[Sports Physical Therapy]

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Therapeutic Exercise for Athletes With Nonspecific Neck Pain: A Current Concepts Review

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Context: Benign neck pain is common in athletes and is usually the result of minor sprains, strains, or contusions. Athletes with neck pain may have deficits in cervical and/or upper thoracic mobility, muscle recruitment, strength and endurance, repositioning acuity, postural stability, and oculomotor control.

Evidence Acquisition: A Medline search was performed via PubMed to locate articles of any publication date through December 2011 using the search terms *cervical pain, neck pain, athlete, athletic, therapeutic exercise*, and *rehabilitation*. Reference lists of retrieved articles were searched for additional relevant references.

Results: Therapeutic exercise has promise as an intervention for individuals with neck pain, although reports on isolated athletic populations are lacking. To date, recommendations for specific therapeutic exercises have been derived largely from anecdotal or uncontrolled level IV or V evidence.

Conclusion: Clinicians should consider deficits, functional limitations, irritability level, and the sport's cervical spine stress profile when selecting exercises for athletes with neck pain.

Keywords: cervical; strengthening; endurance training

High-level athletes and weekend warriors alike are affected by neck pain. In most instances, athletic neck pain is the result of minor injuries, such as ligament sprains, muscle strains, or soft tissue contusions.[60] Data on the prevalence of benign neck pain in athletes are lacking, presumably because surveillance efforts in this population have focused on serious cervical spine injuries (eg, fractures). Cycling athletes, for instance, suffer from neck pain at a relatively high rate,[55,57] yet cyclists are often absent from reports of athletic neck pain. Regardless of the origin of symptoms, athletes with neck pain may have deficits in muscle recruitment,[8,20] strength and endurance,[38] repositioning acuity,[27,46] postural stability,[33] or oculomotor control.[49] Athletes with neck pain may also have mobility deficits in the cervical and/or upper thoracic regions.[7] A growing body of evidence supports therapeutic exercise to address deficits associated with neck pain.[39,43-45,48,53,58,59] Randomized controlled trials comparing different exercises or exercise protocols with various athletic populations are lacking. Consequently, the discussion of therapeutic exercise that follows is impairment based and not sport specific. Nonetheless, the clinician should give consideration to the cervical spine stress profile of the athlete's sport prior to formulating an exercise program.

EXERCISES TO IMPROVE MOBILITY

Self-stretching exercises may reduce neck pain, at least in the short term.[59] Ylinen et al[59] reported that stretching 5 times per week was as effective in reducing chronic neck pain as twice-weekly manual therapy. Stretching exercises for the scalenes, upper trapezius, levator scapulae, pectoralis minor, and pectoralis major may be helpful.[7] Athletes with neck pain associated with an increased thoracic kyphosis may benefit from thoracic extension self-mobilization using a foam roller (Figure 1). Pectoralis minor stretching may also decrease the thoracic kyphosis.[54] Corner self-stretching with the shoulder in 90° of abduction (Figure 2) can effectively lengthen the pectoralis minor.[5]

Athletes lacking cervical rotation may benefit from active or active-assisted rotation on a partially inflated beach ball (Figure 3). A one-half- to one-inch-wide nylon or cotton strap can impart an anteriorly directed force on the contralateral

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DOI: 10.1177/1941738112446138

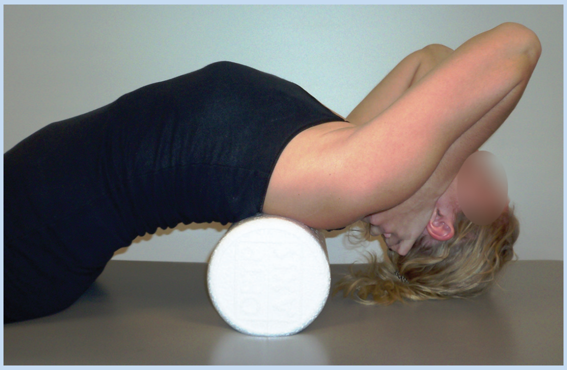

Figure 1. Thoracic spine extension self-mobilization using a foam roller as a fulcrum to focalize the movement.

