Treatment of a Patient with Cervical Radiculopathy Using Thoracic Spine Thrust Manipulation, Soft Tissue Mobilization, and Exercise

Michael Costello, MSPT, MTC

Cervical radiculopathy is a disorder of a cervical nerve root[1] and is common in the general population, with an annual incidence of approximately 83 per 100,000[2]. Patients with cervical radiculopathy often report neck pain; however, they most frequently seek treatment to address their arm pain[1,3,4]. People with neck pain combined with upper extremity symptoms experience greater levels of disability than do people with neck pain alone[4]. Authors have suggested that patients with neck and arm pain should be treated more expeditiously in order to avoid the further negative impact on mental health status associated with chronic symptoms[4].

Treatment strategies for patients with cervical radiculopathy range from conservative management to surgery. Evidence suggests that patients who are treated conservatively may experience superior outcomes compared to those who undergo surgery[5]; however, there is little evidence to suggest which non-operative interventions are the most effective[6,7]. Recently, two case series[3,8] used a combination of thrust and non-thrust mobilization/manipulation techniques directed at the cervical and thoracic spine, mechanical cervical traction, and exercise to treat patients with a clinical diagnosis of cervical radiculopathy. Cleland et al[3] reported that 10 of 11 patients demonstrated clinically meaningful improvement in pain and function at discharge and 6-month follow-up. Waldrop[8] reported improvement of 13% to 88% in the Northwick Park Neck questionnaire scores in 6 patients, with scores ranging from 13% to 88%. A recent prospective cohort study[7] also described the use of an individualized approach including thrust and non-thrust cervical mobilization/manipulation techniques, repeated endrange exercises to promote centralization of symptoms, neural mobilization, traction, and cervical stabilization exercises. Of the participants, 77% surpassed the minimally clinically important difference on the Bournemouth Disability Questionnaire at discharge (mean=11 visits). This value increased to 93% at long-term follow-up (mean=8.2 months).

While these preliminary reports suggest that a multimodal treatment approach may be beneficial for patients with cervical radiculopathy, exactly which interventions should be included in this approach, and in what combination, requires further research. The purpose of this case report is to describe the evaluation, clinical decision-making process, and treatment of a patient with cervical radiculopathy. The rationale for

ABSTRACT: While there is currently little evidence to suggest which non-operative treatment approach is best for the management of patients with cervical radiculopathy, emerging evidence suggests that these patients benefit from a multimodal treatment approach. The purpose of this case report is to describe the physical therapy management of a patient with cervical radiculopathy. Diagnosis was based on the patient's meeting three of the four criteria in the diagnostic test cluster currently used to identify patients with cervical radiculopathy. Treatment included thrust manipulation of the thoracic spine, soft tissue mobilization, and therapeutic exercise. After three visits, patient-perceived disability, as measured by the Patient-Specific Functional Scale, improved from 5/10 to 10/10. The Numeric Pain Rating Score decreased from 4.66/10 to 0/10. The patient rated his improvement as *a very great deal better* on the Global Rating of Change Scale. These clinically meaningful improvements were maintained at the 14-week follow-up. While a cause-and-effect relationship may not be established from a case report, a multimodal approach including thoracic spine manipulation, soft tissue mobilization, and therapeutic exercise was associated with decreased pain and perceived disability in a patient with cervical radiculopathy. Further research is needed to investigate benefits of the components of this approach.

KEYWORDS: Cervical Radiculopathy, Physical Therapy, Soft Tissue Mobilization, Spinal Manipulation

DSc Candidate, Rocky Mountain University of Health Professions, Provo, UT; Cayuga Medical Center Physical Therapy and Sports Medicine Department, Ithaca, NY.

Address all correspondence and requests for reprints to: Michael Costello, mcostello@cayugamed.org

thrust manipulation of the thoracic spine and soft tissue mobilization are discussed. Approval for this case report was provided by the Institutional Review Board at Cayuga Medical Center, Ithaca, New York.

