head rest while at stop lights is another convenient opportunity to stretch these muscles.

PIR may be used to relax the short extensors of the upper cervical spine. The practitioner gently rotates the skull into slight anterior rotation (without flexing the neck in the process) until the barrier is felt and then asks the patient to hold their inhalation while looking up with just eye movement to activate the extensors and then breath out and look down (again only with eye movement) to induce relaxation. The practitioner waits to feel a release and then moves to the next barrier only to perform the sequence again. The procedure is performed with eyes closed and then it is repeated until the practitioner can detect no further gain (usually between 2-4 repetitions).



PIR TO RELAX SUBOCCIPITAL MUSCLES

HAND CRADLES OCCIPUT

Stretch the upper trapezius

PIR or any number of muscle stretching techniques can be performed in this position. The active hand contact is across the superior shoulder. The neck is slightly flexed and it laterally bent away. The cervical spine is rotated toward the contact hand so that the patient is facing the side of treatment. Once the barrier is attained, the stretching force is directed thought he shoulder while the lateral flexion component is simply maintained.

Stretching is often prescribed for the upper trapezius muscle in general exercise programs and exercise handouts. The upper trapezius region is a frequent site of pain but care should be taken in prescribing stretching. For example, in the presentation of a downwardly rotated scapula, the upper trapezius is more likely to be weak and resting in a lengthened position. Further stretching is not indicated. Furthermore, slight elevation of the scapula suggesting some subtle shortness in the upper trapezius may be a protective response for mechanosensitive nerve tissues. Nerve tissues must also be considered in cases of apparent scalene muscle shortness. Stretching is contraindicated in these circumstances. (Jull 2008)

HAND OVER SUPERIOR SHOULDER
HEAD TO BE ROTATED TOWARD THE SIDE BEING STRETCHED

Stretch the levator scapula

Although this position looks very similar to the position for treating the upper trapezius, there are some key differences.

The active hand contact is with the spine of the scapula (instead of the superior shoulder). The neck is more significantly flexed. It is also laterally bent away. The cervical spine is rotated away (instead of toward) the contact hand so that the patient is facing away the side of treatment. Once the barrier is attained, the stretching force is directed thought he scapula.

HAND ON SPINE OF SCAPULA
HEAD ROTATED AWAY

General home stretches

General home stretches can also be prescribed. Stretching should be gentle, associated with the breathing cycle. Patients may have a tendency to stretch too aggressively in the cervical region. As opposed to forcing it, the patient is asked to “relax” into the stretch, letting the weight of the head and gentle fingertip pressure provide the load while breathing out and feeling the muscle relax. Forcible stretching and ballistic stretching should be avoided.

The neck can be stretched into flexion, rotation and lateral bending. In the case of lateral bending, using the indifferent hand to hold onto the chair or bench to stabilize the body is helpful (see picture). A reasonable prescription would be 15-30 seconds holds (although longer holds are also possible) and 5-10 repetitions.

Re-train scapula stabilizers

Corrective exercises should focus on facilitation/strengthening of the scapular retractors and stabilizers (e.g., serratus anterior, lower trapezius, middle trapezius). The external rotators should also be assessed for strength and exercises prescribed as needed. See CSPE Protocol Shoulder Exercises, CSPE Protocol Serratus Anterior Training Track, and CSPE Protocol Scapular Training Track for more information. Progressive strengthening of weakened scapular stabilizers and upper extremity muscles should be continued even after symptoms resolve to restore full cervical spine and upper extremity function. (Sweeney 1990)

Jull (2008) recommended training the scapula in an upright posture. Addressing the scapula positioning (especially by activating the lower trapezius) should occur early in the rehabilitation program, often introduced in the first or second treatment session.

Manipulating or mobilizing the mid thoracic spine has been shown to at least temporarily increase the isometric endurance of the lower trapezius muscles (Liebler 2001). Segmental joint mobility may also be restored. However, improvement of global motion secondary to manipulation is short-lived in some cases (Nansel 1990). Consequently, a physical rehabilitation program may be necessary to maintain any gains.

The treatment goal is to activate and build endurance in the lower trapezius (e.g., wall angel exercises) and occasionally for middle traps and serratus anterior (e.g., push up with a plus or serratus punches).

The ACE approach (activate, teach control, build endurance) can be employed while organizing the exercises and educating patient as to the purpose of this exercise routine.

Exercises for the scapular stabilizers

A. Wall angels
B. Serratus punch
C. Push up with a plus.

A. Wall angels for the lower trapezius

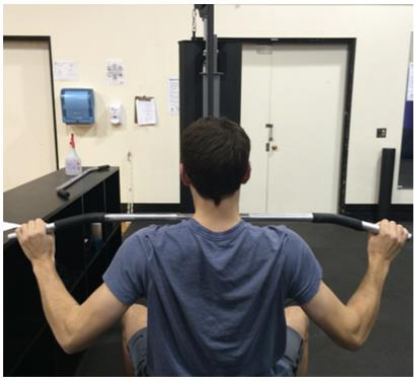
The key emphasis is often directed at the lower trapezius. The patient is directed to draw their scapulae down and in and then release them back to neutral without moving their glenohumeral joints. Many patients have difficulty properly activating this muscle and doing this properly.

EXERCISE PERFORMED AGAINST A WALL

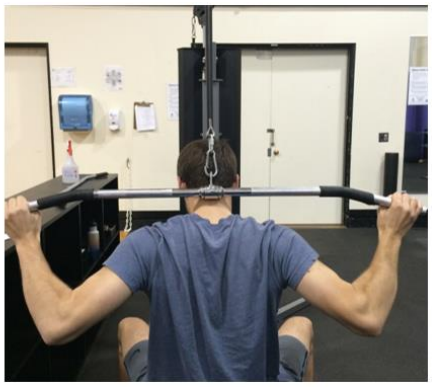
To help promote this motion, the lower trapezius can be activated by direct stimulus while the patient attempts to perform the “wall angel” exercise. The patient can then perform the exercise with his/her back against a wall to provide them with tactile feedback and a plane of motion.

TACTILE CUING THE LOWER TRAPEZIUS

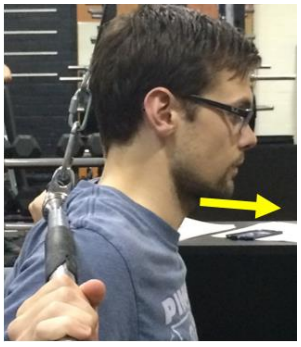
Activating the lower traps should also be encouraged during other exercise activities, for example, while doing pull downs. The patient can “pre-set” the scapula down and in, holding the scapula more or less stationary, while performing the pull down. In addition, patients should be taught that they should pull the pull bar in front of the head (instead of behind) to prevent chin poking.



RECOMMENDED PULL DOWN IN FRONT



TRADITIONAL PULL DOWN



UNWANTED CHIN POKING DURING TRADITIONAL PULL DOWN

Taping is a modality that may also be of benefit when working to correct a faulty movement pattern of the scapula. Various studies have shown an increase in the activation of the scapular stabilizing muscles during shoulder exercises with taping of the scapula. The tape is thought to help by facilitating muscles and increasing proprioception. The specific type of tape or method of taping seems to be unimportant. Both Leukotape and elastic therapeutic tape (Kinesiotape) have been tested, using various application techniques, with similar results (Lin 2011, Hsu 2009).