Figure 2. Corner stretch for pectoralis minor with shoulders abducted approximately 90°.

Figure 3. Facilitated cervical spine rotation using a partially - inflated beach ball and/or a strap.

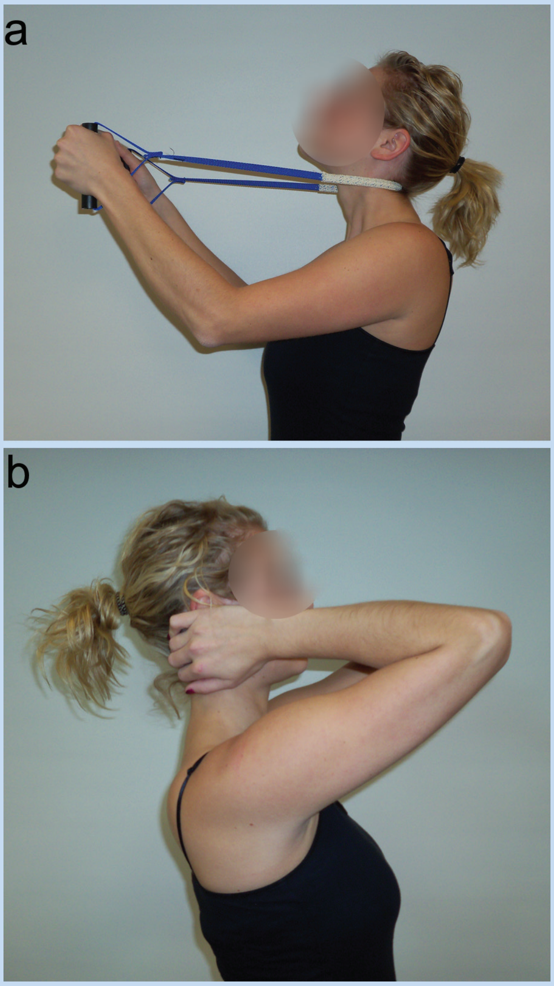

Figure 4. Cervical extension self-mobilization using a strap (a) or the index and middle fingers (b) to create a dynamic accommodating movement fulcrum.

articular process of the cervical segment as the patient actively rotates. A strap, pillow case, or towel can create a fulcrum for extension below a cervical segment (Figure 4a). Alternatively, the index and/or middle fingers can create a dynamic accommodating fulcrum, thereby "biasing" the extension movement to the restricted motion segment (Figure 4b).

Nerve gliding exercises may be beneficial for some athletes with radicular arm symptoms associated with neck pain.[10,35] Athletes with radicular arm symptoms may also benefit from directionally specific exercises.[32] McKenzie advocated repeated movements (eg, retraction) that promote distal-to-proximal symptom migration or "centralization" (Figure 5).[32] The prevalence of centralization in the cervical spine is about 15%.[56] Athletes with isolated neck pain may benefit from the cervical retraction exercise (Figure 5) to reduce anterior shearing of the lower cervical segments, increase upper cervical flexion, and activate the deep cervical flexor

Figure 5. Cervical retraction. The patient moves head posteriorly while keeping eyes horizontal.

