SEYDA TOPRAK CELENAY, PT, PhD[1] • **TURKAN AKBAYRAK,** PT, PhD[2] • **DERYA OZER KAYA,** PT, PhD[3]

A Comparison of the Effects of Stabilization Exercises Plus Manual Therapy to Those of Stabilization Exercises Alone in Patients With Nonspecific Mechanical Neck Pain: A Randomized Clinical Trial

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

STUDY DESIGN: Randomized clinical trial.

BACKGROUND: Little is known about the efficacy of providing manual therapy in addition to cervical and scapulothoracic stabilization exercises in people with mechanical neck pain (MNP).

OBJECTIVES: To compare the effects of stabilization exercises plus manual therapy to those of stabilization exercises alone on disability, pain, range of motion (ROM), and quality of life in patients with MNP.

METHODS: One hundred two patients with MNP (18-65 years of age) were recruited and randomly allocated into 2 groups: stabilization exercise without (n = 51) and with (n = 51) manual therapy. The program was carried out 3 days per week for 4 weeks. The Neck Disability Index, visual analog pain scale, digital algometry of pressure pain threshold, goniometric measurements, and Medical Outcomes Study 36-Item Short-Form Health Survey were used to assess participants at baseline and after 4 weeks.

RESULTS: Improvements in Neck Disability Index score, night pain, rotation ROM, and the Medical Outcomes Study 36-Item Short-Form Health Survey score were greater in the group that received stabilization exercise with manual therapy compared to the group that only received stabilization exercise. Between-group differences (95% confidence interval) were 2.2 (0.1, 4.3) points for the Neck Disability Index, 1.1 (0.0, 2.3) cm for pain at night measured on the visual analog scale, −4.3° (−8.1°, −0.5°) and −5.0° (−8.2°, −1.7°) for right and left rotation ROM, respectively, and −2.9 (−5.4, −0.4) points and −3.1 (−6.2, 0.0) points for the Medical Outcomes Study 36-Item Short-Form Health Survey physical and mental components, respectively. Changes in resting and activity pain, pressure pain threshold, and cervical extension or lateral flexion ROM did not differ significantly between the groups. Pressure pain threshold increased only in those who received stabilization exercise with manual therapy ($P<.05$).

CONCLUSION: The results of this study suggest that stabilization exercises with manual therapy may be superior to stabilization exercises alone for improving disability, pain intensity at night, cervical rotation motion, and quality of life in patients with MNP.

LEVEL OF EVIDENCE: Therapy, level 1b.
J Orthop Sports Phys Ther 2016;46(2):44-55. Epub 11 Jan 2016. doi:10.2519/jospt.2016.5979

KEY WORDS: *cervical spine, manual therapy/spine, therapeutic exercise*

SUPPLEMENTAL VIDEO ONLINE

Nonspecific mechanical neck pain (MNP) is a common condition, affecting 30% to 50% of the general population, and is most prevalent in middle age.[33] It is usually accompanied by a substantial effect on daily life, resulting in extensive use of health care resources.[5,74]

In order to improve functional status and quality of life in patients with MNP, it is important to understand which structures are capable of producing pain and disability. Mechanical neck pain is characterized by a number of structural and functional features.[20-22,26,38,59] Prolonged overactivity of the superficial cervical

[1]Department of Physiotherapy and Rehabilitation, Health Sciences Faculty, Yildirim Beyazit University, Ankara, Turkey. [2]Department of Physiotherapy and Rehabilitation, Health Sciences Faculty, Hacettepe University, Ankara, Turkey. [3]Department of Physiotherapy and Rehabilitation, Health Sciences Faculty, Izmir Katip Celebi University, Izmir, Turkey. The protocol of the study was approved by the Ethics Committee of Hacettepe University, Faculty of Medicine in Ankara, Turkey (approval GO 13/381). The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. Address correspondence to Dr Derya Ozer Kaya, Department of Physiotherapy and Rehabilitation, Izmir Katip Celebi University, Çiğli 35620, Izmir, Turkey. E-mail: deryaozer2000@yahoo.com Copyright ©2016 *Journal of Orthopaedic & Sports Physical Therapy®*

muscles has been found to cause greater muscle fatigability and a reduction in the strength and endurance capacity of the muscles, joint position sense, and range of motion (ROM) in patients with neck pain.[3,8,23,76] Moreover, impairment of the neighboring area, the thoracic spine and shoulder girdle, has been observed in patients with neck pain, with the impairment of scapular function being especially remarkable.[40] Increased activity of the axioscapular muscles and decreased activity of the lower trapezius and serratus anterior have been emphasized in patients with neck disorders.[14,62,78] During rehabilitation in these patients, exercise has been considered one of the most evidence-based modalities.[7,45,74] Specifically, spinal stabilization exercises have been used to activate the deep muscles and decrease overactivity of the surface muscles.[32,63,66] This type of exercise has gained popularity in the treatment of spinal back pain.[10,34] Though the applications of the stabilization exercises in low back pain have become common, few randomized clinical trials have investigated the efficacy of cervical and scapulothoracic stabilization exercises for the management of MNP.[73]

In the rehabilitation process, some techniques additional to exercises may also be used to restore function and decrease pain. A useful method may be manual therapy to the soft tissues and joints to restore ROM, decrease pain, and increase function. Manual therapy, including manipulation or mobilization, has been used to improve neck pain.[70] Though previous studies have reported positive results of cervical and thoracic spine mobilization/manipulation techniques in the improvement of patients with MNP,[28,36] no studies have investigated scapular mobilization for the treatment of neck disorders. Although manual therapy combined with various exercise approaches has been found to be superior to manual therapy alone, there is a lack of randomized clinical trials investigating manual therapy in combination with stabilization exercises in the treatment of MNP.[28,35,56]

Therefore, the current study aimed to investigate and compare the short-term effects of stabilization exercises with manual therapy to those of stabilization exercises alone on disability, pain, ROM, and quality of life in patients with MNP. We hypothesized that patients with MNP who received stabilization exercises combined with manual therapy would demonstrate greater reductions in pain and greater improvements in disability, ROM, and quality of life compared to patients who received stabilization exercises alone.

METHODS

Participants

Patients diagnosed with MNP by their physicians and referred to the Hacettepe University Physiotherapy and Rehabilitation clinic between March 2012 and February 2014 were screened for eligibility to participate in the study. The study was conducted in accordance with the rules of the Declaration of Helsinki. The protocol of the study was approved by the Ethics Committee of Hacettepe University, Faculty of Medicine in Ankara, Turkey (approval GO 13/381). Eligible patients had to be between 18 and 65 years of age and have generalized neck pain for more than 3 months, with symptoms provoked by neck postures, movements, or palpation. The exclusion criteria were neck pain that included inflammatory rheumatologic diseases, malignity, or structural deformity; previous surgery related to cervical spine, cervical spinal stenosis, or bilateral upper extremity symptoms; 2 or more positive radicular signs consistent with nerve root compression (muscle weakness involving a major muscle group of the upper extremity, diminished upper extremity deep tendon reflex, diminished or absent sensation to pinprick in any upper extremity dermatome); severe referred pain (greater than 7 on a 0-to-10 visual analog scale [VAS]) in the related dermatome in the upper extremities; a capsular pattern indicative of arthritis; severe psychological disorder; pregnancy; and any intervention that included exercise or physical therapy in the last 3 months.

Procedure

Participants were assessed at baseline, prior to randomization. The demographic variables, including age, sex, height, weight, exercise habit, smoking and alcohol consumption, mechanism of injury (if any), and location and duration of symptoms, of all participants were recorded. Active and passive movement tests for capsular pattern, resistive movement tests for the cervical region and upper extremity muscle weakness, the vertebrobasilar artery test for vascular sign, the Lhermitte sign test for cord and meningeal sign, upper-limb tension tests for radicular sign, and upper extremity deep tendon reflex and sensory examinations were performed.[52]

Outcome Measures

Assessments related to disability, neck pain intensity, pressure pain threshold (PPT), ROM, and quality of life were administered at baseline and after 4 weeks. All evaluations were conducted by the same physical therapist (D.O.K.), who was blinded to the treatment group of the patients, using a standardized protocol to ensure the consistency of participant positioning, instructions, and overall testing procedures.