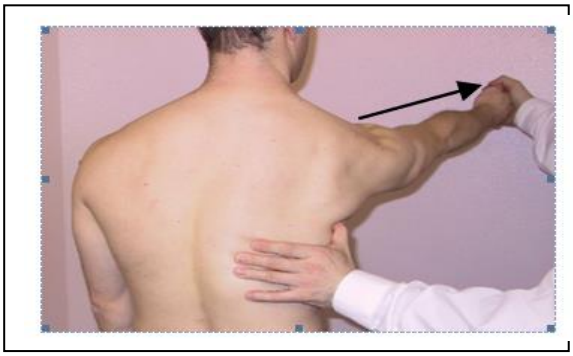
B. Serratus punch

The serratus anterior muscle is most active during the terminal phase of shoulder protraction (or the “punch”). The exercise consists of the patient “pushing” the upper extremity forward, like a piston, without flexing the elbow or twisting the torso. This action must originate from the scapula.

To perform the punch properly, it is important that the patient becomes “aware” of this muscle during the exercise so that it fully engages.

The practitioner can both monitor and facilitate an inhibited serratus by palpating and even goading the muscle while teaching the patient the exercise. In addition, resistance can be provided against the edge of the scapula to help the patient to visualize that the movement should be initiated from there.

Tubing can be used to provide resistance while performing this exercise. Common “cheats’ to watch out for are flexing and extending at the arm at the elbow or to rotating the whole torso in an effort to accomplish the punch.



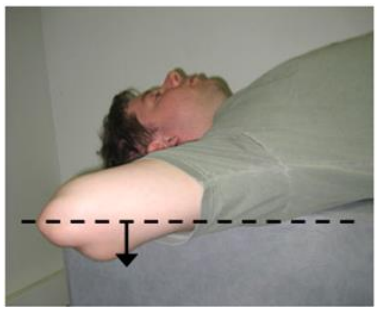
C. Push up with a plus for serratus

Terminal push-ups (AKA push-ups with a “plus”) can be done against a wall or on the floor from the knees or the toes. The patient fully protracts the arms, pushing further away from the floor or wall while maintaining core stability. It is not necessary to go down to complete the entire push up.

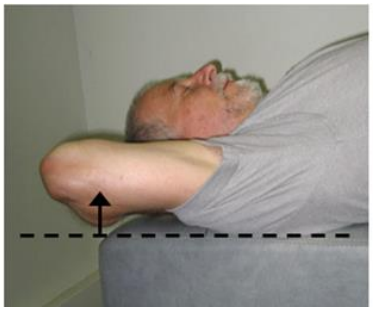
The practitioner should carefully check to see that the serratus anterior is active and be sure that the patient is not using a cheat, such as arching the thoracic spine instead of pushing the torso away by using the scapula.

4. Pec major stretches.

Part of the work up for an upper cross syndrome is to assess the patient for tight pectoralis major muscles. Tight pectoralis muscles can result in a forward, rounded shoulder posture and even forward head carriage. There are number of quick screens that can be done. While the patient is supine with their hands cradling their head, the elbows and upper arms can be observed to see if they settle back parallel to the floor or flair upward toward the ceiling due to tightness.



NORMAL PECTORALIS



TIGHT PECTORALIS

End feel and the degree of soft resistance can be judged by gently pressing the elbows toward the floor.

ASSESSING END FEEL

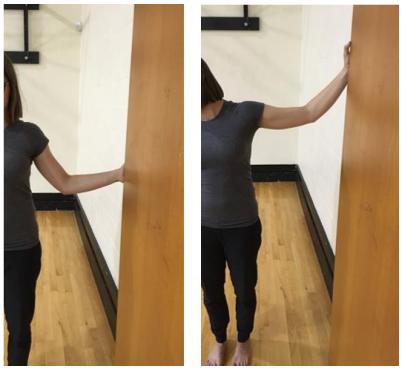
A variety of stretching (e.g., CRAC*, hold relax) or relaxation (e.g., PIR) can be performed in office. These procedures can be performed with the upper extremity in several positions between 90 and 120 degrees of abduction to target different muscle fibers.

PIR ON PEC MAJOR

Home stretches can also be prescribed as necessary. The muscles can be convienently stretched bilaterally by leaning into a corner. Unilateral stretches can be accomplished through a door way.

HOME STRETCH

Note that the upper extremity can be positioned at different angles to target various parts of the muscle (see picture below).



HOME STRETCH

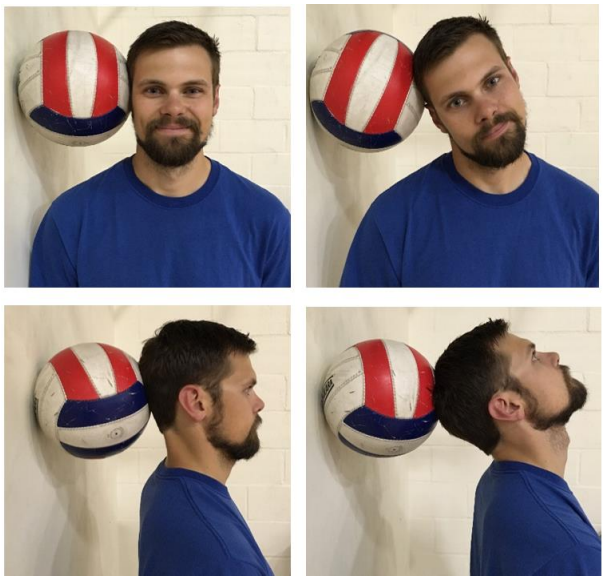
A common prescription would be 10-12 repetitions with 10-30 seconds holds.

* [agonist] ***C****ontract &* ***r****elax,* ***a****ntagonist* ***c****ontract.*

Strengthen the large torque producers of the neck

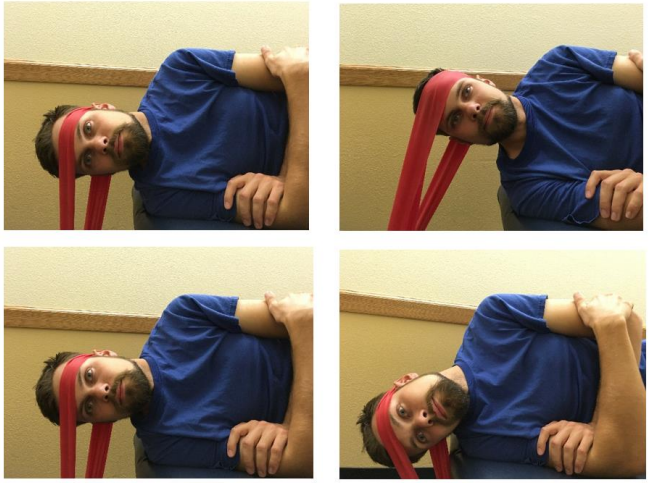
Another approach to cervical rehabilitation is to generally strengthen all of the neck muscles and improve endurance. Although isometric muscle contractions are recommended early in the process, especially in acute cases, strength training should not be introduced too early because it may provoke symptoms. In some approaches it is reserved until control of the deep cervical muscles has improved (Jull 2015).