Case Description

History

A 41-year-old male equipment operator was referred to physical therapy by his primary care physician with a diagnosis of neck pain. His primary complaint was left-sided neck pain that radiated distally down his left arm to his elbow; the pain had begun approximately three to four weeks prior. The patient did not recall a specific injury that precipitated his symptoms, reporting that he just woke up with neck and arm pain. He described the pain as a burning in the neck and a deep ache into the left arm that was aggravated by activities at work including lifting, shoveling, driving, and assuming a slouching posture. He stated that his symptoms generally increased over the course of the day and that he had difficulty getting to sleep at night. He stated that stretching his chest and massage from his wife temporarily reduced his symptoms. The patient worked full time requiring activities such as heavy lifting, shoveling, and driving; however, he had had to modify his pace at work and generally experienced increased pain by the end of the work day. The patient's goals were to decrease pain, increase the mobility of his neck, be able to perform normal work activities without limitation, and to sleep without disturbance. The patient did not have any imaging studies related to this condition.

The patient completed self-report measures, which can be found in Table 1. The Numeric Pain Rating Scale (NPRS) was used to measure pain intensity. The patient rated *average pain*, *least pain*, and *worst pain* over the last 24 hours on a 0 to 10 scale, 0 representing no pain and 10 representing the worst pain imaginable. The average of these three scores was 4.66. The NPRS has demonstrated acceptable levels of reliability and validity[9,10,11], and a 2-point change in the NPRS has been reported to be clinically meaningful[12], though this has not been studied directly in patients with neck pain or cervical radiculopathy. The Patient-Specific Functional Scale (PSFS) is a self-report measure; it was used to measure the patient's perceived level of disability[13]. The patient rates three activities that are difficult due to the patient's condition, each on a 0 to 10 scale, with 0 representing inability to perform the activity and 10 representing the ability to perform the activity as well as he or she could prior to the onset of symptoms. The PSFS has demonstrated high test-retest reliability in patients with cervical radiculopathy (ICC=0.82). The minimally clinically important change is 2.0[13]. The patient in this case study rated shoveling, lifting, and general work duties (driving, climbing into a truck, repetitive activities) all at 5/10 each.

Information from the medical history questionnaire was used to initially screen for potential red flags that would suggest a serious underlying pathology that would necessitate referral. Though the patient marked that he experienced moderate difficulty sleeping at night, he did not present with other signs that would raise the suspicion of cancer. Deyo and Diehl recommended that patients under the age of 50, with no history of cancer, with no weight loss or other signs of systemic illness, and no history of failing conservative therapy be considered low-risk[14]. The patient did not present with any other red flags that might indicate spinal fracture, cervical myelopathy, upper cervical ligamentous instability, vertebral artery insufficiency, or inflammatory or systemic disease. The clinician deemed the patient appropriate for physical therapy intervention and proceeded to the physical examination.

Physical Examination

A summary of physical examination findings are found in Table 2. The physical examination began with observation of posture as described by Kendall et al[15]. The reliability of postural observations has been reported to range from 0.58 to 0.90 for all judgments except for forward head, which has shown a kappa value of –0.1 and a prevalence of 90%[16]. Cervical active range of motion (AROM) was measured with the patient sitting as described by Flynn et al[17] and the results can be found in Table 3. The reliability of AROM measurements ranges from 0.66 to 0.78 (ICC 2,1)[16]. The effect of each movement on symptoms was assessed and recorded as 1) *no effect*, 2) *increased symptoms*, 3) *decreased symptoms*, 4) *symptoms centralized*, or 5) *symptoms peripheralized*.

Shoulder abduction ROM was measured in two conditions: with the elbow extended and the wrist in neutral, and with the elbow extended and the wrist extended (ABD+WE) (Tables 2 and 3). These two conditions have been purported to measure active movement with varying amounts of tension on the median nerve[18]. Shoulder abduction that is limited more with the wrist extended than in neutral may be considered an active movement dysfunction related to neural mechanical sensitivity of the upper extremity[19]. Relative pain-free shoulder abduction AROM was measured in standing with the gravity inclinometer placed on the upper arm with the proximal edge of the base placed at the insertion of the deltoid as described by Lewis et al[20]. They reported the reliability of this method to be high for both asymptomatic subjects and subjects with shoulder pain (ICC=0.98).

TABLE 1. Patient self report measures.