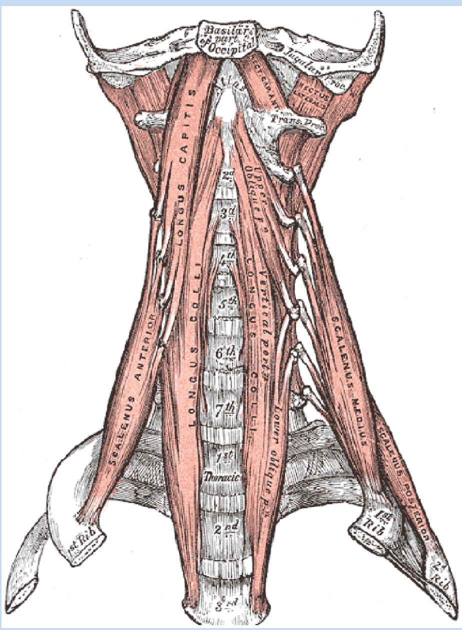

Figure 6. The deep anterior muscles of the cervical spine. From *Gray's Anatomy*. Used with permission from Bartleby.com.

and extensor muscles.[30,40] This exercise may be particularly beneficial for athletes with a forward-head posture (eg, cyclists).[18]

Figure 7. A pneumatic pressure device is inflated to 20 mm Hg and placed between the upper cervical spine (below the occiput) and table with the patient in supine. Starting from a neutral spine position, the patient slowly and subtly flexes the craniocervical spine as though saying "yes" while keeping the sternocleidomastoid (SCM) muscles relaxed. The cervical lordosis will flatten, and the pressure in the device will increase during the craniocervical flexion movement. The clinician should monitor for unwanted SCM activation. If the platysma or hyoid muscles are recruited, the patient can place the tongue on the roof of the mouth, with lips together but teeth slightly apart, to decrease activation of these muscles. Once the patient can control and vary the pressure in the device, he or she should practice holding increased levels of pressure until he or she can sustain 30 mm Hg for 10 seconds with minimal SCM activation.

EXERCISES TO IMPROVE RECRUITMENT OF THE DEEP CERVICAL MUSCULATURE

Cervical muscle deficits may develop rapidly following the onset of neck pain and may persist despite symptom resolution.[47] Since the neck musculature provides roughly 80% of the mechanical stability of the cervical spine,[41] the consequences of muscular impairment may be profound. Impairment of the deep cervical flexor muscles (longus capitis and colli, rectus capitis anterior and lateralis, hyoid muscles) (Figure 6) and deep cervical extensor muscles (semispinalis cervicis, multifidus, rectus capitis posterior major and minor) may occur with neck pain[47]; standardized testing should be performed to identify deficits.[12,19,21,26,29]

One advocated exercise for the deep cervical flexor muscles uses a pressure device (eg, sphygmometer) positioned inferior to the occiput (Figure 7).[25] This exercise involves flattening the cervical lordosis, which requires deep cervical flexor contraction,[30] while minimizing superficial cervical flexor muscle (sternocleidomastoid, anterior scalene) activation.