Progressive isotonic strengthening exercises are performed within the available pain-free ranges of motion. Attention is directed to the cervical flexors, extensors, rotators, lateral flexors, and scapular stabilizers. These exercises are begun once a patient has relatively pain free AROM. Resistance can be provided at first by gravity, then by tubing, exercise balls or other forms of aid.



LATERAL FLEXION & EXTENSION EXERCISES USING A BALL

Two approaches can be used: lower intensity exercise against gravity or higher intensity resistance exercises. Aggressive strength training may be required for some but not necessarily for all patients. There is evidence to support both approaches, and they can be done in sequence, starting with the lower intensity exercises. (Ylinen 2007)



LATERAL FLEXION EXERCISE USING A RESISTANCE BAND

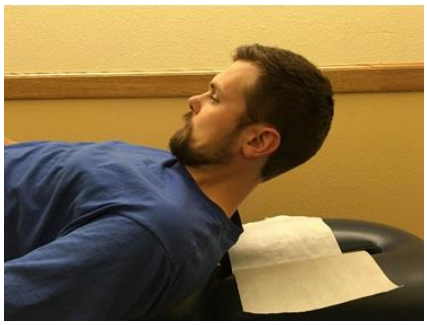
To prevent plateauing, the patient must have goals set and continuously increase either the amount of resistance or number of repetitions. Patients should progress to exercising at an 80% maximum voluntary contraction (MVC). When using weights, one recommendation is to start training at 20% of MCV and progress in increments of 5% when an individual can perform a target of 12 repetitions. (Chiu 2005)

To diminish the chance of delayed onset muscle soreness (DOMS), low intensity and high intensity exercises can be done on alternating sessions.

Exercises can first begin against gravity, moving the neck through each of the cardinal ranges of motion.

LATERAL FLEXION EXERCISE AGAINST GRAVITY

A head lift exercise requires the patient to initiate the movement by a controlled head nodding (i.e., craniocervical flexion) followed by flexion of the rest of the neck to clear the head from the supporting surface.



CRANIOCERVICAL FLEXION WITH CERVCIAL FLEXION

This craniocervical flexion set position must be maintained throughout the exercise. Begin with one set of 5 repetitions with a 1-2 second holding time, gradually increasing the repetitions as the patient improves.

For those patients who find this to be too difficult, “peel back” to an easier position by starting with the head supported by a pillow. This is usually sufficient for many patients as lifting the head from a flat surface may be often too difficult.

Extension strength may be trained in standing, or alternately, in the four-point kneel/prone-on-elbows position against a weight or a resistive strap such as Theraband.

Assessment & Training Targets

The table below provides potential training targets based on repetitions or timed isometric holds.

Position	Exercise	Reps/holds	Function
Supine	Flexion (with chin tuck)	6-8 reps	functional
		3-5 reps	fair
		1-2 reps	poor
		0 reps	non functional
Prone	Head held in extension	Hold 20-25 sec	functional
		Hold 10-19 sec	fair
		Hold 1-9 sec	poor
		Hold 0 sec	non functional
		Hold 20-25 sec	functional
Side lying, neck in neutral supported on pillow	Side flexion off a pillow	Hold 10-19 sec	fair
		Hold 1-9 sec	poor
		Hold 0 sec	non functional
Supine	Head lifted & rotated	Hold 20-25 sec	functional
		Hold 10-19 sec	fair
		Hold 1-9 sec	poor
		Hold 0 sec	non functional

* Younger patients should be able to do the most repetitions and for the longest time; with age, time and repetitions decrease.
Adapted from Palmer, M.L., and M. Epler: Clinical Assessment Procedures in Physical Therapy. Philadelphia, J.B. Lippincott, 1990, pp. 181–182.

An example of a cervical rehabilitation program composed almost entirely of strengthening exercises. (Evans 2012).

This particular program performed well for chronic neck patients, with similar outcomes to manipulation and superior to a home-based exercise program. It is a supervised program, targeting neck and upper body muscles with an emphasis on both high repetitions and progressive loading.

- 20 1-hour sessions.
- 5-minute aerobic warm-up
- Stretching before and after the routine.
- Cervical muscles exercised with the supine patient wearing headgear attached to a pulley system with adjustable weights (1.25–10 lb).
- Three sets of 15 to 25 repetitions performed in extension, flexion, and rotation.
- Additional exercises include push-ups and dumb bell shoulder and chest exercises using dumbbells.

Strategy 4: Re-train the sensory-motor response loop

Poor motor control of the neck or shoulder girdle (Janda 1987), poor proprioception, and a general lack of kinesthetic awareness associated with the cervical joints may be causative or perpetuating agents in patients with neck pain. Patients with a history of whiplash demonstrate proprioception deficits (Loudon 1997, Revel 1991). Murphy (2000) speculates that cervical disc herniations may, as is the case in lumbar herniations, result in inhibition of the deep intrinsic muscles. Lee (2008) reported that there was a positive correlation between poor performance on head re-positioning tests and frequency of neck pain episodes. Stanton et. al. in a 2016 meta-analysis also concluded that patients with chronic, non-traumatic neck pain are worse than asymptomatic controls at repositioning tests.

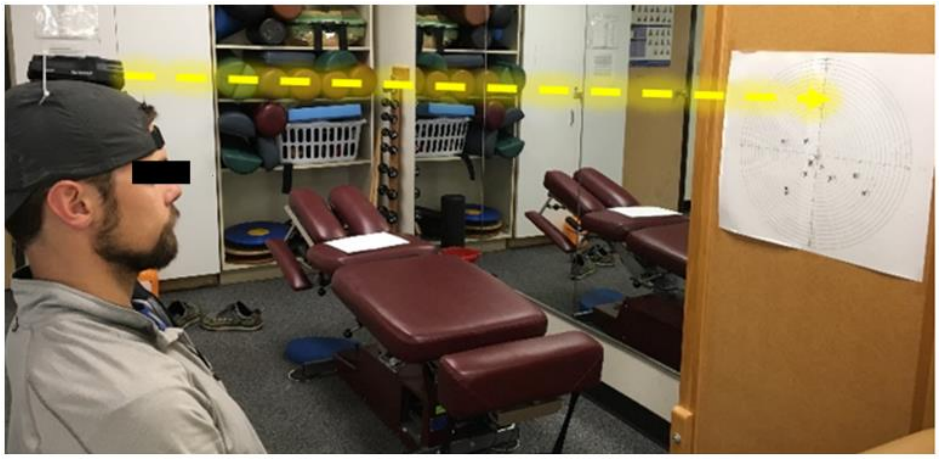
Based on these observations, training activities should also be aimed at restoring the efficiency of the patient's "sensory-motor" response loop. Unless the patient has good proprioception and kinesthetic awareness, healthy responsive muscles, and appropriate motor programming occurring in the central nervous system, the patient may be susceptible to re-injury or may not overcome the presenting symptoms. Revel (1994) was able to demonstrate that improvement in kinesthesia paralleled a decrease in neck pain.