	Visit 1, day 1	Visit 2, day 8	Visit 3, day 24	14-wk follow-up
NPRS	4.66	0	0	0
PSFS	5/10	10/10	10/10	10/10
GROC	NA	+7	+7	+7

NPRS=Numeric Pain Rating Scale, PSFS=Patient Specific Functional Scale, GROC=Global Rating of Change Scale.

TABLE 2. Physical examination findings.

Posture	Forward head, protracted shoulders, increased cervicothoracic kyphosis
Cervical AROM	L rotation and R sidebend peripheralize symptoms into neck and L upper arm
Shoulder abduction	With wrist neutral: pain-free to 180° With wrist extension: painful at 150°
Segmental mobility testing	Left lateral glide C3-C4-C5 hypomobile, non-tender P-A: T1-T3 and T3-T5 regions hypomobile and locally tender
Upper limb neurodynamic testing (ULNT 1) elbow ROM	L=105° reproduces L neck and upper arm pain R=155° stretches anterior forearm
Muscle length testing	Tight upper trapezius, scalenes, levator scapulae L side, pectoralis major and minor bilaterally
Palpation	Tender upper trapezius, scalenes, levator scapulae, deltoid, rhomboids, supraspinatus, infraspinatus L side
Special tests	Spurling's test: L side reproduced L neck and upper arm pain Compression: no change Distraction: no change

P-A=posterior-anterior spring test.

TABLE 3. Physical impairment measures.

	Visit 1, day 1	Visit 2, day 8	Visit 3, day 24
ULNT	105	160	160
SHLD ABD+ WE	150	180	180
CS Forward bend	55	70	70
CS Backward bend	55	70	65
CS Left rotation	58	82	76
CS Right rotation	77	80	78
CS Left sidebend	45	55	55
CS Right sidebend	45	58	58

ULNT=Upper limb neurodynamic test, SHLD ABD+WE=Shoulder abduction + wrist extension, CS=cervical spine.

Relative pain-free range was defined as the amount of movement the patient could abduct his shoulder without increasing his symptoms.

Spurling's, compression, and distraction tests were performed according to Wainner et al[21]. Spurling's test was positive, producing pain in the left side of the neck that radiated into the left shoulder and upper arm. The reliability of Spurling's test is moderate (K=0.60)[21]. According to Wainner et al, the test is highly specific for a diagnosis of cervical radiculopathy (specificity=0.86), with lower sensitivity (0.50). The compression and distraction tests were negative. Deep tendon reflexes, light touch sensation, and myotomal testing of C5-T1 were performed according to Flynn et al[17] and all were unremarkable.

Segmental mobility of the occipito-atlantal segment was tested as described by Flynn et al[17], and the atlanto-axial segment and lateral glides of segments C2-C3 to C7-T1 were performed according to Greenman[22]. The therapist noted any levels that reproduced pain and graded the segments as *hypomobile*, *normal*, or *hypermobile*. Lateral glides at the C3-C4-C5 levels were determined to be hypomobile but were not tender. Prone spring testing of the thoracic spine was performed as described by Maitland et al[23]. Segments T1-T3 and T3-T5 were tender and hypomobile. Reliability of segmental motion testing is considered to be low[24]; however, the lateral cervical glide test has been shown to be a valid method to diagnose cervical intervertebral dysfunction[25].

The upper limb neurodynamic test was performed as described by Wainner et al[21]. The ROM of elbow extension at the onset of pain was measured with a standard goniometer. The patient reported reproduction of his familiar pain in the neck and upper arm at 105° of elbow extension while the left side was tested. This pain was reduced when the wrist was moved from full extension to neutral or when the neck was moved into ispilateral sidebend. During the ULNT, the right arm could be moved to 155° of elbow extension with only a stretching sensation in the anterior forearm. Reliability for the ULNT in subjects with cervico-brachial syndrome is excellent (ICC=0.98)[26].

Muscle length testing was performed according to Flynn et al[17] and was graded as either *normal* or *tight*. Cleland et al[16] reported that reliability of muscle length assessment ranged from 0.54 to 0.90. The upper trapezius, scalenes, levator scapulae, and pectoralis major and minor were graded as tight. Palpation elicited tenderness over several muscles of the left upper quadrant (see Table 2).

