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Manual Physical Therapy, Cervical Traction, and Strengthening Exercises in Patients With Cervical Radiculopathy: A Case Series

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Study Design: A case series of consecutive patients with cervical radiculopathy.
Background: A multitude of physical therapy interventions have been proposed to be effective in the management of cervical radiculopathy. However, outcome studies using consistent treatment approaches on a well-defined sample of patients are lacking. The purpose of this case series is to describe the outcomes of a consecutive series of patients presenting to physical therapy with cervical radiculopathy and managed with the use of manual physical therapy, cervical traction, and strengthening exercises.
Case Description: Eleven consecutive patients (mean age, 51.7 years; SD, 8.2) who presented with cervical radiculopathy on the initial examination were treated with a standardized approach, including manual physical therapy, cervical traction, and strengthening exercises of the deep neck flexors and scapulothoracic muscles. At the initial evaluation all patients completed self-report measures of pain and function, including a numeric pain rating scale (NPRS), the Neck Disability Index (NDI), and the Patient-Specific Functional Scale (PSFS). All patients again completed the outcome measures, in addition to the global rating of change (GROC), at the time of discharge from therapy and at a 6-month follow-up session.
Outcomes: Ten of the 11 patients (91%) demonstrated a clinically meaningful improvement in pain and function following a mean of 7.1 (SD, 1.5) physical therapy visits and at the 6-month follow-up.
Discussion: Ninety-one percent (10 of 11) of patients with cervical radiculopathy in this case series improved, as defined by the patients classifying their level of improvement as at least "quite a bit better" on the GROC. However, because a cause-and-effect relationship cannot be inferred from a case series, follow-up randomized clinical trials should be performed to further investigate the effectiveness of manual physical therapy, cervical traction, and strengthening exercises in a homogeneous group of patients with cervical radiculopathy. *J Orthop Sports Phys Ther 2005;35:802-811.*

Key Words: *cervical spine, manipulation, mobilization, thoracic spine*

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This case series received exempt status from the Institutional Review Boards at Concord Hospital, Concord, NH and approval from the Institutional Review Board at Franklin Pierce College, Concord, NH.
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Cervical radiculopathy is a common clinical diagnosis classified as a disorder of a nerve root and most often is the result of a compressive or inflammatory pathology from a space-occupying lesion such as a disc herniation, spondylitic spur, or cervical osteophyte.[11,13,17,28,39,43] The average annual incidence rate of cervical radiculopathy is 83 per 100 000 for the population in its entirety, with an increased prevalence occurring in the fifth decade of life (203 per 100 000).[33]

The location and pattern of symptoms will vary, depending on the nerve root level affected, and can include sensory and/or motor alterations if the dorsal and/or ventral nerve root is involved.[4,5,36] Although patients with cervical radiculopathy may have complaints of neck pain, the most frequent reason for seeking medical assistance is arm pain.[5,10,18,43] Patients usually present with complaints of pain, numbness, tingling, and weakness in the upper extremity, which often result in significant functional limitations and disability.[35]

Physical therapists often treat patients with cervical radiculop-

athy. One study reported that 26% of those who undergo surgery continue to experience high levels of pain at a 1-year follow-up.[17] Research suggests patients treated conservatively experience superior outcomes to patients treated surgically.[18,35] A multitude of physical therapy interventions have been proposed to be effective in the management of cervical radiculopathy, including mechanical cervical traction, manipulation, therapeutic exercise, and modalities. However, outcome studies using consistent treatment approaches on well-defined samples of patients are lacking. Therefore, the purpose of this study is to describe both short- and long-term patient outcomes for a series of patients with cervical radiculopathy who were treated with a physical therapy management program, including manual physical therapy interventions, mechanical traction, and deep neck flexor and scapulothoracic muscle strengthening exercises.