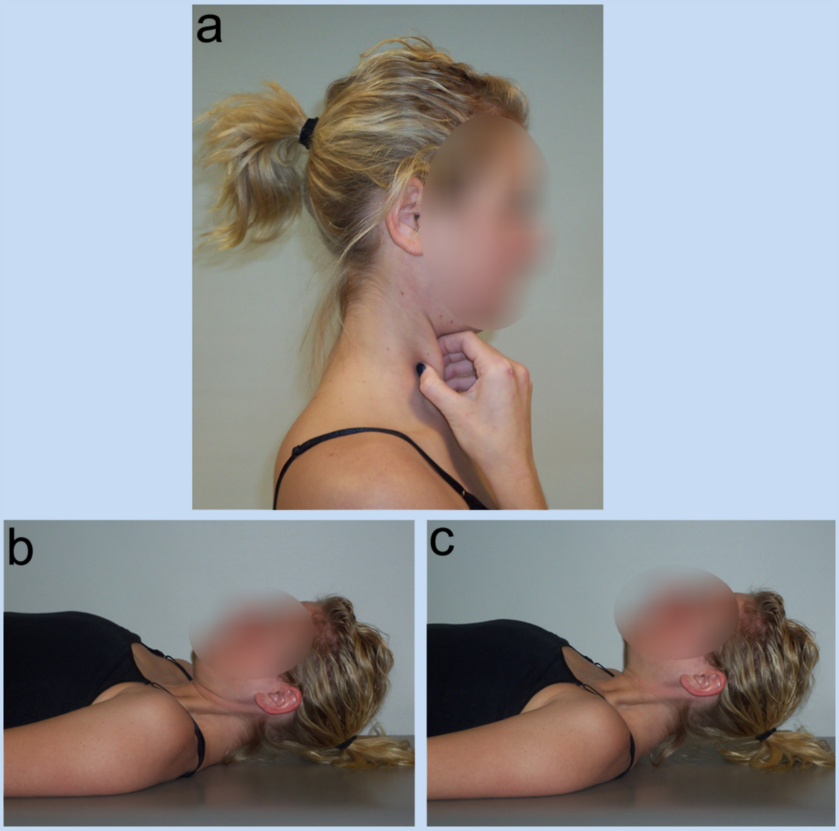

Figure 8. From a sitting or standing position, the patient slowly and subtly flexes the craniocervical spine as though saying "yes" while palpating for excessive sternocleidomastoid activation (a). The starting position can be sequentially reclined to increase gravity resistance (b), although the patient must be able to maintain craniocervical flexion in any position. Inability to sustain upper cervical flexion results in head protrusion, indicating that current position is too challenging (c).

The contractile effort should be low, and focus should be on precise movement control. Movement control and precision may also improve neck repositioning acuity.[25]

Controlled cervical spine flexion (ie, head lift)[39] can be performed to improve synergy between the deep and superficial flexors with the exerciser upright (Figure 8a) to minimize gravity resistance or reclined to increase gravity resistance. Once the patient can perform craniocervical flexion (ie, nodding) in supine with minimal activation of the superficial cervical flexors, he or she should attempt craniocervical flexion through the lower cervical spine (Figure 8b).[28,52] Inability to sustain craniocervical flexion results in head protrusion (Figure 8c), indicating that the exercise should be regressed.

Lower cervical spine extension while maintaining a neutral craniocervical junction has been advocated for the deep extensors (Figure 9).[16,36] Alternate exercises for the deep cervical extensor muscles are shown in Figures 10 and 11, although the extent to which these exercises activate these muscles is unknown. The exercise in Figure 11 can be modified for the cervical flexors or lateral flexors by repositioning the bandand fixing it to a stable post. The athlete can walk forward (flexors), backward (extensors), or sideways (lateral flexors) to increase the isometric muscle challenge.

Low levels of resistance are recommended (~20% maximal voluntary contraction) when exercising the deep cervical muscles[6,25,39] to minimize activity in their superficial synergists.[39] In addition, low-resistance exercise produces a superior, immediate hypoalgesic effect relative to high-resistance exercise.[37] Exercising above the pain threshold can impair neuromuscular control[18] and may amplify the effects of reflexive pain inhibition. Pain may have a profound inhibitory effect on the deep cervical muscles.[6] Therefore, low-intensity exercises should be considered for athletes with high levels of pain and irritability and/or those with deep cervical muscle recruitment deficits.

EXERCISES FOR MUSCULAR ENDURANCE OR STRENGTH

Once recruitment deficits of the deep cervical muscles have been adequately addressed, endurance and strength training should be initiated. Both endurance and strength training may reduce neck pain.[53,58] An endurance approach utilizing

Figure 9. From a position of 4-point kneeling, prone on elbows, or sitting, the patient eccentrically flexes the lower cervical spine while maintaining a neutral craniocervical spine (ie, the head and upper cervical spine do not flex or extend), then slowly extends the lower cervical spine to return to the starting position.

Figure 10. From a supine position, the patient slowly and subtly presses the occiput into a small pillow, rolled towel, or partially inflated beach ball without flexing the craniocervical spine.