Assessment of the sensory-motor response loop

Although a number of screening tests have been suggested in the literature, the history may be the most useful indicator of which patients would benefit from proprioceptive and kinesthetic awareness training.

Assessment tool	Finding	Significance
History	Chronic neck pain or chronic headaches, a history of recurrent neck pain, poor response to a more basic exercise program, presentation of "late" whiplash syndrome.	The prolonged nature of the symptoms suggests the potential for instability due to errors in the proprioception-muscle response loop. Proprioceptive and kinesthetic awareness training may be indicated.
Revel's kinesthetic test (AKA joint positioning test)	Patient cannot reposition head and neck to a set starting point with eyes closed.	May be associated with poor proprioceptive input from the joints and muscles of the neck or a problem in the neuro-programming. Balance and proprioceptive training, especially incorporating neck movements, is indicated.
Various oculomotor tests (eye movement with stationary head; head movement with gaze on a stationary target, coordinated eye and head movement)	Testing reproduces symptoms or displays jerky (non-smooth) head or eye movements; complaints of blurred vision or nausea during testing.	Trauma or even in non-traumatic cases, the normal coordination between cervical and ocular movement may be disturbed. Oculomotor training may be necessary.

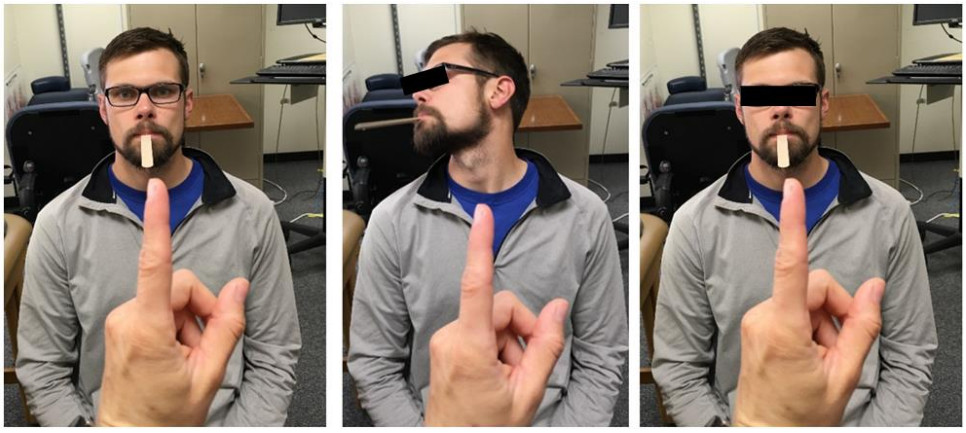
Revel's test. The patient sits 90 cm (35.4 inches) from a 40-cm target composed of concentric circles 1-cm apart. A laser pointer is attached to the top of the patient's head and points directly at the bullseye. The patient is then instructed to, while keeping the eyes closed, maximally rotate their head in one direction, hold that position for 2 seconds, and then return to the starting point where the laser pointed to the bullseye.



PATIENT ATTEMPTS TO FIND BULLSEYE WITH EYES CLOSED

This procedure is repeated three times in rotation to the left and right and then in flexion and extension (additional directions can also be tested). The practitioner measures the amount of under-or over-shot (chart with a "-" if undershot, "+" if overshot). A repositioning error of 7 cm (2.75 inches)* or more (equivalent of 4.5 degrees) suggests a deficit in joint position sense. Additional indications of impaired kinesthetic awareness include jerky movements, uncertain "searching" for the bullseye, and reproduction of dizziness (but not pain). (Roijezon 2015, Murphy 2000, Jull 2008)

A simpler way of screening (although a less reliable or valid method) is to have the patient try to re-align a tongue depressor clenched between the teeth with the practitioner's finger.



LESS ACCURATE SCREEN: EYES CLOSED, PATIENT TRIES TO ALIGN POINTER WITH PRACTITIONER'S FINGER

* Some authors suggest a 3 ring (3 cm) threshold for failure. (Murphy 2000)

Strategy 4: Sensory motor training

Improvements in cervical proprioception will allow the patient to maintain a stable cervical position while progressing to specific strengthening exercises. (Jull 2008)

Summary of treatment options for proprioception-motor response

1. PNF cross patterns
2. Rhythmic stabilization exercises
3. Head re-positioning exercises
4. Oculomotor training
   - eye movement with stationary gaze
   - head movement and stationary target
   - coordinated eye and head movement
5. Balance training with perturbations (2-5 minute sessions)

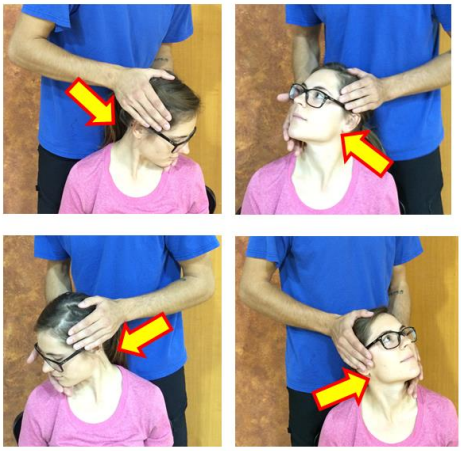
1. PNF cross patterns

Cross patterns can be introduced to the patient once s/he has good active range of motion in the cardinal directions. In some cases, they may be able to incorporate these patterns in a supine position before doing them seated. The advantage of the cross patterns is that they create kinesthetic awareness and coordinated muscle activity in movements that are closer to those of daily living (as opposed to the "robotic" planes captured by pure cardinal planes of movement). They seek to coordinate the activities of multiple cervical joints in angular motions.

PNF CROSS PATTERN AS AN AROM EXERCISE

The patient should practice PNF diagonals first as active range of motion exercises. The patient looks down and tries to place his/her chin behind one clavicle, then looks up and away to the opposite side (i.e., extension plus rotation). The pattern is retraced to the starting point. The complementary pattern repeats the entire up and back process beginning with the opposite shoulder. This cross pattern can be incorporated with eye movement by having the patient initiate each movement with their eyes, immediately followed by movement of the head in the same direction. (See pp 49).

If the patient is too acute, the cross pattern can be done as a passive ROM intervention (multiple repetitions). Later it can also be employed later as part of a resisted exercise program with provider assistance or at home with a partner or with tubing.

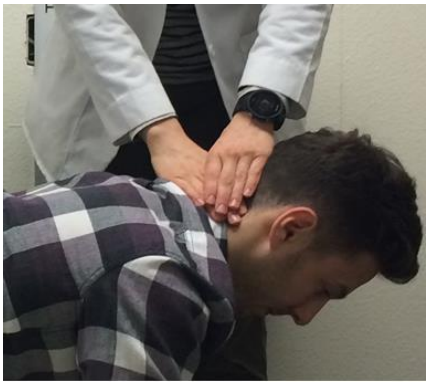


PNF CROSS PATTERN AS A PASSIVE OR RESISTED ROM EXERCISE

2. Rhythmic stabilization exercises (with tongue depressor)

A tongue depressor or other similar object can be placed between the patient's teeth. The practitioner gently and rhythmically attempts to move it up and down, right or left, and the patient resists. Another layer of training can be added by repeating the exercise non- rhythmically and in unexpected patterns to work on patients' coordination and speed of contraction. These can be performed in 15-30 "bouts." Patients with TMD may not be good candidates for this neck exercise.