CASE DESCRIPTION

Patients

Consecutive patients referred by their primary care physician to Rehabilitation Services of Concord Hospital, presenting with neck and upper extremity symptoms over a 10-month period (October 2003-July 2004), were examined for eligibility criteria. Inclusion criteria for this case series included a test item cluster identified by Wainner et al,[42] which included the presence of 4 positive examination findings (Spurling test, upper limb tension test, cervical distraction test, and less than 60° cervical rotation towards the symptomatic side). In the study by Wainner et al[42] the presence of these 4 findings was associated with a positive likelihood ratio of 30.3 for detecting cervical radiculopathy when compared to a reference standard of neurodiagnostic testing. The performance and scoring criteria for these tests can be found in Table 1. Exclusion criteria included the presence of any medical red flags (ie, tumor, fracture, metabolic diseases, rheumatoid arthritis, osteoporosis, prolonged history of steroid use), bilateral upper extremity symptoms, evidence of central nervous system involvement (present Hoffman's sign), and prior surgery to the cervical or thoracic spine. This case series qualified for exempt status from the Institutional Review Board at Concord Hospital, Concord, NH and was approved by the Institutional Review Board at Franklin Pierce College, Rindge, NH.

TABLE 1. The performance and scoring criteria for clinical examination used to identify patients with cervical radiculopathy. Further description can be found in Wainner et al.[42]

Test	Performance	Criteria for Positive Test
Spurling A[37]	The patient is seated and the neck is passively side bent towards the symptomatic side. The examiner applies approximately 7 kg of force through the patient's head with a caudally directed force	Reproduction of the patient's symptoms
Neck distraction test[42]	The patient is supine and the examiner grasps under the patient's chin and occiput. The examiner flexes the neck to patient comfort, then applies a distraction force of approximately 14 kg	Reduction or resolution of the patient's symptoms
Upper limb tension test A[12]	The patient is supine and the examiner places the patient's upper extremity into (1) scapular depression, (2) shoulder abduction, (3) forearm supination, wrist and finger extension, (4) shoulder external rotation, (5) elbow extension, and (6) contralateral then ipsilateral cervical lateral flexion	Any of the following constitute a positive test: 1. Symptom reproduction 2. Greater than 10° difference in elbow extension from side to side 3. An increase in symptoms with contralateral cervical side bending or decrease in symptoms with ipsilateral side bending
Cervical range of motion	The patient is seated. Cervical rotation is measured with a standard goniometer	Ipsilateral cervical rotation less than 60°

Examination

Patients completed a variety of self-report measures, followed by a detailed history and physical examination performed by a physical therapist. The standardized history consisted of age, gender, past medical history, location (with the use of a body diagram), duration and nature of symptoms, relieving/aggravating activities, prior episodes, occupation, and leisure activities.

The physical examination consisted of a postural assessment,[22] neurological assessment (myotomes, dermatomes, and reflexes), cervical and thoracic active range of motion while monitoring of symptom behavior, segmental mobility testing of the cervical spine, spring testing of the cervical and thoracic (T1 through T9) spines,[6] and examination of deep neck flexor and scapulothoracic muscle strength.

Self-report measures collected at baseline included the Neck Disability Index (NDI), the Patient-Specific Functional Scale (PSFS), and the numeric pain rating scale (NPRS). The NDI contains 10 items, with 7 related to activities of daily living, 2 related to pain, and 1 item related to concentration.[40] Each item is scored from 0 to 5 and the total score is expressed as a percentage, with higher scores corresponding to greater disability. The NDI has shown to be reliable and valid for patients with neck pain but has demonstrated poor responsiveness in a group of patients with cervical radiculopathy.[8] However, because patients with cervical radiculopathy also frequently present with neck pain,[5,11] as well as because no other outcomes tool has been shown to be superior to the NDI for use with patients with cervical radiculopathy, we elected to include the NDI as one of our health outcomes assessment tools.