Primary Outcome The Neck Disability Index (NDI) in Turkish, for which validity and reliability have been established by Telci et al,[67] was used to assess the disability caused by neck pain. The NDI, developed by Vernon and Mior[69] in 1991, has 4 sections on subjective symptoms (pain severity, headache, concentration, and sleep) and 6 sections on daily living activities (personal care, lifting loads, reading, work activities, driving, and hobbies). Each section is scored from 0 to 5, with a total score on the NDI ranging from 0 (best) to 50 (worst), lower scores indicating less disability.[69] In the literature, the minimal clinically important difference (MCID) for the NDI has been reported to be 7 points.[1]

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Secondary Outcomes The presence of pain intensity at rest, during activity, and at night was assessed with a 0-to-10-cm VAS, whose reliability has been established by Clark et al.[12] On the VAS, 0 indicates "no pain" and 10 indicates "the worst imaginable pain." The VAS, which has exhibited an MCID between 0.9 and 1.1 cm,[4,27] was also selected as an outcome measure, based on its ability to detect rest, activity, and night changes in pain.

Pressure pain threshold was measured using a digital algometer (JTECH Medical, Midvale, UT) with a 1-cm^2 surface area at the round tip, whose reliability has been established by Chung et al.[11] The tip of the algometer was placed between the acromion and C7 on the middle point of the upper trapezius muscle, perpendicular to the skin, and pressure was applied at the rate of 1 $kg/cm^2/s$. After the explanation of the measurement and a demonstration at the thenar region of the hand, 3 consecutive PPT measurements were performed at each location, with 30 seconds of rest between measurements. The mean of the PPT measurements was recorded. The PPT was assessed bilaterally.[51]

Cervical ROM was assessed with the participant sitting comfortably on a chair, with both feet flat on the floor, hips and knees positioned at 90° angles, and buttocks positioned against the back of the chair. The Baseline goniometer (Fabrication Enterprises, Inc, White Plains, NY) was placed on top of the head. Once the goniometer was set in a neutral position, the patient was asked to move the head as far as possible in a standard fashion: flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation. Three trials were recorded for each direction of movement, and the mean was employed in the analysis. Reliability testing of these specific methods measuring the cervical ROM yielded intraclass correlation coefficients ranging from 0.66 to 0.78.[13]

The Turkish version of the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36), whose validity and reliability have been established by Kocyigit et al,[49] was used to assess quality of life. It mainly comprises the physical component summary (PCS) and mental component summary (MCS) scores. The best score is 100 and the worst score is 0. Higher scores indicate better physical or mental functioning.[72]

Randomization

Following the baseline assessments, patients were randomly assigned to receive a stabilization exercise program without manual therapy (StEx only) or with manual therapy (StEx+MT), using a computer-generated randomized table of numbers created by an individual not involved in the recruitment and treatment of patients, prior to the beginning of the study. Individual, sequentially numbered index cards with a random assignment were prepared. The index cards were folded and placed in sealed, opaque envelopes to ensure concealed allocation. The treating therapist (S.T.C.), blinded to the baseline assessment findings, opened the envelope and proceeded with treatment according to the group assignment.

Interventions

Progressive Cervical and Scapulothoracic Stabilization Exercise Program An experienced physical therapist (S.T.C.) carried out both cervical spinal stabilization and scapulothoracic stabilization exercise programs. Each exercise session comprised 10-minute warm-up exercises, 40-minute stabilization exercises, and 10-minute cool-down and stretching exercises, including neck and shoulder girdle muscles. The whole program was carried out 3 days per week for 4 weeks.

After the baseline assessments, sessions began with postural education by having the participants sit with front and side mirrors to find a neutral balanced position of the lumbar, thoracic, and cervical spine.[61] Before performing cervical stabilization exercises, they were taught to perform the contraction of the deep neck flexor muscle activity using the Chattanooga Stabilizer Pressure Biofeedback Unit (DJO Global, Vista, CA) to provide biofeedback for correct deep neck flexor muscle contraction.[43] The intraclass correlation coefficients for deep neck flexor muscle activation and performance measurements with the biofeedback unit were declared to be 0.81 and 0.93, respectively.[37,39] The programs were designed to maintain the spine in a neutral position and activate the deep muscles of the spine.

For the cervical stabilization exercise, the cervical bracing technique with the activation of deep neck flexors[25] was performed. The participants were asked to maintain the positions and contractions during the exercises and throughout the day as much as possible. The combination and progression of the exercises were designed according to those presented in the literature.[19,46,47,58,77] The exercises included workouts using the bracing technique in neurodevelopment stages (supine, prone, quadrupedal, bipedal) for the cervical spine. Participants held the contraction for 10 seconds at each position, with 10 repetitions. Extremity ROM exercises were conducted while maintaining a stable spine at the specific positions. All exercise repetitions were increased progressively from 8 to 12 (**FIGURE 1A**). Then, cervical isometric exercises were performed directly forward, obliquely, toward right and left, and directly backward by maintaining a stable spine with elastic resistive bands, with 10 repetitions and a holding time of 6 to 10 seconds each (**FIGURE 1B**). The exercises also included functional training with elastic resistance and exercise balls on unstable surfaces, with 10 repetitions and a holding time of 10 to 15 seconds each (**FIGURE 1C**).

The scapulothoracic stabilization exercise consisted of specific exercises for the muscles affecting scapular orientation related to neck pain. The exercises used were selected based on the literature.[29,46,58] First, the thoracic bracing technique, with postural alignment and minimal multifidus muscle activation with scapular orientation, for the scapulothoracic stabilization exercise

FIGURE 1. Cervical stabilization exercise program. (A) The cervical bracing technique was performed in neurodevelopment stages, and then extremity range-of-motion exercises were conducted. (B) Cervical dynamic isometric exercises were performed directly forward, obliquely, toward right and left, and directly backward by maintaining a stable spine with elastic resistive bands. (C) Functional training with elastic resistance and exercise balls on unstable surfaces was performed in combination with cervical bracing.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

was taught.[57] The patients were asked to maintain the positions and contractions during the exercises. The following exercises were administered: scapular adduction and shoulder external rotation, bilateral shoulder extension with scapular retraction, eccentric scapular retraction, Brügger's exercise, forward punch, and dynamic hug (**FIGURE 2**).[29,47,58] The participants began exercising using the latex yellow or red band and a 200-cm-long precut section of Thera-Band (The Hygenic Corporation, Akron, OH), with mild or medium tension. They carried out 10 repetitions, with a holding time of 6 to 10 seconds each. When they performed 15 repetitions without significant pain or fatigue, they were progressed to the next color of resistive band in the sequence of green and blue.

Mobilization Applications Cervical and scapular mobilization applications according to Cyriax[16] and Maitland[17] were applied by an experienced physical therapist credentialed in manual therapy practice (S.T.C.). The applications were carried out 3 days per week for 4 weeks.

Cervical mobilization applications were composed of the bridging technique, manual traction, rotation during traction, anterior/posterior gliding during traction, and lateral gliding. Suitable techniques were chosen according to the patients' specific requirements. The applications lasted 15 to 20 minutes (**FIGURE 3**).[16]

Scapular mobilization was applied in the sidelying position, with 10 repetitions of gliding in superior/inferior and rotational directions and distraction of the scapula of both sides (**FIGURE 3**).[17]

Sample Size

We used the G*Power software program (Version 3.0.10; Heinrich-Heine Universität, Düsseldorf, Germany) to determine the necessary sample size for this study. The calculations were based on a 5-point difference in the NDI for 4 weeks, assuming a standard deviation of 7 points (data taken from Dunning et al[18]), a 2-tailed test, an alpha level of .05, and a desired power of 80%. The estimated desired sample size was calculated to be 42 patients per group. Due to an expected dropout rate of 20%, we planned to recruit at least 102 patients (51 per group) into the study.