A provider-assisted activity that can be performed in the quadruped position is gentle externally administered rhythmic loads to the cervical spine as the patient attempts to resist the impulse. The loads can eventually be administered arhythmically so that the patient cannot anticipate them.

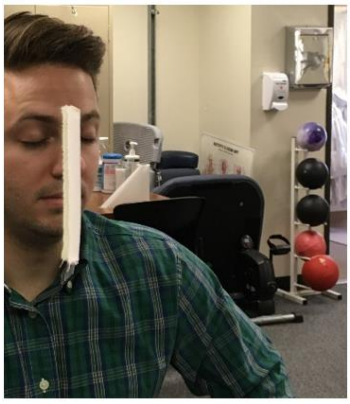


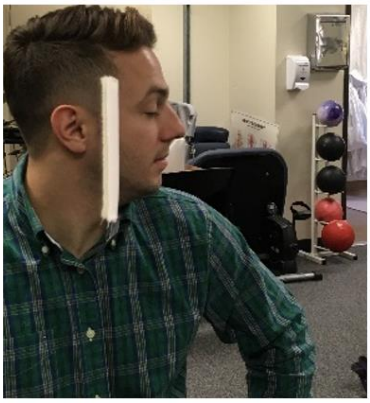
3. Head re-positioning exercises

The patient can be given kinesthetic awareness exercises patterned after the Revel test. Patients wear an apparatus with a laser or flash light attached to the top of their head. Sitting or standing about 3 feet away from the target, they practice aiming the light on the bullseye of the target or any mark on a wall.

Starting with the light on the target or bullseye, the patient closes his/her eyes, rotates away to one side and with eyes still closed attempts to re-align with the target. They then open their eyes and check their accuracy. Next they practice rotating to the opposite direction and return again to the starting point, checking their accuracy. Then they train in flexion and extension. Once the target can be consistently re-acquired with accuracy, the patient can be advanced to tracing diagonals. Movement should be kept within a pain free range. More complex exercises would consist of tracing figure 8's (intersecting through the target) and altering speed. (Jull 2008)

A target and a mirror can also be used to simulate this training activity. In the series of pictures below, the patient attempts to line up his nose with a piece of athletic tape. With eyes closed, he moves his head away from the target, and then tries to find his way back by kinesthetic awareness alone.





This retracing head positon exercise can be done in rotation, flexion and extension and diagonals.

An alternative suggested by the primary author of this CSPE protocol is as follows: The patient looks in a bathroom mirror and places a dab of toothpaste on the reflection of the tip of his or her nose. With eyes closed and moving only his/her neck, the face is turned away from the mirror, held at end range for 2 seconds, and then the patient attempts to find the way back and line up the tip of the nose with the target. This can be repeated in flexion, extension, rotation and moving through oblique angles. Training sessions are at least twice a day, 30-60 seconds (or until fatigue).

4. Oculomotor Training

Oculomotor training may be appropriate for patients with post-traumatic neck pain who experience delayed recovery. Although the exercises themselves have demonstrated some effectiveness (Fitz-Ritson 1995, Humphreys 2002), no single screening test has been established as being an accurate predictor of who would most benefit from this type of intervention (Murphy 2011). Other authors suggest that these exercises can be introduced early (even the first or second visit) in patients with moderate to severe whiplash injuries. Additional indications in non-traumatic patients include those who complain of associated dizziness, those who initially have trouble performing the exercises themselves, or patients who have not adequately responded to a more traditional exercise and spinal care program. (Jull 2008, Roijezon 2015)

This training consists of a series of exercises requiring them to first isolate oculomotor movements from movements of the neck and then retrain the neck and eyes to work in a coordinated fashion. The exercises should be performed both sitting and standing.

General prescription: start with 10-30 second practice sessions per exercise, progress to 1-2 minutes and then to 3-5 minutes. Frequency of exercise can begin with twice a day, progressing to 3 times a day and finally 5 times a day. (Roijezon 2015)

Adverse effects: These simple exercises can produce neck pain, headache or dizziness.

Contraindications and peel backs: They are contraindicated if they cause/exacerbate neck pain or headache. They may, however, be performed to the point of dizziness[*] (or eye blurriness) as long as the symptom is only temporary while doing the activity. Decreasing the number of repetitions or peeling back to a supine position often mitigates these adverse effects. (Jull 2008, Roijezon 2015)

Oculomotor exercises

A. Eye movement with stationary head
B. Head movement with gaze on a stationary target
C. Coordinated eye and head movement

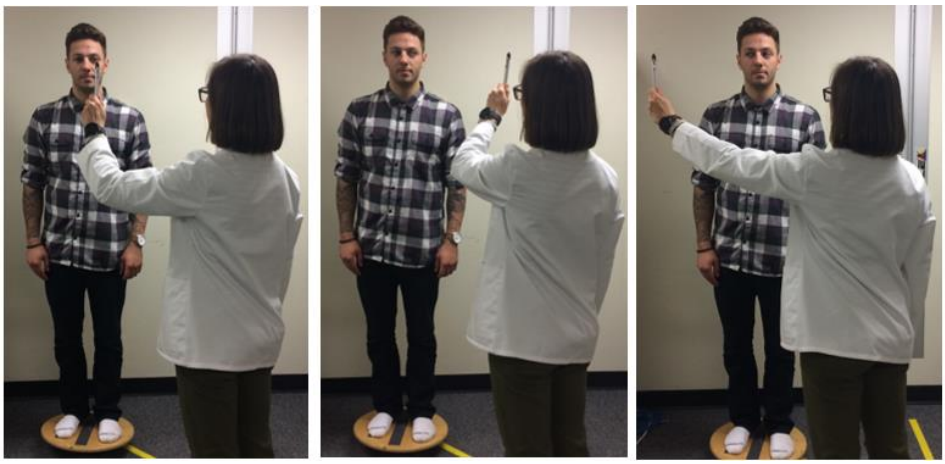
[*] Dizziness as opposed to vertigo, loss of balance or pre-syncope.

A. Eye movement with stationary head

The patient faces forward and moves his/her eyes without any movement of the head. A pen or any suitable target is moved from side to side and up and down. The patient tracks the target with his/her eyes, but the head and neck remain still.

If used as a test, reproduction of symptoms or jerky (non-smooth) head or eye movements constitute test failure. Blurred vision or nausea are also abnormal findings and suggest that training may be beneficial. (Jull 2008)

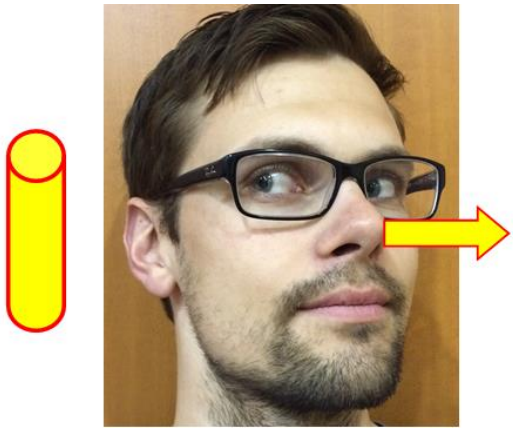
Once the patient can do 10-20 repetitions (Murphy 2016) without pain or lasting dizziness, the speed can be increased and more intricate patterns can be traced in the air (e.g., progressing from an H, to diagonals, and then to random tracings at variable speeds).