The PSFS requires patients to list 3 activities that are difficult to perform as a result of their symptoms, injury, or disorder.[21] The patient rates each activity on a 0-to-10 scale, with 0 representing the inability to perform the activity and 10 representing the ability to perform the activity as well as they could prior to the onset of symptoms.[21] The final PSFS score is determined from the average of the 3 activity scores. The PSFS was developed by Stratford et al[21] in an attempt to present a standardized measure for recording a patient's perceived level of disability across a variety of conditions. We have found the PSFS to exhibit excellent test-retest reliability and construct validity in patients with neck pain and cervical radiculopathy.[8]

The NPRS was used to capture the patient's level of pain. Patients were asked to indicate the intensity of current, best, and worst levels of pain over the past 24 hours using an 11-point scale ranging from 0 (''no pain'') to 10 (''worst pain imaginable'').[20] The average of the 3 ratings was used to represent the patient's level of pain over the previous 24 hours.

Intervention

All patients were evaluated by 1 physical therapist with 4 years experience and treated by the evaluating therapist or 1 of 2 physical therapist assistants (PTAs) with 4.5 and 8.0 years of experience working in an orthopaedic setting. All patients received the following 4 treatment components: cervical lateral glide mobilization in an upper limb neurodynamic position, thoracic spine mobilization/manipulation, strengthening exercises of the deep neck flexors and scapulothoracic muscles, and mechanical traction. All interventions were provided in the standardized order listed below.

Cervical Lateral Glides in Upper Limb Neurodynamic Position All treatment sessions commenced with the primary therapist (or physical therapist assistant) performing lateral cervical glides while the patient's involved upper extremity was in an upper limb neurodynamic test position, which has been purported to bias the median nerve.[23] This technique was performed as described by Vicenzino.[41] The patient's upper extremity was placed into scapular depression, shoulder abduction, forearm supination, wrist and finger extension, shoulder external rotation, and elbow extension by a second clinician. If the second clinician was not available, the upper extremity was placed in neurodynamic test position described above and supported by a chair with pillows on it. If the upper extremity was supported on a chair, the therapist placed the patient's wrist and fingers in extension and asked the patient to maintain this position. If the patient exhibited symptoms in the above position, the elbow was placed in flexion to a point where symptoms diminished. The treating therapist then cradled the patient's head and neck and performed a lateral translation (Maitland[26] grade III and IV) of the target cervical segment toward the contralateral side (away from the side of symptoms) (Appendix A). Both PTAs were instructed in the proper application of this technique and had been practicing it clinically for 6 months prior to using it on any patients that were involved in this case series.

This technique has been shown to be effective in increasing range of motion during upper limb neurodynamic testing and decreasing pain and disability in patients with cervicobrachial pain syndrome.[1,9] Studies[1,9] providing evidence to the effectiveness of this technique allowed the treating clinician to mobilize multiple segments. In addition, recent evidence suggests that cervical mobilization techniques are not specific to a single segment.[24] Considering that available evidence to date suggests that cervical mobilization is not segment specific, all patients in this case series received the lateral glide techniques directed at segments C2 though C7 at each physical therapy session.

Thoracic Spine Manipulation During treatment sessions performed by the primary physical therapist, patients received manipulation directed at the upper and middle thoracic spine regions. Although we were unable to locate evidence for the use of thoracic spine manipulation in a patient population with cervical radiculopathy, Norlander[29-31] has demonstrated that an association exists between mobility in the thoracic spine and neck/shoulder pain. Additionally, patients with cervical radiculopathy often suffer from neck pain and demonstrate decreased cervical range of motion.[5,11] Also, thoracic manipulation has been demonstrated to decrease pain in a patient population with neck pain.[7] Based on these findings, it seems reasonable that a clinician would at least consider utilization of manual therapies to the thoracic spine for patients with cervical radiculopathy.