Statistical Analysis

The variables were investigated using visual (histograms, probability plots) and analytical methods (Shapiro-Wilk test) to determine whether they were normally distributed.

A 2-way, mixed-model analysis of variance (ANOVA) was used to examine the effects of treatment on disability, pain intensity, PPT, cervical ROM, and quality of life, with group (StEx only, StEx+MT) as the between-patient variable and time (baseline, final) as the within-patient variable. Additionally, pairwise compari-

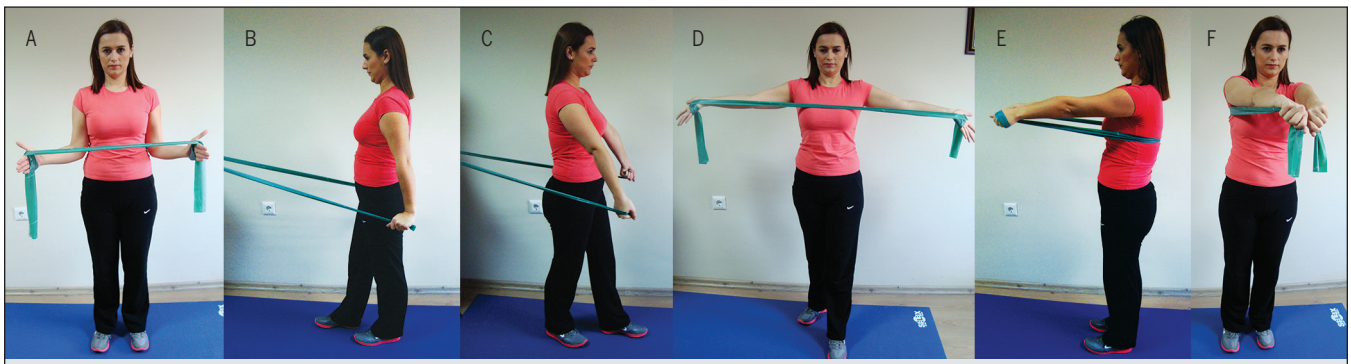

FIGURE 2. Scapular thoracic stabilization exercises. (A) Scapular adduction and shoulder external rotation. (B) Bilateral shoulder extension with scapular retraction. (C) Eccentric scapular retraction. (D) Brügger's exercise. (E) Forward punch. (F) Dynamic hug exercise.

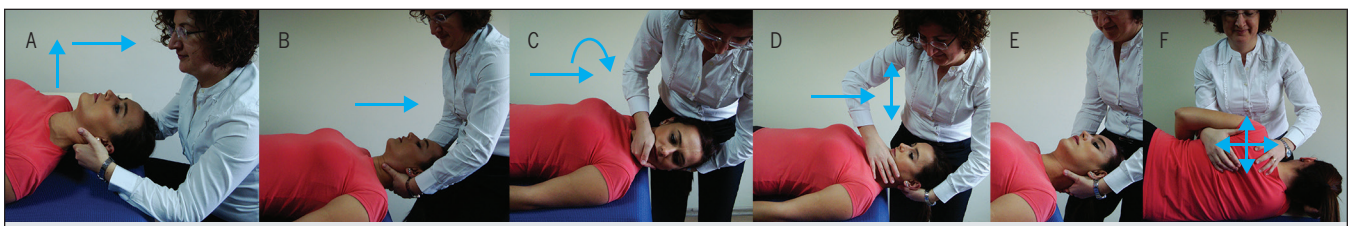

FIGURE 3. Mobilization applications. (A) Bridging technique: the therapist placed her fingers at the bridging position under the occiput. Head tilt was applied gently via wrist radial deviation. Then, during tilt, traction was performed with elbow flexion. (B) Manual traction: one hand supported the occiput while the other hand was hooked under the jaw. The head was maintained in neutral. The therapist then pulled straight by leaning back heavily. (C) Rotation during traction: the therapist turned the head smoothly until resistance during manual traction. (D) Anterior/posterior gliding during traction: the therapist placed a hand on the chin and the other hand dorsally to the occiput. Traction was applied via the hand at the occiput. The hand pushed down on the chin and then the other hand raised up the occiput consecutively. (E) Lateral gliding: the thumbs of the therapist were aligned on the patient's mandible to keep the head in line with the body and prevent side flexion. The therapist pressed sideways with one thumb and maintained the patient's head in line with her body. Then, the other hand pressed in the opposite direction. (F) The manual therapy application for the scapular region in the sidelying position (gliding superior/inferior and rotational directions and distraction of the scapula).

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

sons, known as Bonferroni correction, were performed to examine differences from baseline to the final treatment session between groups to investigate if any between-group differences in change scores were statistically significant.

Data analysis was conducted using IBM SPSS Statistics Version 21.0 (IBM Corporation, Armonk, NY).

RESULTS

Between March 2012 and February 2014, 116 participants were screened for eligibility, and 102 participants met the eligibility criteria. Eligible participants were randomized into the StEx-only (n = 51; mean ± SD age, 44 ± 13 years) or the StEx+MT (n = 51; age, 47 ± 10 years) group after obtaining written informed consent. No participants withdrew from the study, thus 102 participants completed the study at the end of 4 weeks. Details of participant allocation through the final data analysis are provided in **FIGURE 4**. No significant or clinically important differences between the groups were noted in the baseline characteristics (**TABLE 1**). None of the 102 participants reported adverse effects of the treatment other than soreness that resolved within 24 to 48 hours following the treatment.

Disability

The 2-way, mixed-model ANOVA of the NDI score indicated a significant group-by-time interaction (F = 4.553, *df* = 1, *P* = .03). The StEx+MT group experienced significantly greater improvements in disability than the StEx-only group. The point estimate of the mean change score (−7.6 points; 95% confidence interval [CI]: −9.1, −6.1) across all patients in the StEx+MT group exceeded the MCID (7 points) on the NDI,[1] whereas the point estimate of the mean change score (−5.4 points; 95% CI: −6.8, −3.9) across all patients in the StEx-only group did not exceed the MCID. In addition, a comparison of change scores between the StEx-only and the StEx+MT groups demonstrated a between-group difference of 2.2 points (95% CI: 0.1, 4.3) on the NDI (**TABLE 2**).

Pain

The 2-way, mixed-model ANOVA of resting neck pain (F = 0.945, *df* = 1, *P* = .33) and neck pain with activity (F = 0.961, *df* = 1, *P* = .58) indicated no significant group-by-time interaction, whereas the 2-way, mixed-model ANOVA of night neck pain demonstrated a significant group-by-time interaction (F = 4.170, *df* = 1, *P* = .04). Patients in the StEx+MT group experienced greater improvements in night neck pain than those in the StEx-only group. The point