NOTE THAT THE OCULOMOTOR EXERCISE CAN BE AUGMENTED BY STANDING ON AN UNSTABLE SURFACE SUCH AS A WOBBLE BOARD.

B. Head movement with gaze on a stationary target

This exercise helps to train “gaze stability” and the cervico-ocular coordination to function in a dynamic world, which requires activities such as driving. This time, the patient focuses on a stationary point while moving the head.



If used as a test, inability for the patient to maintain their focus on the target, jerky or awkward cervical movement, reduced ROM (e.g., < 45 degrees), or reproduction of dizziness, blurred vision or nausea are abnormal findings and suggest that training may be beneficial. (Roijezon 2015)

The exercises are usually performed seated and then progressed to a standing position. The patient locks their gaze on the target while moving the head up and down, rotating left to right, and then progressing to tracing diagonal directions. Twenty repetitions are performed in each direction (Murphy 2016).

HEAD IS MOVING WHILE EYES ARE LOCKED ON A TARGET

The difficulty of the exercise is progressed through the following steps:

- increasing the speed and range of head movements,
- displaying the target against distracting patterns (e.g., stripes or checkerboards) or using a printed word as the target rather than just a spot. The target can be created on a computer screen or printed out and attached to a wall or taped to the bathroom mirror
- tracking an object, with head stationary, while sitting on an exercise ball or standing on a wobble board
- practicing gaze fixation while walking and turning the head. (Jull 2008)

C. Coordinated eye and head movement

This last exercise now trains “smooth pursuit” with the eyes and neck to work in tandem. The sitting/standing patient faces forward and fixes their gaze on a moveable target. The practitioner slowly moves the target up and down and left to right. When the patient can appropriately follow these movements with eyes and head moving together without pain or residual dizziness, the target can then trace H’s, diagonals (see p. 43) and finally more complex random patterns. Once the patient can do these maneuvers successfully without pain or lasting dizziness, the speed can be increased and more intricate patterns can be traced in the air at variable speeds.

THE TARGET IS TRACKED BY COORDINATED EYE AND HEAD MOVEMENT

The patient can also practice tracking a moving target by first leading with the eyes focused on the target, followed by movement of the head. (Jull 2008) This can be incorporated with PNF patterns (see 43). A simple home exercise which can eventually be prescribed is having the patient toss a tennis ball from hand to hand while tracking it with his head and eyes. (Murphy 2016) This training can be further progressed by doing this exercise on a rocker board or balance pad.

Troubleshooting: If the exercise triggers unwanted side effects, consider the following modifications:

- begin in a supine position
- narrow the range of movement
- shorten the training session (beginning with as little as 5 seconds)
- reduce the speed of the movements
- reduce the number of repetitions
- delay the exercises until the patient has progressed further in the rest of the rehabilitation program.

5. Balance training with perturbations

Balance training can be done on any uneven surface. Rocker boards, balance boards, disks, propriopads, rocker sandals, or any unstable training surface may be used. Home improvisations include standing on rolled up towels, throw pillows, or at least standing on one leg.

The progression is to move patients from stable to less stable platforms, through more difficult challenges (e.g., progressing from double leg stance to single leg, eyes open to closed, simply maintaining balance to performing complex activities).

In general, patients should perform the activities bare foot. With feedback from the practitioner, they should attempt to evenly distribute their weight over their soles or adopt and maintain a "short foot." A towel can be placed over the surface for sanitation purposes.

Once this is done, for many of the exercises, they should hold a Brügger or modified Brügger position: feet forward, knees slightly rotated out and bent, neutral pelvis with bracing, sternum raised up (allowing the shoulder to drift back), a straight "long" neck with chin gently protracted (or at least held in neutral).

Control of core stability may also contribute to control of three-dimensional scapular motion and therefore should be an integrated component of a rehabilitation regimen.

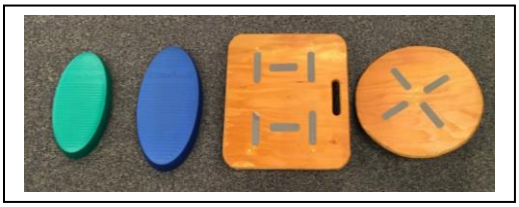
Practice sessions should be short (e.g. 1-5 minutes, stopping sooner if there is fatigue) and frequent. Ideally 2-5 times daily. For example, an exercise routine on balance pads of different degrees of difficulty could be composed of 1 leg standing, eyes open for 10 seconds for 2-3 reps, and then again with eyes closed. A routine on rocker board could be composed of 2-3 minutes of "gripping" the board with the feet (or adopting the short foot) and then leaning forward and then leaning side to side, performing 3 sets of 8-10 reps.

Improvement in muscle coordination, speed of contraction, and balance should be expected within two weeks, and a basic training program extending from 4-6 weeks. Patients train at the relevant level until they can maintain their balance steadily for a period of 30 seconds. (Jull 2008)

Six Key Ingredients for Designing a Cervical Program

1. **Advance from stable to progressively less stable surfaces**

   If using a rocker board, exercise facing the long side, the short side, and an oblique angle. (Note, each of these positions is more unstable). Optionally, move from rocker board to wobble board or through various colors of propriopads.



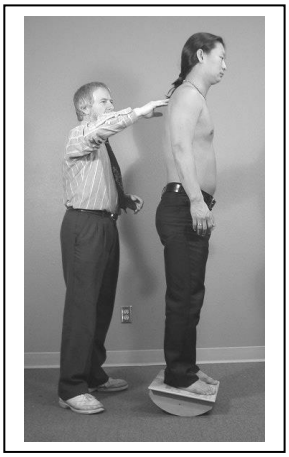
2. **Single leg stance**

Advance the patient *as soon as possible* to a single leg stance. The most effective training may only really start in this position. The steps below can be done while on one leg. (Murphy 2000)

3. Add upper extremity activities

These activities begin with simple range of motion exercises in the cardinal planes. Later, tubing or hand weights can be added to provide resistance. Shoulder PNF cross patterns can also be introduced. Next, dynamic activities are performed (e.g., tossing a ball back and forth with the practitioner or to oneself). Most important of all, any upper extremity activity which has been identified as problematic for the patient or important for his/her work or recreational activities should be practiced, first in slow controlled movements and finally mimicking the speed actually used in real life.

4. Challenge the patient with perturbations



These should be rapid, shallow, with low force. They should come from unexpected directions so that the reaction does not rely on vision but rather is dependent on proprioception. Some perturbations should be administered around the Shoulder girdle, some directed at the thoracic spine especially to challenge the patient's ability to maintain chin retraction. They can be rhythmic at first and then arrhythmic so that they Cannot be as easily anticipated.