The thoracic spine manipulation techniques used in this study are illustrated and described in Appendix A. The location of manipulation was based upon

intersegmental mobility assessment and targeted at hypomobile segments, despite the lack of evidence suggesting that spinal manipulation techniques are isolated to the targeted joints.[2,34] Each of the therapist's treatment sessions started with manipulation directed at the upper thoracic spine. If a cavitation was heard during the first manipulation attempt, the treating therapist proceeded to the middle thoracic spine. If no cavitation was heard, the patient was repositioned and the manipulation intervention was repeated. Although an audible cavitation associated with spinal manipulation directed at the lumbopelvic region in patients with low back pain is not correlated with a successful outcome,[15] no such evidence exists regarding the thoracic spine. All patients received all of the aforementioned treatment techniques in the standardized fashion at each physical therapy visit, with the exception of the thoracic spine manipulations, which were not performed on days that patients were treated by a PTA. All patients were treated by the primary physical therapist for 2 to 4 sessions. Therefore, patients received thoracic spine manipulation for an average of 2.7 visits with each patient receiving a mean of 6.6 manipulations throughout the course of physical therapy treatment. Patients were scheduled based on patient convenience and availability of the primary therapist or PTAs.

Strengthening Exercises Following the thoracic spine manipulation, patients were instructed in and performed exercises focusing on strengthening of the deep neck flexors and scapulothoracic muscles regardless of their strength levels. The patients performed deep neck flexor strengthening exercises as described by Petersen,[32] without the use of a biofeedback unit. The patient was supine, with the cervical spine in neutral, and instructed to flatten the curve of the neck by nodding the head. This position was held for 10 seconds and repeated 10 times. Scapulothoracic exercises included serratus anterior and both middle and lower trapezius muscle strengthening, as described by Flynn et al[16] and described and illustrated in Appendix B. All patients were instructed to perform all strengthening exercises at home, twice daily.

Mechanical Traction Cervical traction has been shown to decrease pain and perceived disability[27,21] in patients with cervical radiculopathy; however, no standard parameters have been reported. In this study, all patients received intermittent cervical traction for 15 minutes per session with the following parameters: traction force was started at 8.2 kg (18 lb) and increased a maximum of 0.5 to 0.9 kg (1-2 lb) per session, depending on patient response (ie, centralization or reduction of symptoms). The traction force was adjusted to optimally produce centralization or reduction of the patient's symptoms.[44] The on/off cycle time was set to a ratio of 30:10 seconds. The traction force during the off time was set at 5.4 kg (12 lb). The duration and on/off cycle remained the same for all treatments. The cervical spine was placed in approximately 25° of flexion for all treatment sessions and minor adjustments to this angle were made to optimally reduce the patient's symptoms.

Discharge and Follow-up Outcome Measures

Discharge from physical therapy was determined in combination by the magnitude of functional recovery, resolution of physical impairments, clinical decision making on behalf of the primary therapist, and achievement of the patient's goals. Physical impairment level measures at follow-up and discharge included the test item cluster described by Wainner et al[42] (Spurling test, upper limb tension test, cervical distraction test, and cervical rotation towards the symptomatic side).

All patients completed the NDI, PSFS, and NPRS self-report measures at the final physical therapy treatment session and again by mail after 6-months. In addition, patients completed a global rating of change (GROC), as described by Jaeschke et al,[19] at both the final visit and 6-month follow-up. Patients were asked to rate their overall perception of improvement since beginning physical therapy on a scale ranging from −7 (a very great deal worse) to 0 (about the same) to +7 (a very great deal better). It has been recommended[19] that scores on the GROC between ±3 and ±1 represent small changes, scores of ±4 and ±5 represent moderate changes, and scores of ±6 or ±7 large changes in patient status.

OUTCOMES

A total of 28 patients referred to physical therapy were screened for eligibility criteria. Eleven patients satisfied the eligibility requirements and were included in this case series. Of those that were not eligible, 16 did not satisfy the diagnostic criteria described by Wainner et al[42] during the physical examination and 1 was only able to attend 2 physical therapy sessions as a result of relocating to another state. Demographic information for each patient included in the case series can be found in Table 2. The mean age of the group was 51.7 years (SD, 8.2) and the median duration of symptoms was 18 weeks (range, 8-52 weeks). The mean number of physical therapy sessions attended was 7.1 (range, 6-10; SD, 1.5). Of the patient's participating in this case series, 9 of 11 (82%) identified that they experienced neck pain as well as upper extremity pain on the body diagram.