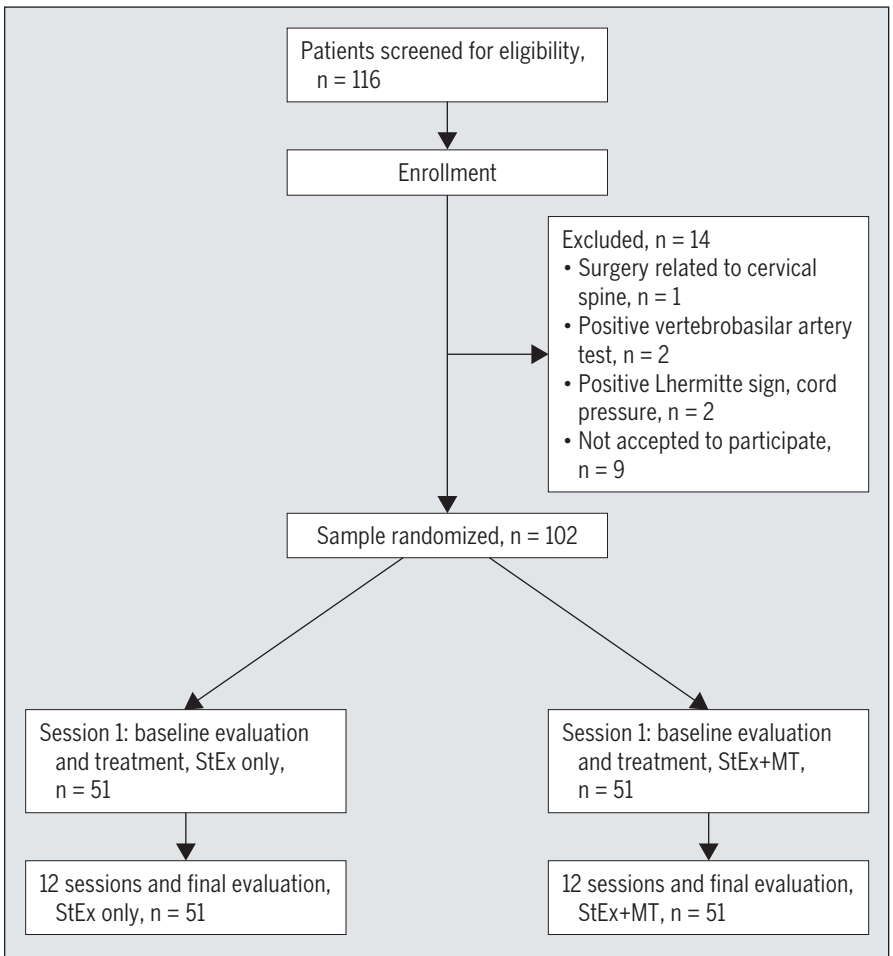

FIGURE 4. The flow chart diagram for the participants. Abbreviations: MT, manual therapy; StEx, stabilization exercise.

estimate of the mean change scores (2.0, 2.8, and 2.6 cm) across all patients in the StEx+MT group exceeded the MCID (0.9-1.1 cm) on the VAS[4,27] at rest, during activity, and at night. The point estimate of the mean change scores (1.6, 2.6, and 1.6 cm) across all patients in the StEx-only group also exceeded the MCID on the VAS[4,27] at rest, during activity, and at night. Furthermore, a comparison of change scores between the StEx-only and StEx+MT groups demonstrated a between-group difference of 0.4 cm (95% CI: −0.4, 1.3) on the VAS at rest, a between-group difference of 0.2 cm (95% CI: −0.7, 1.2) on the VAS during activity, and a between-group difference of 1.1 cm (95% CI: 0.0, 2.3) on the VAS at night (**TABLE 2**).

Pressure Pain Threshold

The 2-way, mixed-model ANOVA of right (F = 1.328, *df* = 1, *P* = .25) and left (F = 1.308, *df* = 1, *P* = .25) PPTs indicated no significant group-by-time interaction. The comparison of change scores between the StEx-only and StEx+MT groups revealed a between-group difference of −0.6 kg/cm^2 (95% CI: −1.8, 0.4) on the right PPT value, and a between-group difference of −0.6 kg/cm^2 (95% CI: −1.6, 0.4) on the left PPT value (**TABLE 2**).

Cervical ROM

The 2-way, mixed-model ANOVA of the cervical flexion (F = 3.744, *df* = 1, *P* = .05), extension (F = 0.415, *df* = 1, *P* = .52), right lateral flexion (F = 0.009, *df* = 1, *P* = .92), and left lateral flexion (F = 1.531, *df* = 1, *P* = .21) motions indicated no significant group-by-time interaction, whereas the 2-way, mixed-model ANOVA of the cervical right rotation (F = 5.207, *df* = 1, *P* = .02) and left rotation (F = 9.102, *df* = 1, *P* = .003) motions indicated a significant group-by-time interaction. Patients in the StEx+MT group demonstrated a greater improvement in cervical rotation motions than those in the StEx-only group. **TABLE 2** summarizes between-group differences and associated 95% CIs for the baseline and final treatment measurements for all directions of cervical ROM.

Quality of Life

The 2-way, mixed-model ANOVA of the quality of life, including the PCS (F = 5.602, *df* = 1, *P* = .02) and MCS (F = 4.096, *df* = 1, *P* = .04), indicated a significant group-by-time interaction. Patients who received StEx+MT showed significantly greater improvements in quality of life, as indicated by improved PCS and MCS scores, compared to those who received StEx only. The comparison of change scores between the StEx-only and StEx+MT groups indicated a between-group difference of −2.9 points (95% CI: −5.4, −0.4) on the PCS (**TABLE 2**), while the comparison of change scores between the StEx-only and StEx+MT groups showed a between-group difference of −3.1 points (95% CI: −6.2, 0.0) on the MCS (**TABLE 2**).

Moreover, pairwise comparisons revealed significant differences between pretreatment and posttreatment for the NDI (*P*<.001), VAS at rest (*P*<.001), VAS during activity (*P*<.001), VAS at night (*P*<.001), cervical flexion (*P*<.001), extension (*P*<.001), right lateral flexion (*P*<.001), left lateral flexion (*P*<.001), right rotation (*P*<.001), left rotation (*P*<.001), PCS (*P*<.001), and MCS scores (*P*<.001 in StEx+MT; *P* = .024 in StEx only) in both intervention groups. However, pairwise comparisons showed significant differences between pretreatment and posttreatment for the right (*P*<.001) and left (*P* = .001) PPT values in the StEx+MT group, whereas no significant differences in the StEx-only group

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

were observed for the right ($P = .083$) and left ($P = .053$) PPT values.

DISCUSSION

This study aimed to investigate and compare the short-term effects of stabilization exercises with manual therapy to those of stabilization exercises alone on disability, pain, ROM, and quality of life in patients with MNP. The study put forward the following short-term findings at 4 weeks: stabilization exercises with manual therapy were superior in improving disability, pain intensity at night, cervical rotation motion, and quality of life compared to stabilization exercises alone; PPT only increased in the StEx+MT group; and decreases in resting pain and pain intensity with activity, and increases in extension and lateral flexion ROM, in patients with chronic MNP were not significantly superior in the StEx+MT group compared to the StEx-alone group.

Previous studies have suggested that stabilization training with and without different manual therapy techniques may improve disability in patients with MNP.[19,24,41,71] Jull et al[41] reported a decline in neck pain and disability in a multimodal physical therapy program that included mobilization and stabilization exercise, and that advice was superior to a self-management program that included home exercise and advice. Walker et al[71] concluded that cervical manipulation and mobilization techniques, together with cervical stabilization and motion exercises, resulted in clinically and statistically significant short- and long-term improvements in disability. Similarly, we found within-group improvements in mean NDI scores that were statistically significant for both groups. The NDI score in the StEx+MT group exceeded the MCID after treatment (4 weeks). But, in both groups there was some uncertainty as to its clinical significance, because the 95% CI included the MCID. Therefore, we cannot rule out the possibility that the effects may not be clinically significant.