5. Incorporate neck & eye movement

This activity should not be introduced until the patient has good, relatively pain-free active angle of motion and reasonable neck strength. Eye movement and neck movement should be coordinated. Brief activities should include the patient following a moving target first with the eyes (face forward) and then coordinating both eye and neck movement. The eyes should lead the neck movement, but avoid forcing the eyes to end range. The moving target can trace out regular smooth movements (such as an "H") but can then be advanced to more rapid and random movements. (Also see pp 47-49)

6. The last stage of training should, whenever possible, create an exercise sequence that mimics the demanding or risky activities that the patients will be returning to. For example, holding a racket, dumbbell or using bands or tubing to provide resistance, the patient may practice going through the motion of serving a tennis ball, coordinating head, upper extremity and eye movement. This can be done at first in slow, deliberate motions with the practitioner correcting any problems in form and then eventually increased to the actual speed demanded by the activity.

The activity must be an activity specific for each individual patient (e.g., hanging dry wall, hammering overhead, putting dishes away).

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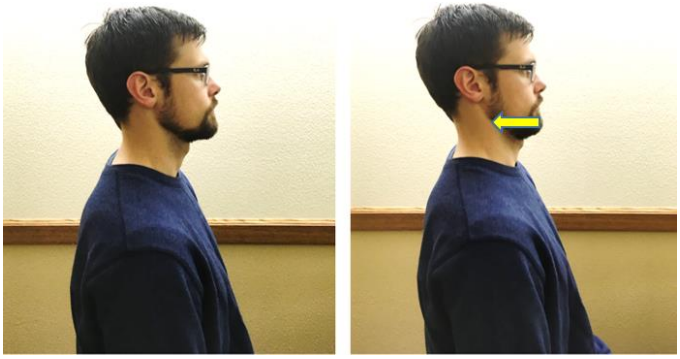
Appendix I: Neck Exercises

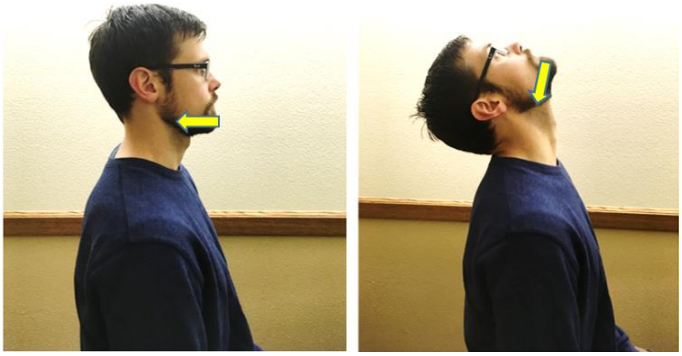
The following is a home-based, high frequency, exercise program used in a 2012 trial comparing home exercise to spinal manipulation for acute and subacute neck pain. It is unclear how it would perform in chronic cases. It is unusual in that it applies a typical McKenzie treatment approach emphasizing repetitive range of motion exercises taken to end range along with a prominent role for chin retraction.

A striking difference is that, unlike a typical McKenzie/directional preference approach, all directions are utilized with no particular attention to finding a preferred direction (although directions that aggravate the symptoms should be avoided). For more details, see CSPE protocol *Directional Preference Protocol: Centralizing Neck, Shoulder and Arm Pain*

SITTING CHIN RETRACTION



SITTING CHIN RETRACTION WITH EXTENSION



LYING CHIN RETRACTION

LYING CHIN RETRACTION WITH EXTENSION

CHIN RETRACTION HELD AT DIFFERENT END RANGES

SIDE BENDING **NECK ROTATION** **NECK FLEXION**

Hold at end range for 2-3 seconds (duirng a breath cycle: inhale-exhale-relax)

Frequency: 6-8 sessions everyday

Repetitions

Head retraction	**Sitting or lying**	**10X**
With extension	**Sitting or lying**	**10X**
With side bending		**5X**
With rotation		**5X**
With flexion		**5X**
With extension	**Sitting or lying**	**10X**
Scapular retraction		**5X**

Reference

Bronfort G1, Evans R, Anderson AV, Svendsen KH, Bracha Y, Grimm RH. Spinal manipulation, medication, or home exercise with advice for acute and subacute neck pain: a randomized trial. Ann Intern Med. 2012 Jan 3;156(1 Pt 1):1-10.

Appendix II: Craniocervical Test (with pressure sensor) & Exercise

The head is in a neutral position and an inflatable air-filled pressure sensor (Stabilizer, Chattanooga South Pacific) is placed behind the neck with the edge of the bladder against the occiput. It is then inflated to 20 mmHg. Watching the pressure gauge, the patient very slowly flexes the upper cervical spine with a gentle head nodding action and holds the position steady for 10 seconds. *Note: This should occur with minimal activity in the superficial muscles*. Most neck pain patients' initial performance is an increase of only 2-4 mmHg and they demonstrate an inability to hold the position steady. An ideal result is that a patient can increase the pressure 10 mmHg by 2 mm intervals for a total of 5 levels of increased pressure. Most neck pain patients fail after the first two intervals and demonstrate an inability to hold the position steady (Jull 1997).

Passing the test requires the following:

⇒ Slow, smooth movement (as opposed to a jerky movement suggesting the substitution of more phasic muscles).
⇒ Controlled holds at intervals from 22 to 30 mmHg.
⇒ 26 mmHg held steady for 10 second for 10 repetitions.
⇒ No recruitment of the jaw muscles, SCM, or other superficial muscles of the neck.
⇒ No lifting of the neck or pivoting of the occiput on the table.

Use the following checklist to insure a standardized assessment:

⇒ Neutral head position (the plane of the face is parallel to the table).
⇒ Neutral neck position (the neck is not flexed or extended, i.e., the longitudinal plane of the neck is parallel to the table).
⇒ The edge of the bladder should be against the occiput.
⇒ The patient should gently press his/her tongue against the roof of the mouth just behind the teeth with teeth apart and lips closed (this will help prevent recruitment of jaw muscles or muscles attached to the hyoid).
⇒ The patient slowly nods the head in a controlled manner until the needle on the gauge registers 22.
⇒ The head returns to the starting position and then attempts to nod again until the pressure gauge goes to 24.
⇒ This is continued up to 30 or until the patient fails.
⇒ Return to 22 and see if the patient can hold for 10 seconds for 10 repetitions. If they can, test them again at 24 and so on up to 30 if this is possible. ***Note that testing stops either when the patient cannot achieve the 10 second goal or the patient uses a substitute movement like chin retraction***.

Rationale and test performance

Several studies have shown neuromuscular impairment during this test in patients with chronic neck pain and cervicogenic headache patients. (Amiri 2007, Dumas 2001, Jull 2007, Zito 2006, Zwart 1997).

***Clinical Tip*:** In one study, test failure had 100% sensitivity and 94% specificity (+LR 16) for differentiating cervicogenic headache from tension-type headache and migraine when in combination with palpably painful upper cervical joint dysfunction and restricted active range of cervical extension. (Amiri and Jull 2007).