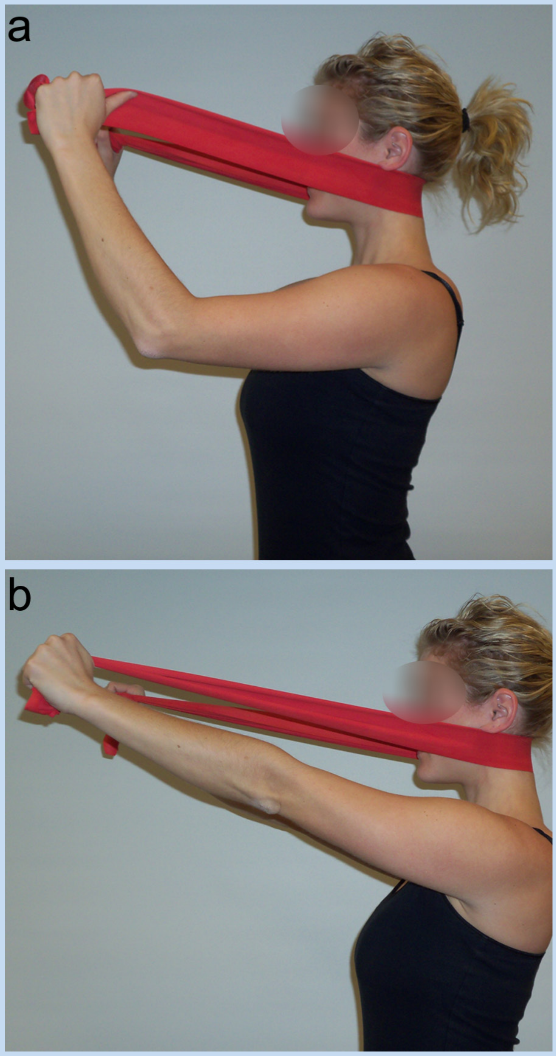

Figure 11. From a sitting or standing position, with an elastic band passed around the cervical spine (a), the patient then slowly extends the elbows to provide progressive isometric challenge to the cervical extensors (b). The patient should maintain a neutral craniocervical spine alignment during the exercise.

low loads may be sensible for athletes with low-to-moderate irritability to avoid aggravation or for endurance athletes (eg, cycling). A strength approach using high levels of resistance should be considered for athletes who need high levels of muscular stabilization and force dissipation (eg, wrestlers, football players).

Neck pain is more prevalent in women,[22] which may be attributable to reduced muscle strength.[51] The neck flexors and extensors are roughly 30% and 20% weaker, respectively, in healthy females compared with males even when adjusted for body size.[24,51] Therefore, the neck muscles in women may have a lower capacity to stabilize the cervical spine during athletic activities making strength training particularly efficacious for some female athletes with neck pain.

In addition to the intrinsic cervical musculature, the axioscapular muscles (levator scapulae, trapezius) influence the cervical spine as well as the shoulder girdle.[4] Weakness of the axioscapular muscles—in particular, the trapezius—is common with neck pain.[2,17] Accordingly, exercises to strengthen the trapezius muscles may be beneficial (Table 1).

The intensity, volume (repetitions and sets), and frequency of endurance and strengthening exercises should be "titrated" to stimulate adaptive changes without side effects.[23] Irritable

Table 1. Exercises with high levels of trapezius electromyographic activity.[a]

Electromyographic Activity	Exercises
Upper trapezius	Prone rowing[34]
	Military press[34]
	T with neutral glenohumeral rotation or with ER[34]
	Shoulder shrugs[2]
	Shoulder lateral raises[2]
	Upright rows[2]
Middle trapezius	Prone shoulder extension[9,34]
	Prone rowing[34]
	Side-lying glenohumeral ER[9]
	Side-lying shoulder flexion[9]
	T with neutral glenohumeral rotation or with ER[34]
Lower trapezius	Shoulder abduction[34]
	Bilateral glenohumeral ER at 0° abduction[31]
	Flexion in standing/sitting[34] or side-lying[9]
	Prone glenohumeral ER at 90° abduction[3,15]
	Prone shoulder rowing[34]
	Side-lying glenohumeral ER[3,9]
	T with glenohumeral ER[9,15,34]
	Y[15]