TABLE 1 Baseline Demographics and Self-report Variables for All Patients in the Study*

Variables	StEx Group (n = 51)	StEx+MT Group (n = 51)
Age, y	44 ± 13	47 ± 10
BMI, kg/m^2	27.2 ± 4.7	28.9 ± 5.6
Sex, n (%)		
Female	35 (68.6)	39 (76.5)
Male	16 (31.4)	12 (23.5)
Exercise habits, n (%)		
No	34 (66.7)	34 (66.7)
Yes	17 (33.3)	17 (33.3)
Smoking, n (%)		
No	40 (78.4)	40 (78.4)
Yes	11 (21.6)	11 (21.6)
Alcohol consumption, n (%)		
No	46 (90.2)	49 (96.1)
Yes	5 (9.8)	2 (3.9)
Disability†	17.2 ± 8.7	17.5 ± 7.2
Neck pain, cm‡		
Rest	4.0 ± 2.9	3.8 ± 2.5
Activity	6.5 ± 2.7	6.6 ± 2.3
Night	3.9 ± 3.9	4.8 ± 3.6
Right PPT, kg/cm^2	6.7 ± 2.8	6.0 ± 2.6
Left PPT, kg/cm^2	6.4 ± 2.5	5.9 ± 2.5
Cervical ROM, deg		
Flexion	39.4 ± 10.3	42.7 ± 11.4
Extension	35.3 ± 11.0	37.4 ± 13.9
Right lateral flexion	32.5 ± 7.1	35.6 ± 9.7
Left lateral flexion	32.6 ± 7.9	36.4 ± 13.3
Right rotation	42.6 ± 10.7	47.0 ± 12.9
Left rotation	45.6 ± 10.3	46.9 ± 14.3
Quality of life§		
PCS	37.0 ± 9.1	33.9 ± 7.4
MCS	41.9 ± 12.6	42.6 ± 11.6

Abbreviations: BMI, body mass index; MCS, mental component summary; MT, manual therapy; PCS, physical component summary;.PPT, pressure pain threshold; ROM, range of motion; StEx, stabilization exercise.
**Values are mean ± SD unless otherwise indicated. There was no difference between groups for all variables (P>.05).*
†Measured with the Neck Disability Index (score range of 0-50, with higher scores indicating greater disability).
‡Measured with a 0-to-10-cm visual analog scale (0, no pain; 10, worst pain imaginable).
§Measured with the Medical Outcomes Study 36-Item Short-Form Health Survey, consisting of the PCS and MCS (score range of 0-100, with higher scores indicating greater physical and mental functioning).

Further research and meta-analysis are required to increase the certainty of the effectiveness of adding manual therapy to stabilization exercises for patients with

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

TABLE 2 Baseline and Final Treatment and Change Scores for Disability, Neck Pain, PPT, Cervical ROM, and Quality of Life

Measures	Baseline*	Final (After Fourth Week)*	Within-Group Change Scores†	Between-Group Difference in Change Scores†	*P* Value
Primary outcome					
Disability‡				2.2 (0.1, 4.3)	.03
StEx	17.2 ± 8.7	11.8 ± 6.7	−5.4 (−6.8, −3.9)		
StEx+MT	17.5 ± 7.2	9.9 ± 6.0	−7.6 (−9.1, −6.1)		
Secondary outcomes					
Rest neck pain, cm§				0.4 (−0.4, 1.3)	.33
StEx	4.0 ± 2.9	2.4 ± 2.2	−1.6 (−2.2, −1,0)		
StEx+MT	3.8 ± 2.5	1.7 ± 1.5	−2.0 (−2.6, −1.4)		
Activity neck pain, cm§				0.2 (−0.7, 1.2)	.58
StEx	6.5 ± 2.7	3.9 ± 2.5	−2.6 (−3.2, −1.9)		
StEx+MT	6.6 ± 2.3	3.7 ± 1.9	−2.8 (−3.5, −2.1)		
Night neck pain, cm§				1.1 (0.0, 2.3)	.04
StEx	3.9 ± 3.9	2.3 ± 3.1	−1.6 (−2.4, −0.8)		
StEx+MT	4.8 ± 3.6	2.2 ± 2.5	−2.6 (−3.6, −1.9)		
Right PPT, kg/cm^2				−0.6 (−1.8, 0.4)	.25
StEx	6.7 ± 2.8	7.5 ± 3.8	0.7 (0.0, 1.6)		
StEx+MT	6.0 ± 2.6	7.5 ± 2.5	1.4 (0.6, 2.3)		
Left PPT, kg/cm^2				−0.6 (−1.6, 0.4)	.25
StEx	6.4 ± 2.5	7.1 ± 3.2	0.7 (0.0, 1.4)		
StEx+MT	5.9 ± 2.5	7.3 ± 2.5	1.3 (0.5, 2.0)		
Cervical flexion, deg				2.3 (0.0, 4.7)	.05
StEx	39.4 ± 10.3	45.2 ± 8.6	5.8 (4.1, 7.5)		
StEx+MT	42.7 ± 11.4	46.2 ± 10.3	3.5 (1.8, 5.2)		
Cervical extension, deg				1.0 (−2.1, 4.1)	.52
StEx	35.3 ± 11.0	40.8 ± 9.5	5.4 (3.2, 7.7)		
StEx+MT	37.4 ± 13.9	41.9 ± 11.3	4.4 (2.2, 6.6)		

Table continues on page 52.

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

MNP. In addition, the point estimates of the between-group difference for the NDI data were statistically, but not clinically, significant. Examination of the 95% CI upper bound demonstrated that the lack of clinical significance was convincing. However, the addition of manual therapy to stabilization exercises increased the point estimate of within-group change to a value that exceeded the MCID; although, again, the 95% CI included the MCID, so the possibility remains that the change may not be clinically significant. The addition of manual therapy to stabilization exercises also may hasten achievement of MCID improvement.

Neck and scapulothoracic exercise and exercise with manual therapy have been found to be effective in pain intensity for nonspecific MNP.[2,28,31,35,42,50,56,65] The findings regarding pain reduction with stabilization exercises, with and without manual therapy, in this study were similar to those of previous studies.[19,42,56,77] The investigation of the point estimates and 95% CIs of the within-group differences for rest, activity, and night pain intensity (VAS scores) in both groups demonstrated significant results statistically and clinically. The VAS scores in both groups also exceeded the MCID after treatment (4 weeks). It may be that the improvement in neuromuscular control from stabilization exercises decreases the stresses placed on the joints,[48,54] and the afferent input induced by mobilization applications may stimulate neural inhibitory systems at various levels in the spinal cord and activate descending inhibitory pathways from the midbrain.[9,75] The point estimate of the between-group change scores for night neck pain (VAS)

TABLE 2 Baseline and Final Treatment and Change Scores for Disability, Neck Pain, PPT, Cervical ROM, and Quality of Life (continued)

Measures	Baseline*	Final (After Fourth Week)*	Within-Group Change Scores†	Between-Group Difference in Change Scores‡	*P* Value
Cervical right lateral flexion, deg				0.1 (−2.3, 2.5)	.92
StEx	32.5 ± 7.1	38.7 ± 6.1	6.1 (4.4, 7.9)		
StEx+MT	35.6 ± 9.7	41.6 ± 9.1	6.0 (4.2, 7.7)		
Cervical left lateral flexion, deg				−1.6 (−4.2, 0.9)	.21
StEx	32.6 ± 7.9	37.3 ± 7.6	4.7 (2.8, 6.5)		
StEx+MT	36.4 ± 13.3	42.8 ± 10.1	6.3 (4.4, 8.1)		
Cervical right rotation, deg				−4.3 (−8.1, −0.5)	.02
StEx	42.6 ± 10.7	48.0 ± 9.3	5.3 (2.7, 8.0)		
StEx+MT	47.0 ± 12.9	56.8 ± 13.3	9.7 (7.0, 12.3)		
Cervical left rotation, deg				−5.0 (−8.2, −1.7)	.003
StEx	45.6 ± 10.3	49.4 ± 9.3	3.7 (1.4, 6.0)		
StEx+MT	46.9 ± 14.3	55.6 ± 13.0	8.7 (6.4, 11.0)		
Quality of life, PCS‖				−2.9 (−5.4, −0.4)	.02
StEx	37.0 ± 9.1	41.0 ± 9.6	4.0 (2.2, 5.8)		
StEx+MT	33.9 ± 7.4	40.9 ± 7.8	7.0 (5.2, 8.8)		
Quality of life, MCS‖				−3.1 (−6.2, 0.0)	.04
StEx	41.9 ± 12.6	44.8 ± 12.2	2.9 (0.7, 5.1)		
StEx+MT	42.6 ± 11.6	48.7 ± 10.2	6.1 (3.8, 8.3)		