Clinical Impression

The diagnostic test cluster to identify patients with cervical radiculopathy[21] was used to aid in the diagnostic process. Three of the four items were present: ipsilateral cervical rotation less than

60°, positive Spurling's test, and a positive ULNT. The positive likelihood ratio when 3 of 4 items are present is 6.1, which produced a moderate shift in probability that the patient had cervical radiculopathy. The patient was classified as having cervical radiculopathy without signs of nerve root compression as sensation, deep tendon reflexes, and strength testing were all unremarkable. Physical impairments identified during the examination included poor posture, limited range of motion of the cervical spine and shoulder, hypomobility of the cervical and thoracic spine, positive ULNT, positive Spurling's test, and soft tissue dysfunction (tenderness and decreased length) of the upper quarter musculature.

According to the *Guide to Physical Therapist Practice*, 80% of patients with cervical radiculopathy should achieve expected outcomes within 8 to 24 visits over a 1-month to 6-month timeframe[27]. Cleland et al[6] recently identified a 4-variable model to identify patients with cervical radiculopathy (4/4 on the test item cluster) who were most likely to achieve success with physical therapy interventions. These variables included age >54 years, dominant arm not affected, looking down does not aggravate symptoms, and use of a multimodal treatment including manual therapy, deep neck flexor strengthening, and traction. Considering that the patient fit the three variables from the history and physical examination that predicted a positive outcome, the prognosis for the patient was very good.

The clinician chose interventions based on the therapist's knowledge of the current research, the therapist's experience, and the patient's attitudes regarding treatment[28]. Although there is no evidence to suggest what is the optimal management for patients with cervical radiculopathy, use of a multimodal treatment that includes manual therapy, cervical traction, and deep neck flexor strengthening has been shown to be one variable associated with sort-term success[6]. Manual therapy techniques were chosen to address physical impairments that the therapist hypothesized might be contributing to the patient's condition: thoracic and cervical hypomobility and neural mechanosensitivity. Management would also include therapeutic exercise to address neural mechanosensitivity and to strengthen the deep neck flexors and scapulo-thoracic muscles.

TABLE 4. Interventions.

Session 1, day 1	Instruction in posture correction while sitting and driving High-velocity thrust to T1-T3 region sitting High-velocity thrust to T3-T5 region supine Soft tissue mobilization to L upper quadrant in ULNT position Instruction in home exercise program: • Deep neck flexor strengthening supine 10 repetitions, 10-sec hold • Prone scapular retraction (arms neutral), 10 repetitions, 10-sec hold • Pectoralis stretching in doorway, 3 repetitions, 30-sec hold • Median nerve slider 5–10 repetitions, pain-free range, 3 times per day
Session 2, day 8	Reviewed home exercise program Progressed to: • Deep neck flexor strengthening, 2 sets, 10 repetitions • Prone scapular retraction, 2 sets, 10 repetitions • Prone "Y" scapular retraction, 2 sets, 10 repetitions • Median nerve tensioner with palm on a wall Encouraged to return to full work duties without limitation
Session 3, day 24	Reviewed home exercise program Reviewed posture correction and proper lifting techniques

Intervention

Interventions used in the treatment of this patient are summarized in Table 4. During the first session, manual therapy techniques were chosen first to address thoracic hypomobility, then to address neural mechanosensitivity. High-velocity low-amplitude thrust manipulations were directed to the thoracic spine in sitting and supine. Following the manipulation, the patient reported decreased pain (3/10) with cervical rotation. No change in elbow ROM during the ULNT was observed.

Next, the therapist addressed the neural mechanosensitivity exhibited by the positive UNLT by using a combination of soft tissue mobilization directed at the soft tissue structures surrounding the neural tissues of the upper quarter and lateral cervical glides with the upper extremity placed in a position to preload the brachial plexus. Soft tissue mobilization was performed to the muscles of the upper quarter with the involved UE positioned in abduction and external rotation to preload the neural structures of the upper limb[19]. Manual pressure was applied to the soft tissues of the upper quadrant in a deep, stroking manner with the intention to decrease pain and improve the mobility of the soft tissues surrounding the pathway of the neural structures of the upper limb (Figures 1 and 2). The therapist concentrated on any tissues on the cervical and scapular region and upper extremity that were graded as *tight* or *tender* in the evaluation. Following the technique, the patient demonstrated a significant increase in elbow extension ROM during the ULNT, which was visually estimated as being equal to that of the opposite side. The patient reported only a stretching sensation in the upper arm instead of the familiar pain that was produced during the examination. Additionally, the patient was able to abduct his shoulder while maintaining the wrist in extension through full range without symptoms. After observing the marked improvement in these two impairments after soft tissue mobilization, the therapist decided to forego any further manual intervention for that session. The patient was educated in a home exercise pro-

gram to strengthen the deep neck flexors[29] and scapular retractors, stretch the chest muscles, and encourage mobility of the neural structures of the upper extremity[30].