[a]T, prone horizontal abduction starting at 90° abduction; Y, prone horizontal abduction starting at ~120° abduction; ER, external rotation.

athletes may only tolerate brief bouts of very low intensity exercise through a limited arc. Athletes with moderate or low irritability may tolerate longer and more intense exercise sessions.

The majority of strength gains occur in response to the first exercise set stimulus.[14,42] Accordingly, the American College of Sports Medicine[1] recommends 1 set per exercise, with each set performed to volitional exhaustion. Pollock et al reported that strength gains in the cervical extensors were not statistically different between healthy subjects who performed 1 or 2 sets of 8 to 12 repetitions.[42] According to Randlov et al, there was no difference in pain, activities of daily living, strength, or endurance outcomes for patients with neck pain who performed 1 or 5 sets of cervical and shoulder exercises over a 3-month period.[43]

Figure 12. With the patient's eyes open, the clinician passively moves the patient's head/neck until the light is aimed at a designated focal point on the target (eg, bull's-eye). Next, the patient's eyes are closed or covered, and the clinician passively moves the patient's head/neck in multiple directions to disorient them ("pin the tail on the donkey"). After this, with eyes still closed or covered, the patient actively repositions the head/neck to try to aim the light source at the designated starting focal point. While holding this position, the patient opens or uncovers the eyes to assess repositioning accuracy.

EXERCISES TO IMPROVE REPOSITIONING ACUITY, OCULOMOTOR CONTROL, OR POSTURAL STABILITY

People with chronic or recurrent neck disorders are prone to deficits in head/neck repositioning acuity,[27,46] postural stability,[33,50] and oculomotor control[50]—apparently as a result of impaired afferentiation from cervical mechanoreceptors.[11] Significant sensorimotor dysfunction is less likely with pain of nontraumatic origin emanating from the lower cervical region. Regardless of the source, exercises may rectify some sensorimotor impairments.[45]

Repositioning acuity can be improved by using a light source and a target (Figure 12). Relocation exercises should start in stable sitting or standing and progress to labile surfaces (eg, ball, dome, wobble board).

Oculomotor exercises to improve eye/head coupling and gaze stability can progress from head stationary to trunk and/or head movements with visual fixation on a target. The speed and range of eye, head, or trunk movements can be increased and backgrounds and visual targets altered to increase the challenge. Exercises to improve oculomotor control (Table 2) may reduce dizziness and pain and improve postural control and cervical range of motion in athletes with neck pain.[44,48]

Postural stability exercises are often progressed from stable to labile surfaces and from bilateral to unilateral stance (Table 3).

Table 2. Exercises to improve oculomotor control.

"Sky-writing," or tracing patterns on wall with eyes with head stationary
Rotate eyes and head to same side, in both left and right directions
Move eyes to target followed by head with eyes remaining focused on the target
Move eyes then head to look between 2 targets positioned horizontally or vertically
Maintain fixed gaze on target while weight shifting or rotating torso (passively or actively)
Maintain fixed gaze on target while head is passively or actively rotated
Quickly move head and/or eyes then focus on designated location on target
Move eyes and head in opposite directions

Table 3. Exercises to improve postural stability.

Seated weight shifting on different surfaces (eg, stool, dome, wobble board, ball)
Standing weight shifting on various surfaces
Balancing on floor or labile surface (eg, pillow, foam, dome, trampoline, wobble-board) with different stances (eg, preferred, narrow, tandem, single-leg)
Balancing while moving upper extremities in patterns
Balancing while playing "catch"
Balancing while performing oculomotor or repositioning exercises (Table 2)
Walking while balancing foam pad or pillow on top of head
Walking while flexing and extending head/neck
Walking while rotating head/neck

These activities should be sport specific and include elements of changing speed, direction, and center of gravity. When appropriate, agility and plyometric exercises for the upper and/or lower extremities should be included at progressively higher levels of intensity and complexity prior to returning an athlete to competition.