Abbreviations: MCS, mental component summary; MT, manual therapy; PCS, physical component summary;.PPT, pressure pain threshold; ROM, range of motion; StEx, stabilization exercise.
**Values are mean ± SD.*
†Values are mean (95% confidence interval).
‡Measured with the Neck Disability Index (score range of 0 to 50, with higher scores indicating greater disability).
§Measured with a 0-to-10-cm visual analog scale (0, no pain; 10, worst pain imaginable).
‖Measured with the Medical Outcomes Study 36-Item Short-Form Health Survey, consisting of the PCS and MCS (score range of 0 to 100, with higher scores indicating greater physical and mental functioning).

was 1.1 cm, which was equal to the MCID, suggesting a clinically significant impact of adding manual therapy to the stabilization exercises. However, this interpretation should take into account that the 95% CI of this difference ranged from 0.0 to 2.3 cm, including values below the MCID. Therefore, although the difference in improvement between groups was statistically significant, there was some uncertainty as to its clinical significance because the 95% CI included the MCID. Consequently, a combined treatment that includes stabilization exercise with manual therapy may be a better approach to treat patients with night pain, which is usually associated with inflammatory processes.[52]

In the present study, the improvements in active neck mobility were marginal and mainly occurred after 4 weeks in both groups. The initial active ROMs of the participants in all directions were smaller than the normative values reported in the literature.[44] In addition, to date, no MCID has been reported for cervical ROM. Previous studies, including those of different exercise interventions[19,77] and cervical mobilization techniques and exercise,[35] have revealed an increase in cervical ROMs in patients with neck pain after treatment. The present study's results are similar to the results of these previous studies. However, the differences in cervical flexion, extension, and lateral flexion motions between groups were fairly small, while the differences in cervical rotation motions between groups were bigger and statistically significant. This may be related to the cervical rotation maneuver and scapular mobilization techniques included in the manual therapy intervention. Previous studies have emphasized that cervical rotation motion may increase significantly in patients with neck pain when the scapulae are passively elevated.[30,68] They have pointed out that compressive stress on the cervical spine may be reduced with modification of scapular posture and mobility. The loss of cervical rotation motion has been associated with greater disability compared to the loss of cervical motion in other directions in patients with MNP.[60]

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

Therefore, using stabilization exercises with cervical and scapular mobilization techniques could be effective for improving the functional status of patients with restricted cervical rotation motion.

Furthermore, it has been reported that different exercise interventions, including neck and upper-body strength training, endurance training, stretching exercises, and yoga, were effective in improving quality of life in patients with chronic MNP.[15,55,64] However, no MCID has been reported for quality of life evaluated by the SF-36. Our study also revealed that progressive cervical and scapulothoracic stabilization exercise training was an alternative method for improving quality of life in patients with chronic MNP. Moreover, few studies have investigated the effects of both exercise and mobilization techniques on life quality. Maiers et al[53] studied the effectiveness of spinal manipulative therapy and exercise for seniors with chronic neck pain. They reported improvements in disability and general health status but detected no significant improvement. Our study also found that stabilization exercises with manual therapy were more effective in improving quality of life compared to stabilization exercises alone. This improvement may be associated with manual therapy, particularly touching with hands, which has beneficial therapeutic effects. Moreover, it may be related to an appropriate treatment program that includes the cervical and scapulothoracic regions. Therefore, these results should be taken into account in further studies in order to improve quality of life.

There exist a few limitations of the current study. The decision to follow patients for only 4 weeks precludes inferences about longer-term effects of treatment and residual effects beyond the treatment period. Previous studies have supported the idea that exercise training may be effective over longer periods, such as 6 or 8 weeks.[6,24,55] A longer treatment period was not possible in this study due to the limitations of the health insurance plan covering the treatment. This trial should not be interpreted as evidence that stabilization exercise alone is ineffective, given the limited length of follow-up, despite the CI excluding the MCID. However, it was observed that the 4-week stabilization exercise with manual therapy treatment might be sufficient to provide satisfactory results. In addition, this shorter treatment period enabled all of the participants to complete the study, without dropout. The duration of the study should be taken into account in future studies related to the management of patients with MNP. We recommend that future studies investigating the effects of stabilization exercise, with and without manual therapy, compared to other physical therapy interventions for the management of MNP assess longer-term outcomes.

CONCLUSION

Stabilization exercise with manual therapy was more effective in improving disability, pain intensity at night, cervical rotation motion, and quality of life compared to stabilization exercise alone in patients with chronic MNP. ◉

KEY POINTS

FINDINGS: Stabilization exercises with manual therapy was superior to stabilization exercises alone for improving disability, pain intensity at night, cervical rotation ROM, and quality of life in patients with MNP. Stabilization exercise with manual therapy did not result in superior improvements in resting pain or neck pain with activity, or other cervical ROMs, compared with stabilization exercise alone.

IMPLICATIONS: A treatment program that includes both manual therapy and stabilization exercises may be more beneficial than stabilization exercises alone for patients with MNP.

CAUTION: Results seen in the short-term, 4-week follow-up period in this study may not be generalizable to longer-term outcomes, and the additional benefit may not be clinically important.

REFERENCES

1. Abbott JH, Schmitt J. Minimum important differences for the Patient-Specific Functional Scale, 4 region-specific outcome measures, and the numeric pain rating scale. *J Orthop Sports Phys Ther*. 2014;44:560-564. http://dx.doi.org/10.2519/jospt.2014.5248
2. Andersen CH, Andersen LL, Zebis MK, Sjøgaard G. Effect of scapular function training on chronic pain in the neck/shoulder region: a randomized controlled trial. *J Occup Rehabil*. 2014;24:316-324. http://dx.doi.org/10.1007/s10926-013-9441-1
3. Barton PM, Hayes KC. Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. *Arch Phys Med Rehabil*. 1996;77:680-687. http://dx.doi.org/10.1016/S0003-9993(96)90008-8
4. Bird SB, Dickson EW. Clinically significant changes in pain along the visual analog scale. *Ann Emerg Med*. 2001;38:639-643. http://dx.doi.org/10.1067/mem.2001.118012
5. Boden SD, Swanson AL. An assessment of the early management of spine problems and appropriateness of diagnostic imaging utilization. *Phys Med Rehabil Clin N Am*. 1998;9:411-417.
6. Chiu TT, Hui-Chan CW, Chein G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. *Clin Rehabil*. 2005;19:850-860. http://dx.doi.org/10.1191/0269215505cr920oa
7. Chiu TT, Lam TH, Hedley AJ. A randomized controlled trial on the efficacy of exercise for patients with chronic neck pain. *Spine (Phila Pa 1976)*. 2005;30:E1-E7.
8. Chiu TT, Lo SK. Evaluation of cervical range of motion and isometric neck muscle strength: reliability and validity. *Clin Rehabil*. 2002;16:851-858. http://dx.doi.org/10.1191/0269215502cr550oa
9. Christian GF, Stanton GJ, Sissons D, et al. Immunoreactive ACTH, beta-endorphin, and cortisol levels in plasma following spinal manipulative therapy. *Spine (Phila Pa 1976)*. 1988;13:1411-1417.
10. Chung S, Lee J, Yoon J. Effects of stabilization exercise using a ball on mutifidus cross-sectional area in patients with chronic low back pain. *J Sports Sci Med*. 2013;12:533-541.
11. Chung SC, Um BY, Kim HS. Evaluation of pressure pain threshold in head and neck muscles by electronic algometer: intrarater and interrater reliability. *Cranio*. 1992;10:28-34.
12. Clark P, Lavielle P, Martínez H. Learning from pain scales: patient perspective. *J Rheumatol*. 2003;30:1584-1588.
13. 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. http://dx.doi.org/10.1016/j.apmr.2006.06.011