A 2008 systematic review questioned the test's reliability (de Koning 2008). The review reported acceptable intra-examiner ratings (ICC scores 0.65 to 0.93) from four studies, but three of these suffered from design flaws and small cohort sizes. (Chiu 2005, Jull 1999, Jull 2000). One study judged to have a "satisfactory" design reported "fair" inter-examiner reliability (ICC values of 0.51) but below the criterion of 0.70. (Hudswell 2005) A subsequent 2010 study (James 2010) found intra-examiner reliability to be excellent (0.983; standard error of the mean = 8.94) although this test, too, had issues with blinding. A 2011 study (Arumugam 2011) on asymptomatic subjects reported excellent inter-examiner reliability with an ICC of 0.91 (95%CI 0.83-0.96). Other studies have related an altered electromyographic amplitude of the deep and superficial neck flexors to changes found on the pressure gauge during the craniocervical flexion test. (Jull 2004, Falla 2004) Although electromyography of the superficial neck muscles has been shown to be reproducible, (Oksanen 2007), evidence for the reproducibility of measuring deep cervical flexor muscles with electromyography is lacking (Falla 2004). Therefore, whether the craniocervical flexion test truly reflects deep flexor activity is still in question (deKoning 2008).

Craniocervical flexion exercise.

Liebensen (2007) and Jull (2008) suggest a craniocervical flexion exercise as part of an initial training program to activate the deep flexors of the neck (e.g., the longus capitis and **l**ongus colli). The exercise is performed in the supine position using a stabilizer cuff under the head. This is similar to the craniocervical flexion test but is used as a rehabilitation exercise for improving motor control and muscular endurance.

Patients monitor one of their SCMs, attempting to perform the exercise with *minimal* contraction. This acts as a biofeedback mechanism to prevent excessive substitution by the SCM and helps them isolate firing of the deep neck flexors.

The head nodding action must be performed slowly and precisely with the patient training at a level of pressure that can be controlled. The exercise should be pain free. If the patient reports pain, it may be that s/he is performing the exercise the movement too vigorously. Another possibility is an error in technique. The patient may be mixing the gentle head nodding motion with a shearing chin retraction movement. Another possible correction is to have the patient rest his/her arms across the abdomen, to decrease tension on the brachial plexus and nerve roots.

Finally, if these corrections fail, then the rotation of the cranium is performed from a position of extension and the head is "nodded" into a neutral position.

Before using the pressure biofeedback instrument, the patient should practice the craniocervical nodding movement, 10 repetitions, 2-3 times a day for a few days to become familiar with it. (Jull 2008) When the patient can successfully perform the exercise, then a biofeedback component can be added, using the pressure cuff.

This exercise can also be used to assist in retraining kinesthetic sense with the patient carefully targeting different pressures between 20 and 30 mmHg while watching the pressure gauge. The patient can palpate the superficial muscles of the neck and the jaw muscles to insure minimal recruitment and/or s/he can be sent home with a pressor sensor.

This training activity should be performed twice a day (however, it requires that a patient have access to the proper equipment). The overall training program is about 6 weeks. The training level starts at a target pressure that can be successfully held for 5 seconds.

Key home instructions include:

- ⇒ Movements must be slow and controlled.
- ⇒ The patient should hold the tongue against the roof of the mouth, with lips closed and teeth parted.
- ⇒ Recruitment of jaw or superficial neck muscles should consciously be minimized.
- ⇒ The exercise must stop when fatiguing or starting to shake so the incorrect movement pattern is not re-enforced." (Jull 2008)
- ⇒ The target goal would be for a patient to be able to use good form and perform 10 repetitions for 10 second holds up to the 26 or 28 pressure level.

Appendix III: The Quadruped Track

The quadruped track, adapted by Murphy (2000, 2016), is an exercise sequence that incorporates many of the strategies addressed in this CSPE protocol. More specifically, it incorporates deep neck flexor, scapular, and balance components of a rehabilitation program along with some focus on lumbopelvic core stability.

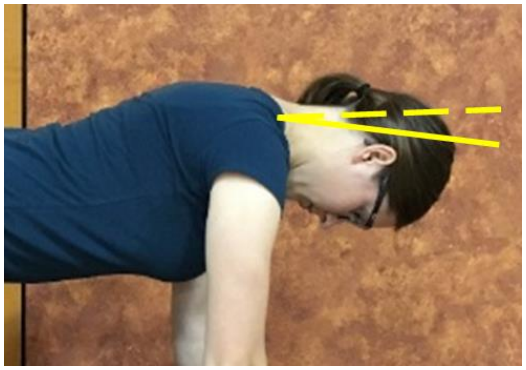
The patient holds a specific "cervical brace" throughout a quadruped exercise track. The patient is assessed through each of the following steps to ascertain the most difficult step that they can do correctly with minimal discomfort. That step becomes the focus of the exercise program. They can also use the earlier, easier steps as a warm-up for the step that they are training in. The provider monitors their progress over time and moves them to the next level of difficulty whenever the patient demonstrates proficiency.

STEP 1: Quadruped static hold. The patient is on all fours, adopts a specific craniocervical postural brace (see below), with the lumbar spine held in neutral, locked in with abdominal bracing, and the scapula stabilized without any medial border winging. Optionally, the scapula can also be held be in a tucked down position by activating the lower trapezius. The exercise is to simply hold the position for 30 seconds without losing form or shaking.

THE "CERVICAL BRACE"

The functional cervical brace, unlike a simple chin retraction, requires the following: The head is positioned face down looking at the floor. The tongue is placed firmly against the hard palate just behind the teeth (as if to make a "cluck" sound). In *one smooth sweeping motion*, the patient protracts the chin toward the floor and then *flexes* (not retracts) it as if scooping something back up to the neck, and holds that positon. The goal is to focus the movement to the craniocervical junction and upper cervical joints.

In the final position, the neck itself is in relatively neutral alignment with the chin tucked in. As a result, the patient should feel tension between the throat and the lower cervical and upper thoracic spine. If the patient does not sense this, the movement should be performed again with cues from the practitioner. The sequence of chin protrusion and the scooping craniocervical flexion must occur as one single continuous motion. In some patients with true structural instability, the initial "reach" of the protrusion may need to be shortened.



NECK SHOULD NOT BE FLEXED!

STEP 2: Quadruped arm raise. Same as step 1, but the patient slowly alternates arm raising (10-20 repetitions per limb). The arm is held in the extended position for 2 seconds and then lowered. ***NOTE: The practitioner's and patient's focus is on maintaining all of the elements of good form outlined in step 1.***

STEP 3: Quadruped leg raise. The patient slowly, alternately raises each leg (10-20 repetitions per limb). Again the focus is on holding the correct form. Be sure that during the leg raise, the patient does not lose their neutral pelvis and hyperextend their lumbar spine.

STEP 4: Reciprocal arm and leg raise. The patient slowly, alternately raises each leg (10-20 repetitions per limb). Again the focus is on holding the correct form.

STEP 5: Quadruped book balance. Same as step 1, but an additional motor control element is added by creating a balance demand. The patient balances a light book (1-2 kg/2-4 lbs) or some other relatively light object on his head.

Once the patient can hold the position for 30 seconds without losing form, then the training proceeds by progressively incorporating the arm and leg movements again.

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