At the time of the final physical therapy session, 8 of the 11 (73%) patients were negative for all the impairments in the Wainner et al[42] test item cluster.

TABLE 2. Patient demographics and number of physical therapy sessions.

Patient	Age (y)	Gender	Duration of Symptoms (wk)	Dominant or Nondominant Arm Affected	Number of Physical Therapy Sessions
1	42	M	18	D	6
2	56	M	27	D	8
3	37	F	12	D	5
4	59	F	23	N	6
5	62	M	24	N	8
6	44	F	12	D	7
7	53	F	10	N	10
8	60	M	8	N	6
9	48	M	12	D	9
10	50	M	52	D	7
11	58	F	26	N	6
Mean:	51.7	Median:	18.0	Mean:	7.1

Abbreviations: D, dominant; F, female; M, male; N, nondominant.

Two patients exhibited a positive Spurling test (patients 4 and 9), but were still discharged from physical therapy, based on the magnitude of functional improvements. One patient (patient 7) exhibited positive findings for the upper limb neurodynamic test and the Spurling test at the time of discharge.

The minimum clinically meaningful change measured by the PSFS and NDI in patients with cervical radiculopathy has been reported to be 2 and 7 points, respectively.[8] By the conclusion of physical therapy treatment, 10 patients (91%) demonstrated clinically meaningful reductions in pain and disability, as measured by the PSFS and NDI, which continued to persist at the 6-month follow-up (Figures 1 and 2). At the time of the 6-month follow-up, 5 patients (45%) scored the PSFS as a 10, indicating they were able to do the previously listed functional limitations as well as they could prior to the onset of their symptoms, while 5 others still exhibited mild limitations in function as recorded by both the PSFS and NDI.

Farrar et al[14] identified a reduction in the NPRS of 2 points to be indicative of a clinically important change in patient status. All patients exceeded this level both at the time of discharge and the 6-month follow-up (Figure 3). In addition, at the time of discharge 10 of the 11 patients (91%) rated their improvement on the GROC as "quite a bit better" or higher. At the 6-month follow-up, 7 of the 11 patients (64%) rated their perceived level of improvement as "a very great deal better," and 3 as "a great deal better."

One of the 11 patients (patient 7) exhibited improvements with physical therapy, as demonstrated by a clinically meaningful reduction in pain; however, she only reported her perceived change as "a little bit better" and continued to experience symptoms that required an epidural injection. Despite receiving

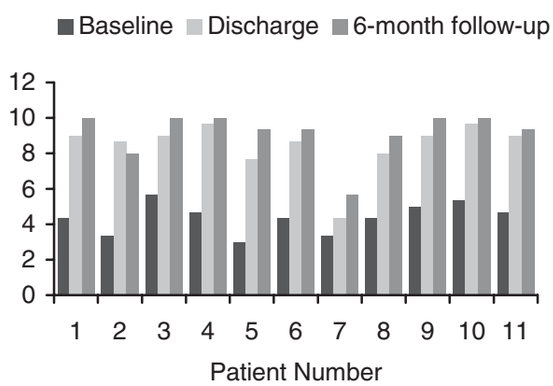

FIGURE 1. Baseline, discharge, and follow-up scores for the Patient Specific Functional Scale for each patient. Scores range from 0 to 10, with 0 representing the inability to perform various activities and 10 representing the ability to perform the activities as well as they could prior to the onset of symptoms.

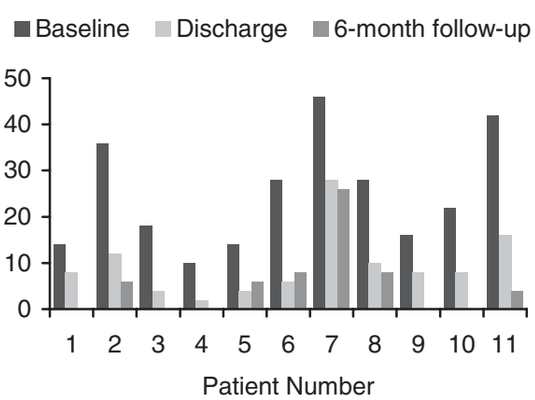

FIGURE 2. Baseline, discharge, and follow-up scores for the Neck Disability Index for each patient. Scores range from 0% to 100% with higher scores corresponding to greater disability. The 6-month follow-up scores for patients 1, 3, 4, 9, and 10 was 0%.