At the second session, the patient reported that he no longer experienced pain in his neck or left arm and that he felt that he had full range of motion. His PSFS was 10/10 (see Table 1). The patient completed the Global Rating of Change Scale (GROC), a self-report measure used to measure the subject's overall perception of improvement since the beginning of treatment[31]. The scale ranges from –7 (a very great deal worse) to +7 (a very great deal better) with 0 representing no change. The GROC has been used to determine the effectiveness of physical therapy interventions for subjects with neck pain[32]. His GROC was +7, or *a very great deal better*. Upon questioning about his activity level, he stated that he had been able to work without pain but admitted that he was still not working at his normal intensity.

Physical examination demonstrated that the patient had full symmetrical cervical AROM without pain (Table 2). Overpressure in all directions was also pain-free. Spurling's test was negative and the ULNT for the left upper extremity reproduced only a stretching sensation at 160° of elbow extension. Posterior-anterior spring testing of the thoracic spine was pain-free and judged to have normal mobility.

Considering that the patient's symptoms were abolished and that he no longer exhibited impairments that would indicate the need for manual therapy interventions, the therapist decided to review the patient's home exercise program and progress the exercises as appropriate. The therapist increased the difficulty of the strengthening exercises and advanced the neuromobilization exercise from a *slider* to a *tensioner*[18]. The patient was instructed to attempt to return to work activities without limitation in order to determine if he had indeed fully recovered. A follow-up session was scheduled in two weeks.

At two-week follow-up, the patient reported that he had returned to full work activities without difficulty. His GROC was +7 and his PSFS was 10/10.

FIGURE 1: (Left) Soft tissue mobilization at the shoulder in the ULNT position.
FIGURE 2: (Right) Soft tissue mobilization at the elbow in the ULNT position.

He continued to demonstrate full cervical and shoulder AROM without pain and a negative Spurling's test and ULNT. There was no tenderness with PA testing of the cervical or thoracic spine. The patient and therapist agreed that no further care was necessary at this time. He was instructed to contact the therapist if any symptoms or functional limitations returned.

Fourteen weeks following discharge, the therapist telephoned the patient to follow up on his status. The patient reported that he had only experienced one episode of his neck and shoulder pain that was brought on by plowing snow for 12 hours. These symptoms completely resolved after performing his exercises and having his wife massage his neck and shoulders. His PSFS was 10/10, NPRS was 0, and GROC was +7. The therapist emphasized the importance of proper posture while driving and advised him to continue with his home exercise program to help prevent reoccurrence.

Outcomes

After the first treatment session, the patient demonstrated a rapid improvement in function and pain. The PSFS improved from a 5/10 to a 10/10 while the NPRS decreased from a 4.66 to 0. Both the NPRS and the PSFS surpassed the minimally clinically important change of 2.0 points for each scale[12,13]. The patient reported that he was a *very great deal better* (GROC=+7) at the second session. It has been suggested that GROC scores of ± 6 or ± 7 represent large changes[31]. These improvements were maintained at the 14-week follow-up.

The patient demonstrated a rapid improvement in key physical impairments within the first session, which were maintained at follow-up sessions. Immediately following soft tissue mobilization, relative pain-free elbow ROM in the ULNT increased from 105° to approximately equal (by visual estimation) to the opposite side (155°). A further increase to 160° was observed for elbow ROM in the ULNT at follow up. This increase in ROM far exceeds the minimally statistically meaningful change of 7.5°[26]. Though not formally measured in the first session, large improvements in cervical rotation and shoulder abduction ROM with wrist extension were also observed within the first session. At follow-up sessions, cervical and shoulder ROM were full and pain-free (Table 3).