Trunk/core exercises that develop neck muscle endurance should be included (appendix). Exercises from a supine bridged position with the head and shoulders supported on a therapy ball may provide a higher level of isometric challenge for the neck muscles (Figure 13). Return to full, unrestricted activity

Figure 13. Diagonal "chops" with cable or elastic band/cord from supine bridged position with the head and shoulders supported on a therapy ball.

can be considered when the athlete is symptom-free and has regained full neck range of motion and muscle strength.[13]

SUMMARY

Athletes with neck pain may have deficits in mobility,[7] muscle recruitment,[8,20] strength and endurance,[38] repositioning acuity,[27,46] postural stability,[33] or oculomotor control.[49] The treatment of athletic neck pain should thoroughly address these deficits. The resultant exercise program should adequately prepare the athlete for the demands of their sport and a safe return to full participation.

APPENDIX: SAMPLE THERAPEUTIC EXERCISE PROGRAM FOR ATHLETES WITH NONSPECIFIC NECK PAIN

Phase 1

Status: High pain and irritability
Emphasis: Slow, controlled, minimally painful exercises to improve muscle coordination and proprioception

- Supine cervical rotation on partially inflated beach ball (Figure 3)
- Craniocervical flexion (ie, chin nods) in sitting position or on a pressure device (Figures 5 and 7)
- Supine cervical retraction into small pillow, rolled towel, or partially inflated beach ball (Figure 10)
- Light targeting (or other target practice) (Figure 12)
- Walking while balancing foam pad on head
- Weight shifting or rotating torso on stool or therapy ball with fixed gaze
- Side-lying shoulder external rotation and/or prone shoulder extension
- Repeated movement(s) in direction of symptom centralization (if indicated for arm symptoms)
- Daily walking for 10 to 20 minutes

Phase 2

Status: Low-moderate irritability; pain with increased activity
Emphasis: Muscular endurance

- Four-way neck isometrics with low-resistance elastic band/tubing
- Isometric retraction with low-resistance elastic band/tubing (Figure 11)
- "T" with shoulder external rotation (Table 1)
- Bilateral shoulder external rotation at 0° abduction with low-moderate resistance elastic band/tubing
- Shoulder abduction standing with back against wall (aka wall slide)
- Side-lying shoulder flexion
- Progress proprioceptive exercises
- Sternocleidomastoid, scalene, upper trapezius, levator scapulae, pectoralis minor stretching (as needed)
- Thoracic spine extension self-mobilization using foam roller (as needed) (Figure 1)
- Low-moderate intensity aerobic exercise for ≥20 minutes
- Postural stability exercises (Table 3)

Phase 3

Status: Very low or no irritability; little or no pain with activity
Emphasis: Muscle strengthening

- Four-way isometrics with moderate-heavy resistance elastic band/tubing
- Isometric retraction with moderate-heavy resistance elastic band/tubing
- Exercises for trunk muscles (prone bridge/plank, side bridge, arm and/or opposite leg lifts/circles/diagonals in quadruped; exercises from supine bridged position with the head and shoulders supported on a therapy ball; Figure 13)
- I, Y, T's with dumbbells (Table 1)
- Chest press, rows, shoulder raises, latissimus pull-downs
- Progress proprioceptive exercises (as needed)
- Continue stretching and thoracic spine extension self-mobilization (as needed)
- Moderate-high intensity aerobic exercise for ≥20 minutes
- Progress postural stability exercises (as needed)
- Agility activities for the lower extremities and plyometric exercises for the upper and/or lower extremities

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