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

14. Cools AM, Dewitte V, Lanszweert F, et al. Rehabilitation of scapular muscle balance: which exercises to prescribe? *Am J Sports Med*. 2007;35:1744-1751. http://dx.doi.org/10.1177/0363546507303560
15. Cunha AC, Burke TN, França FJ, Marques AP. Effect of global posture reeducation and of static stretching on pain, range of motion, and quality of life in women with chronic neck pain: a randomized clinical trial. *Clinics (São Paulo)*. 2008;63:763-770. http://dx.doi.org/10.1590/S1807-59322008000600010
16. Cyriax JH. *Cyriax's Illustrated Manual of Orthopaedic Medicine*. London, UK: Butterworth-Heinemann; 1993.
17. Donatelli RA, Wooden MJ. *Orthopaedic Physical Therapy*. New York, NY: Churchill Livingstone; 1989.
18. Dunning JR, Cleland JA, Waldrop MA, et al. Upper cervical and upper thoracic thrust manipulation versus nonthrust mobilization in patients with mechanical neck pain: a multicenter randomized clinical trial. *J Orthop Sports Phys Ther*. 2012;42:5-18. http://dx.doi.org/10.2519/jospt.2012.3894
19. Dusunceli Y, Ozturk C, Atamaz F, Hepguler S, Durmaz B. Efficacy of neck stabilization exercises for neck pain: a randomized controlled study. *J Rehabil Med*. 2009;41:626-631. http://dx.doi.org/10.2340/16501977-0392
20. Elliott J, Jull G, Noteboom JT, Darnell R, Galloway G, Gibbon WW. Fatty infiltration in the cervical extensor muscles in persistent whiplash-associated disorders: a magnetic resonance imaging analysis. *Spine (Phila Pa 1976)*. 2006;31:E847-E855. http://dx.doi.org/10.1097/01.brs.0000240841.07050.34
21. Elliott J, Jull G, Noteboom JT, Galloway G. MRI study of the cross-sectional area for the cervical extensor musculature in patients with persistent whiplash associated disorders (WAD). *Man Ther*. 2008;13:258-265. http://dx.doi.org/10.1016/j.math.2007.01.012
22. Falla D, Bilenkij G, Jull G. Patients with chronic neck pain demonstrate altered patterns of muscle activation during performance of a functional upper limb task. *Spine (Phila Pa 1976)*. 2004;29:1436-1440. http://dx.doi.org/10.1097/01.BRS.0000128759.02487.BF
23. Falla D, Farina D. Muscle fiber conduction velocity of the upper trapezius muscle during dynamic contraction of the upper limb in patients with chronic neck pain. *Pain*. 2005;116:138-145. http://dx.doi.org/10.1016/j.pain.2005.03.038
24. Falla D, Lindstrøm R, Rechter L, Boudreau S, Petzke F. Effectiveness of an 8-week exercise programme on pain and specificity of neck muscle activity in patients with chronic neck pain: a randomized controlled study. *Eur J Pain*. 2013;17:1517-1528. http://dx.doi.org/10.1002/j.1532-2149.2013.00321.x
25. Falla D, O'Leary S, Fagan A, Jull G. Recruitment of the deep cervical flexor muscles during a postural-correction exercise performed in sitting. *Man Ther*. 2007;12:139-143. http://dx.doi.org/10.1016/j.math.2006.06.003
26. Falla DL, Jull GA, Hodges PW. Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. *Spine (Phila Pa 1976)*. 2004;29:2108-2114.
27. Gallagher EJ, Liebman M, Bijur PE. Prospective validation of clinically important changes in pain severity measured on a visual analog scale. *Ann Emerg Med*. 2001;38:633-638. http://dx.doi.org/10.1067/mem.2001.118863
28. Gross AR, Goldsmith C, Hoving JL, et al. Conservative management of mechanical neck disorders: a systematic review. *J Rheumatol*. 2007;34:1083-1102.
29. Gross AR, Haines T, Goldsmith CH, et al. Knowledge to action: a challenge for neck pain treatment. *J Orthop Sports Phys Ther*. 2009;39:351-363. http://dx.doi.org/10.2519/jospt.2009.2831
30. Ha SM, Kwon OY, Yi CH, Jeon HS, Lee WH. Effects of passive correction of scapular position on pain, proprioception, and range of motion in neck-pain patients with bilateral scapular downward-rotation syndrome. *Man Ther*. 2011;16:585-589. http://dx.doi.org/10.1016/j.math.2011.05.011
31. Häkkinen A, Salo P, Tarvainen U, Wiren K, Ylinen J. Effect of manual therapy and stretching on neck muscle strength and mobility in chronic neck pain. *J Rehabil Med*. 2007;39:575-579. http://dx.doi.org/10.2340/16501977-0094
32. Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. *Spine (Phila Pa 1976)*. 2001;26:E243-E248.
33. Hogg-Johnson S, van der Velde G, Carroll LJ, et al. The burden and determinants of neck pain in the general population: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine (Phila Pa 1976)*. 2008;33:S39-S51. http://dx.doi.org/10.1097/BRS.0b013e31816454c8
34. Hosseinifar M, Akbari M, Behtash H, Amiri M, Sarrafzadeh J. The effects of stabilization and McKenzie exercises on transverse abdominis and multifidus muscle thickness, pain, and disability: a randomized controlled trial in non-specific chronic low back pain. *J Phys Ther Sci*. 2013;25:1541-1545. http://dx.doi.org/10.1589/jpts.25.1541
35. Hoving JL, de Vet HC, Koes BW, et al. Manual therapy, physical therapy, or continued care by the general practitioner for patients with neck pain: long-term results from a pragmatic randomized clinical trial. *Clin J Pain*. 2006;22:370-377. http://dx.doi.org/10.1097/01.ajp.0000180185.79382.3f
36. Izquierdo Pérez H, Alonso Perez JL, Gil Martinez A, et al. Is one better than another?: A randomized clinical trial of manual therapy for patients with chronic neck pain. *Man Ther*. 2014;19:215-221. http://dx.doi.org/10.1016/j.math.2013.12.002
37. Jull G. *The Physiotherapy Management of Cervicogenic Headache: A Randomized Clinical Trial [thesis]*. Brisbane, Australia: The University of Queensland; 2001.
38. Jull G, Amiri M, Bullock-Saxton J, Darnell R, Lander C. Cervical musculoskeletal impairment in frequent intermittent headache. Part 1: subjects with single headaches. *Cephalalgia*. 2007;27:793-802. http://dx.doi.org/10.1111/j.1468-2982.2007.01345.x
39. Jull G, Barrett C, Magee R, Ho P. Further clinical clarification of the muscle dysfunction in cervical headache. *Cephalalgia*. 1999;19:179-185. http://dx.doi.org/10.1046/j.1468-2982.1999.1903179.x
40. Jull G, Sterling M, Falla D, Treleaven J, O'Leary S. *Whiplash, Headache, and Neck Pain: Research-Based Directions for Physical Therapies*. Edinburgh, UK: Elsevier/Churchill Livingstone; 2008.
41. Jull G, Sterling M, Kenardy J, Beller E. Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? – A preliminary RCT. *Pain*. 2007;129:28-34. http://dx.doi.org/10.1016/j.pain.2006.09.030
42. Jull G, Trott P, Potter H, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. *Spine (Phila Pa 1976)*. 2002;27:1835-1843; discussion 1843.
43. Jull GA, O'Leary SP, Falla DL. Clinical assessment of the deep cervical flexor muscles: the craniocervical flexion test. *J Manipulative Physiol Ther*. 2008;31:525-533. http://dx.doi.org/10.1016/j.jmpt.2008.08.003
44. Kapandji IA. *The Physiology of the Joints*. Edinburgh, UK: Churchill Livingstone; 1974.
45. Kay TM, Gross A, Goldsmith CH, et al. Exercises for mechanical neck disorders. *Cochrane Database Syst Rev*. 2012;8:CD004250. http://dx.doi.org/10.1002/14651858.CD004250.pub4
46. Kaya DO, Ergun N, Hayran M. Effects of different segmental spinal stabilization exercise protocols on postural stability in asymptomatic subjects: randomized controlled trial. *J Back Musculoskelet Rehabil*. 2012;25:109-116. http://dx.doi.org/10.3233/BMR-2012-0318
47. Kisner C, Colby LA. *Therapeutic Exercise: Foundations and Techniques*. 5th ed. Philadelphia, PA: F.A. Davis; 2007.
48. Kjellman GV, Skargren EI, Öberg BE. A critical analysis of randomised clinical trials on neck pain and treatment efficacy. A review of the literature. *Scand J Rehabil Med*. 1999;31:139-152.
49. Kocyigit H, Aydemir O, Olmez N, Memis A. Reliability and validity of the Turkish version of Short-Form-36 (SF-36). *Turk J Drug Ther*. 1999;12:102-106.
50. Linton SJ, van Tulder MW. Preventive interventions for back and neck pain problems: what is the evidence? *Spine (Phila Pa 1976)*. 2001;26:778-787.
51. Lluch E, Schomacher J, Gizzi L, Petzke F, Seegar D, Falla D. Immediate effects of active cranio-cervical flexion exercise versus passive