Discussion

This case report describes the physical therapy management of a patient with cervical radiculopathy. Physical impairments of limited ROM, tenderness to palpation, and provocative testing all improved dramatically after the first session and were maintained over the next three weeks. Large improvements were observed in the NPRS and GROC, and the patient reported complete resolution of functional disability as indicated by the PSFS.

There has been emerging evidence to suggest that patients who meet the diagnostic classification for cervical radiculopathy might benefit from a multi-

modal treatment package that includes manual therapy, mechanical traction, and strengthening exercises[3,7,8]. Cleland et al recently reported that for patients with cervical radiculopathy, receiving this multimodal package was a predictor of a positive outcome[6]. The therapist in this case study chose a treatment approach that included manual therapy techniques and therapeutic exercises that included strengthening of the deep neck flexors and scapular stabilizers. Since the patient did not demonstrate a positive cervical distraction test, mechanical traction was not included in the treatment plan because it was not expected to be beneficial.

Impairments of the thoracic spine may be related to complaints of neck and shoulder pain[33]. Immediate improvements in AROM and pain have been demonstrated in patients with neck pain following thoracic thrust manipulation[32,34]. Thoracic thrust manipulation has also been used as a part of the multimodal package to treat patients with cervical radiculopathy[3,8]. Cleland et al has identified a clinical prediction rule (CPR) for patients with neck pain who are likely to benefit from thrust manipulation of the thoracic spine (see Table 5)[32]. The patient demonstrated only two of the six factors from the CPR, raising the post-test probability to 71%. The Fear-Avoidance Beliefs Questionnaire (FABQ) was not administered; however, the therapist believed that the patient could be classified as having low fear-avoidance beliefs because he continued to work full time performing heavy manual labor despite his condition. If he had indeed tested to a FABQ-PA score of >12, he would have scored 3/6 on the thoracic spine CPR, raising the post-test probability of success to 86%. Considering the evidence supporting the use of thoracic thrust manipulation for this patient and the lack of contraindications, the therapist determined that thoracic thrust techniques would be used at the initial session. Following the thoracic thrust techniques, the patient reported decreased pain with cervical AROM, and an increase in available ROM was observed. These improvements were maintained over the follow-up sessions.

TABLE 5. Clinical prediction rule for patients with neck pain likely to benefit from thoracic spine manipulation. Adapted from Cleland et al[32].

Thoracic Spine Manipulation Clinical Prediction Rule
• Symptoms <30 days
• No symptoms distal to the shoulder
• Looking up does not aggravate symptoms
• FABQ-PA <12
• Diminished kyphosis T3-T5
• Cervical backbend ROM<30°

Neural mobilization techniques have been used as a component of treatment for patients with cervical radiculopathy[3,7]. While there is evidence that the lateral cervical glide mobilization may be beneficial for patients with a positive ULNT[3,19], this author is not aware of any research describing the use of soft tissue mobilization to address this impairment. It has been the experience of this therapist that patients who present with a positive ULNT and tightness and tenderness of the upper quarter musculature respond positively to soft tissue mobilization techniques applied with the intention of decreasing tenderness and improving mobility of the soft tissue structures that surround the neural pathways. The therapist often uses the two techniques in combination. Considering the therapist's experience and the patient's positive experience of reduced symptoms after massage, the therapist chose to perform soft tissue mobilization prior to the lateral glide technique. Immediately after the application of soft tissue mobilization, this patient demonstrated a large increase in elbow ROM during the ULNT and reported that he no longer experienced his familiar pain during the test. Due to the significant improvement in the ULNT during the first session, which was maintained at all follow-up sessions, the lateral glide mobilization was not used.

Strengthening exercises for the deep cervical flexors and scapular muscles were chosen to address the postural impairments, which were considered a contributing factor to the patient's condition since he reported that his symptoms were affected by changing his posture. Falla et al[35] reported that subjects with chronic neck pain demonstrated an improved ability to maintain upright posture following an exercise program targeted at training the deep cervical flexors. Strengthening of the neck and shoulder muscles has also been successfully used as a component of a multimodal program for patients with neck pain[36] and cervical radiculopathy[8].