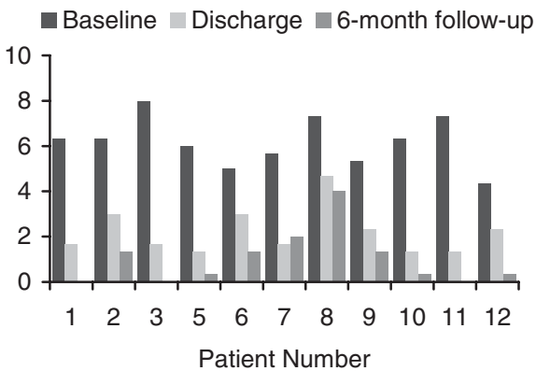

FIGURE 3. Baseline, discharge, and follow-up scores for the numeric pain rating scale for each patient. Scores range from 0 (no pain) to 10 (worst pain imaginable). The 6-month follow-up scores for patients 1, 3, and 11 was 0.

an epidural injection, this patient continued to experience moderate disability (NDI, 26%; PSFS, 5.7) and reported being "a little bit worse" at the 6-month follow-up.

DISCUSSION

While recent research has identified accurate methods for clinical diagnosis of cervical radiculopathy,[42] identification of appropriate conservative management strategies appears to remain a clinical enigma. While other studies[21,27] have investigated the effectiveness of physical therapy in patients with expected cervical radiculopathy, we believe that our case series is the first to do so in a specific series of patients with cervical radiculopathy, as identified by clinical examination techniques demonstrated to exhibit strong diagnostic utility.[42] The purpose of our case series was to describe the outcomes in a homogeneous group of patients with cervical radiculopathy who underwent a standardized physical therapy treatment regimen, including manual physical therapy interventions, strengthening exercises, and intermittent cervical traction. Although a cause-and-effect relationship cannot be inferred from a case series, our results suggest that this particular treatment approach may be beneficial in improving self-reported outcomes in patients with cervical radiculopathy and these benefits may persist at a 6-month follow-up.

The findings of our case series are similar to those of Moeti and Marchetti,[27] who reported the outcomes in a group of patients with cervical radiculopathy treated with cervical intermittent traction, neck retraction exercises, scapular muscle strengthening, and mobilization/manipulation techniques (not used for every patient) for patients with cervical radiculopathy. These authors reported full resolution of pain in 8 of 15 (53%) patients at the time of discharge.

This case series suggests that a treatment approach emphasizing manual physical therapy, deep neck flexor, and scapulothoracic strengthening exercises, and intermittent traction may be an appropriate treatment strategy for patients with cervical radiculopathy. Only 1 patient (patient 7) did not exhibit substantial improvement with this treatment approach. The only readily apparent difference between patient 7 and the rest of the group was that this was the only patient experiencing a traumatic onset of symptoms (motor vehicle accident). The remaining 10 patients reported a gradual insidious onset of their symptoms. Suggesting that the mechanism of injury is the reason for the lack of improvement is beyond the scope of this case series. But this would certainly be an interesting topic for future research.

The generalizability is somewhat limited by the fact that all patients were examined by 1 physical therapist and treated by 1 physical therapist and 2 physical therapist assistants. In addition, no cause-and-effect relationship conclusions can be made with a case series. Future research in the form of randomized clinical trials should be conducted to investigate the effectiveness of such a treatment approach.