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

mobilisation of the upper cervical spine on pain and performance on the cranio-cervical flexion test. *Man Ther*. 2014;19:25-31. http://dx.doi.org/10.1016/j.math.2013.05.011
52. Magee DJ. *Orthopedic Physical Assessment*. 4th ed. Philadelphia, PA: Elsevier/Saunders; 2002.
53. Maiers M, Bronfort G, Evans R, et al. Spinal manipulative therapy and exercise for seniors with chronic neck pain. *Spine J*. 2014;14:1879-1889. http://dx.doi.org/10.1016/j.spinee.2013.10.035
54. Mayoux-Benhamou MA, Revel M, Vallée C, Roudier R, Barbet JP, Bargy F. Longus colli has a postural function on cervical curvature. *Surg Radiol Anat*. 1994;16:367-371. http://dx.doi.org/10.1007/BF01627655
55. Michalsen A, Traitteur H, Lüdtke R, et al. Yoga for chronic neck pain: a pilot randomized controlled clinical trial. *J Pain*. 2012;13:1122-1130. http://dx.doi.org/10.1016/j.jpain.2012.08.004
56. Miller J, Gross A, D'Sylva J, et al. Manual therapy and exercise for neck pain: a systematic review. *Man Ther*. 2010;15:334-354. http://dx.doi.org/10.1016/j.math.2010.02.007
57. Mottram SL, Woledge RC, Morrissey D. Motion analysis study of a scapular orientation exercise and subjects' ability to learn the exercise. *Man Ther*. 2009;14:13-18. http://dx.doi.org/10.1016/j.math.2007.07.008
58. Murphy DR, Ierna GF. *Cervical Spinal Stabilization Exercises*. Minneapolis, MN: RISES; 2003.
59. O'Leary S, Falla D, Elliott JM, Jull G. Muscle dysfunction in cervical spine pain: implications for assessment and management. *J Orthop Sports Phys Ther*. 2009;39:324-333. http://dx.doi.org/10.2519/jospt.2009.2872
60. Olson SL, O'Connor DP, Birmingham G, Broman P, Herrera L. Tender point sensitivity, range of motion, and perceived disability in subjects with neck pain. *J Orthop Sports Phys Ther*. 2000;30:13-20. http://dx.doi.org/10.2519/jospt.2000.30.1.13
61. O'Sullivan PB. 'Clinical instability' of the lumbar spine: its pathological basis, diagnosis and conservative management. In: Boyling JD, Jull GA, eds. *Grieve's Modern Manual Therapy: The Vertebral Column*. 3rd ed. Edinburgh, UK: Churchill Livingstone; 2005:311-331.
62. Petersen SM, Wyatt SN. Lower trapezius muscle strength in individuals with unilateral neck pain. *J Orthop Sports Phys Ther*. 2011;41:260-265. http://dx.doi.org/10.2519/jospt.2011.3503
63. Saal JA. The new back school prescription: stabilization training. Part II. *Occup Med*. 1992;7:33-42.
64. Salo P, Ylönen-Käyrä N, Häkkinen A, Kautiainen H, Mälkiä E, Ylinen J. Effects of long-term home-based exercise on health-related quality of life in patients with chronic neck pain: a randomized study with a 1-year follow-up. *Disabil Rehabil*. 2012;34:1971-1977. http://dx.doi.org/10.3109/09638288.2012.665128
65. Sarig-Bahat H. Evidence for exercise therapy in mechanical neck disorders. *Man Ther*. 2003;8:10-20. http://dx.doi.org/10.1054/math.2002.0480
66. Stuge B, Laerum E, Kirkesola G, Vøllestad N. The efficacy of a treatment program focusing on specific stabilizing exercises for pelvic girdle pain after pregnancy: a randomized controlled trial. *Spine (Phila Pa 1976)*. 2004;29:351-359.
67. Telci EA, Karaduman A, Yakut Y, Aras B, Simsek IE, Yagli N. The cultural adaptation, reliability, and validity of Neck Disability Index in patients with neck pain: a Turkish version study. *Spine (Phila Pa 1976)*. 2009;34:1732-1735. http://dx.doi.org/10.1097/BRS.0b013e3181ac9055
68. Van Dillen LR, McDonnell MK, Susco TM, Sahrmann SA. The immediate effect of passive scapular elevation on symptoms with active neck rotation in patients with neck pain. *Clin J Pain*. 2007;23:641-647. http://dx.doi.org/10.1097/AJP.0b013e318125c5b6
69. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. *J Manipulative Physiol Ther*. 1991;14:409-415.
70. Vincent K, Maigne JY, Fischhoff C, Lanlo O, Dagenais S. Systematic review of manual therapies for nonspecific neck pain. *Joint Bone Spine*. 2013;80:508-515. http://dx.doi.org/10.1016/j.jbspin.2012.10.006
71. Walker MJ, Boyles RE, Young BA, et al. The effectiveness of manual physical therapy and exercise for mechanical neck pain: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2008;33:2371-2378. http://dx.doi.org/10.1097/BRS.0b013e318183391e
72. Ware JE, Jr. SF-36 health survey update. *Spine (Phila Pa 1976)*. 2000;25:3130-3139.
73. Wegner S, Jull G, O'Leary S, Johnston V. The effect of a scapular postural correction strategy on trapezius activity in patients with neck pain. *Man Ther*. 2010;15:562-566. http://dx.doi.org/10.1016/j.math.2010.06.006
74. Wolsko PM, Eisenberg DM, Davis RB, Kessler R, Phillips RS. Patterns and perceptions of care for treatment of back and neck pain: results of a national survey. *Spine (Phila Pa 1976)*. 2003;28:292-297; discussion 298. http://dx.doi.org/10.1097/01.BRS.0000042225.88095.7C
75. Wright A. Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological mechanism. *Man Ther*. 1995;1:11-16. http://dx.doi.org/10.1054/math.1995.0244
76. Ylinen J, Salo P, Nykänen M, Kautiainen H, Häkkinen A. Decreased isometric neck strength in women with chronic neck pain and the repeatability of neck strength measurements. *Arch Phys Med Rehabil*. 2004;85:1303-1308. http://dx.doi.org/10.1016/j.apmr.2003.09.018
77. Ylinen J, Takala EP, Nykänen M, et al. Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial. *JAMA*. 2003;289:2509-2516. http://dx.doi.org/10.1001/jama.289.19.2509
78. Zakharova-Luneva E, Jull G, Johnston V, O'Leary S. Altered trapezius muscle behavior in individuals with neck pain and clinical signs of scapular dysfunction. *J Manipulative Physiol Ther*. 2012;35:346-353. http://dx.doi.org/10.1016/j.jmpt.2012.04.011

@ MORE INFORMATION
WWW.JOSPT.ORG

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on March 4, 2022. For personal use only. No other uses without permission.
Copyright © 2016 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

VIEW Videos on *JOSPT*'s Website

Videos posted with select articles on the *Journal*'s website (**www.jospt.org**) show how conditions are diagnosed and interventions performed. To view the associated videos for an article, click on **Supplementary Material** and scroll down to stream the videos online or download them to your computer or device.