Although no cause-and-effect relationship can be established from a case report, this patient demonstrated a significant improvement in ROM and pain during the ULNT immediately after receiving soft tissue mobilization and that improvement was maintained over the next three weeks. Further research into the effects of soft tissue mobilization for patients with a clinical diagnosis of cervical radiculopathy or with an impairment of the mobility of the neural structures of the upper quarter is warranted. It is possible that the dramatic improvement observed in this patient is due to any one of the interventions, their combination, or the natural history of the patient's condition.

Conclusion

Patients with cervical radiculopathy present with neck and arm pain that may be related to several factors. While there is currently no optimal non-surgical treatment strategy for this population, there is emerging evidence for various physical therapy interventions, including manual therapy, traction, and exercise. In this case report, manipulation techniques directed to the thoracic spine, exercise, and soft tissue mobilization techniques directed to the upper quarter were associated with a dramatic improvement in physical impairments, pain, and function for a patient with cervical radiculopathy. Clinicians should consider interventions directed at improving soft tissue mobility of the upper quarter in patients with cervical radiculopathy or when there is evidence of neural mechanosensitivity. Further research investigating the effects of soft tissue mobilization as a component of a multimodal treatment package for patients with cervical radiculopathy is warranted.

Acknowledgements

The author would like to thank Joshua Cleland, DPT, PhD, OCS, FAAOMPT; Emilio "Louie" Puentdura, PT, DPT, OCS, FAAOMPT; and Charles Ciccone, PT, PhD, FAPTA for their assistance in preparing this manuscript.