CONCLUSION

In this case series, 91% (10 of 11) of patients with cervical radiculopathy treated with the multimodal treatment approach of manual physical therapy, strengthening exercises, and intermittent cervical traction exhibited reduced pain and improved function at the time of discharge and at a 6-month follow-up. Although we cannot suggest a cause-and-effect relationship from a case series, this report allows for initial hypothesis development that this approach may have clinical merit. Future studies in the form of well-designed, randomized clinical trials should be performed to evaluate the effectiveness of this approach in patients with cervical radiculopathy.

ACKNOWLEDGMENTS

The authors would like to thank Frank "Chip" Carson, PTA and Valerie Brunell, PTA for assisting with the treatment of patients in this case series. In addition, we would like to graciously thank Diane Olimpio, PT, Director of Physical Therapy, Rehabilitation Services of Concord Hospital, Concord, NH for her continued support in research endeavors.

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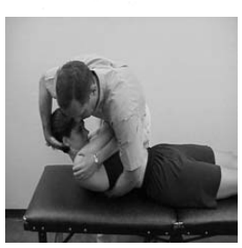
APPENDIX A

Manual Physical Therapy Techniques

Technique	Description of Technique	Illustration
Cervical lateral glides in upper limb neurodynamics position	• The patient is supine and the examiner places the patient's upper extremity into scapular depression, shoulder abduction, forearm supination, wrist and finger extension, shoulder external rotation, and elbow extension. If a second operator is not available (as shown in the pictures to the right), then the patient's arm is supported in this position with a chair and pillows or something similar • If the patient is unable to tolerate this position, the patient's elbow is flexed to the point where symptoms are diminished to a tolerable level • With the involved upper extremity in this position, the therapist cradles the patient's head and neck and performs a lateral translation toward the contralateral side (away from the side of symptoms) • Oscillatory translational mobilizations of the neck toward the nonsymptomatic side are performed at the end range of translation at a grade III and IV, as described by Maitland[26] • The mobilizations are performed for approximately 30 seconds at each motion segment of the spine	 
Upper thoracic spine manipulation in supine*	Part 1 • Position your manipulative hand to stabilize the inferior vertebra of the motion segment Part 2 • Roll the patient into supine and pull the patient's arms downward to create spinal flexion down to the motion segment • Use your body to push down through the patient's arms and perform a high-velocity, low-amplitude thrust	Part 1  Part 2 
Midthoracic spine manipulation in supine†	• Have the patient place arms across his/her chest • Establish hand contact over the inferior vertebra of the motion segment • Apply downward pressure with the weight of your body through the patient's folded arms until motion is felt at the selected segment • Further localize the technique by adjusting the patient's body and your body • Apply a manipulative thrust with your body in an anterior-to-posterior direction • Be careful not to pull on the patient's head	

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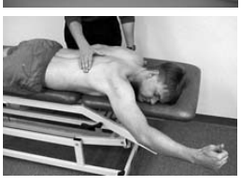
APPENDIX B

Strengthening Exercise Techniques

Technique	Description of Technique	Illustration
Deep neck flexor strengthening	• The patient is instructed to slowly nod the head and flatten the curve of the neck without pushing the head back into the table/bed • The therapist or patient monitors the sternocleidomastoid muscles to ensure minimal to no activation of these muscles during the deep neck flexor contraction	
Lower and middle trapezius strengthening*	• The patient should horizontally abduct the shoulder with scapular depression, adduction, and upward rotation • This should be performed at approximately 120° to 135° abduction for lower trapezius muscle re-education and at approximately 90° abduction for middle trapezius muscle re-education • Note that the shoulder should be externally rotated so the thumb points up toward the ceiling and scapula should not elevate towards the head • Also, the patient may place his/her head and neck in any comfortable posture. If unable to rotate the neck, place a pillow under the upper chest and keep the neck in neutral, with the forehead resting on the patient's opposite forearm or a small towel roll	
Serratus anterior strengthening*	Part 1 • The patient should stand at the wall with the arms approximately shoulder width apart Part 2 • The patient performs a "push-up with a plus" exercise by pushing away from the wall until the elbows are fully extended and the scapulae are protracted as far as possible	Part 1  Part 2 

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