REFERENCES

1. Wainner RS, Gill H. Diagnosis and nonoperative management of cervical radiculopathy. *J Ortho Sports Phys Ther* 2000;30:728–744.
2. Radhakrishnan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy: A population-based study from Rochester, Minnesota, 1976 through 1990. *Brain* 1994;117:325–335.
3. Cleland JA, Whitman JM, Fritz JM, Palmer JA. Manual physical therapy, cervical traction, and strengthening exercises in patients with cervical radiculopathy: A case series. *J Orthop Sports Phys Ther* 2005;35:802–811.
4. Daffner SD, Hilibrand AS, Hanscom BS, et al. Impact of neck and arm pain on overall health status. *Spine* 2003;28:2030–2035.
5. Sampath P, Bendebba M, Davis JD, Ducker T. Outcome in patients with cervical radiculopathy: Prospective, multicenter study with independent clinical review. *Spine* 1999;24: 591–597.
6. Cleland JA, Whitman JM, Fritz JM, Heath R. Predictors of short-term outcome in people with a clinical diagnosis of cervical radiculopathy. *Phys Ther* 2007;87:9–23.
7. Murphy DR, Hurwitz EL, Gregory A, Clary R. A nonsurgical approach to the management of patients with cervical radiculopathy: A prospective observational cohort study. *J Manipulative Physiol Ther* 2006;29: 279–287.
8. Waldrop MA. Diagnosis and treatment of cervical radiculopathy using a clinical prediction rule and a multimodal intervention approach: A case series. *J Orthop Sports Phys Ther* 2006;36:152–159.
9. Jensen MP, Miller L, Fisher LD. Assessment of pain during medical procedures: A comparison of three scales. *Clin J Pain* 1998; 14:343–349.
10. Jensen MP, Turner JA, Romano JM. What is the maximum number of levels needed in pain intensity measurement? *Pain* 1994;58: 387–392.
11. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analog scales as a ratio measure for chronic and experimental pain. *Pain* 1983;17:45–56.
12. Childs JD, Piva SR, Fritz JM. Responsiveness of the numeric pain rating scale in patients with low back pain. *Spine* 2005;10:1331–1334.
13. Cleland JA, Fritz JM, Whitman JM, Palmer JA. The reliability and construct validity of the Neck Disability Index and Patient Specific Functional Scale in patients with cervical radiculopathy. *Spine* 2006;31:598–602.
14. Deyo RA, Diehl AK. Cancer as a cause of back pain: Frequency, clinical presentation, and diagnostic strategies. *J Gen Intern Med* 1988;3:230–238.
15. Kendall FP, McCreary EK, Provance PG. *Muscles Testing and Function*. 4th ed. Baltimore, MD: Williams and Wilkins, 1983.
16. Cleland JA, Childs JD, Fritz JM, Whitman JM. Interrater reliability of the history and physical examination in patients with mechanical neck pain. *Arch Phys Med Rehabil* 2006;87:1388–1395.
17. Flynn TW, Whitman J, Magel J. *Orthopaedic Manual Physical Therapy Management of the Cervical-Thoracic Spine and Ribcage*. San Antonio, TX: Manipulations Inc., 2000.
18. Butler DS. *The Sensitive Nervous System*. Unley, South Australia: NoiGroup Publications, 2000.
19. Coppieters MW, Stappaerts KH, Wouters LL, Janssens K. The immediate effects of a cervical lateral glide technique in patients with neurogenic cervicobrachial pain. *J Orthop Sports Phys Ther* 2003;33:369–378.
20. Lewis JS, Wright C, Green A. Subachromial impingement syndrome: The effect of changing posture on shoulder range of movement. *J Orthop Sports Phys Ther* 2005; 35:72–87.
21. Wainner RS, Fritz JM, Irrang JJ, et al. Reliability and diagnostic accuracy of the clinical examination and patient self-report measures for cervical radiculopathy. *Spine* 2003;28:52–62.
22. Greenman P. *Principles of Manual Therapy*. 2nd ed. Baltimore, MD: Williams & Wilkins, 1996.
23. Maitland G, Hengeveld E, Banks K, English K. *Maitland's Vertebral Manipulation*. Woburn, MA: Reed Educational and Professional Publishing, Ltd., 2001.
24. van Trijffel E, Andregg Q, Bossuyt PMM, Lucas C. Inter-examiner reliability of passive assessment of intervertebral motion in the cervical and lumbar spine: A systematic review. *Man Ther* 2005;10:256–269.
25. Fernandez-de-las-Peñas C, Downey C, Miangolarra-Page JC. Validity of lateral gliding test: A tool for the diagnosis of intervertebral joint dysfunction in the lower cervical spine. *J Manipulative Physiol Ther* 2005;28:610–616.
26. Coppieters MW, Stappaerts KH, Janssens K, Jull G. Reliability of detecting 'onset of pain' and 'submaximal pain' during neural provocation testing of the upper quadrant. *Physiother Res Int* 2002;7:146–156.
27. American Physical Therapy Association. Guide to physical therapist practice. 2nd ed. *Phys Ther* 2001;81:9–744.
28. Sackett DL, Straus SE, Richardson WS, Rosenberg W, Haynes RB. *Evidence-Based Medicine: How to Practice and Teach EBM*. 2nd ed. New York: Churchill Livingstone, 2000.
29. Jull G. Deep cervical muscle dysfunction in whiplash. *J Musculoskeletal Pain* 2000;8:143–154.
30. Totten PA, Hunter JM. Therapeutic techniques to enhance nerve gliding in thoracic outlet syndrome and carpal tunnel syndrome. *Hand Clinics* 1991;7:505–520.
31. Jaeschke R, Singer J, Guyatt GH. Measurement of health status: Ascertaining the minimally clinically important difference. *Control Clin Trials* 1989;10:407–415.
32. Cleland JA, Childs JD, Fritz JM, et al. Development of a clinical prediction rule for guiding treatment of a subgroup of patients with neck pain: Use of thoracic spine manipulation, exercise, and patient education. *Phys Ther* 2007;87:9–23.
33. Norlander S, Aste-Norlander U, Nordgren B, Sahlstedt B. Mobility in the cervico-thoracic motion segment: An indicative factor of musculo-skeletal neck-shoulder pain. *Scand J Rehabil Med* 1996;28:183–192.
34. Cleland JA, Childs JD, McRae M, et al. Immediate effects of thoracic manipulation in patients with neck pain: A randomized clinical trial. *Man Ther* 2005;10:127–135.
35. Falla D, Jull G, Russell T, Vicenzino B, Hodges P. Effect of neck exercise on sitting posture in patients with chronic neck pain. *Phys Ther* 2007;87:408–417.
36. Jordan A, Bendix T, Nielson H, et al. Intensive training, physiotherapy, or manipulation for patients with chronic neck pain: A prospective, single-blinded, randomized clinical trial. *Spine* 1998;23:311–318.