Physical Therapy
Journal of the American Physical Therapy Association

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PHYS THER. 2007; 87:408-417.
Originally published online March 6, 2007
doi: 10.2522/ptj.20060009

Research Report

Effect of Neck Exercise on Sitting Posture in Patients With Chronic Neck Pain

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Background and Purpose

Poor sitting posture has been implicated in the development and perpetuation of neck pain symptoms. This study had 2 purposes: (1) to compare change in cervical and thoracic posture during a distracting task between subjects with chronic neck pain and control subjects and (2) to compare the effects of 2 different neck exercise regimens on the ability of people with neck pain to maintain an upright cervical and thoracic posture during this task.

Subjects

Fifty-eight subjects with chronic, nonsevere neck pain and 10 control subjects participated in the study.

Method

Change in cervical and thoracic posture from an upright posture was measured every 2 minutes during a 10-minute computer task. Following baseline measurements, the subjects with neck pain were randomized into one of two 6-week exercise intervention groups: a group that received training of the craniocervical flexor muscles or a group that received endurance-strength training of the cervical flexor muscles. The primary outcomes following intervention were changes in the angle of cervical and thoracic posture during the computer task.

Results

Subjects with neck pain demonstrated a change in cervical angle across the duration of the task (mean=4.4°; 95% confidence interval [CI]=3.3–5.4), consistent with a more forward head posture. No significant difference was observed for the change in cervical angle across the duration of the task for the control group subjects (mean=2.2°; 95% CI=1.0–3.4). Following intervention, the craniocervical flexor training group demonstrated a significant reduction in the change of cervical angle across the duration of the computer task.

Discussion and Conclusion

This study showed that people with chronic neck pain demonstrate a reduced ability to maintain an upright posture when distracted. Following intervention with an exercise program targeted at training the craniocervical flexor muscles, subjects with neck pain demonstrated an improved ability to maintain a neutral cervical posture during prolonged sitting.

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[Falla D, Jull G, Russell T, et al. Effect of neck exercise on sitting posture in patients with chronic neck pain. *Phys Ther*. 2007;87:408–417.]

For The Bottom Line:
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In an upright, neutral posture of the cervical spine, passive resistance to motion is minimal.[1] Support of the cervical segments is provided by the muscular sleeve formed by the longus colli muscle anteriorly and the semispinalis cervicis and cervical multifidus muscles posteriorly.[2–5] In particular, the longus colli muscle has a major postural function in supporting and straightening the cervical lordosis.[4] In addition, the craniocervical region is supported by muscles that attach to the cranium and span the upper cervical motion segments, such as the longus capitis muscle anteriorly and the suboccipital extensor, semispinalis, and splenius capitis muscles posteriorly.[6]

The importance of the deep muscles for the maintenance of cervical posture was verified in a computer model, which showed regions of local segmental instability if only the large superficial muscles of the neck were simulated to produce movement, particularly in near-upright or neutral postures.[7] Deep cervical muscle activity was required in synergy with superficial muscle activity to stabilize the cervical segments, especially in functional mid-ranges of the cervical spine.

Recent studies have identified impaired activation of the deep cervical flexor muscles, the longus colli and longus capitis, in people with neck pain.[8,9] Given the role of the deep cervical flexor muscles in postural support and the knowledge of impaired activation of these muscles in people with neck pain, it is likely that this patient population also would display deficits in the postural endurance of these muscles. Indeed, evidence is emerging that suggests that people with neck pain drift into a more forward head position when distracted.[10] This has been observed despite a lack of postural differences in people with neck pain in erect sitting.[11–14] Moreover, retraining the deep cervical flexor muscles, which has been shown to decrease neck symptoms[15,16] and increase the activation of the deep cervical flexor muscles during performance of the clinical test of craniocervical flexion,[16] may improve the ability to maintain an upright posture of the cervical spine.

This study had 2 purposes: (1) to identify whether people with neck pain demonstrate differences in their ability to maintain an upright posture when distracted by a computer task compared with a group of control subjects and (2) to compare the effects of a low-load craniocervical flexion training regimen against a conventional neck flexor endurance-strength training program on functional control of head and neck posture in people with chronic neck pain. The low-load craniocervical flexion training regimen was compared with a conventional strengthening regimen because it is not known whether such specific training of the deep cervical muscles is required in rehabilitation or if a more general strengthening exercise of the neck flexor muscles would be sufficient to improve control of the cervical postural position.

This study forms part of a series of experiments to investigate the mechanisms of efficacy of cervical muscle retraining. The effect of both exercise regimens on measures of pain and disability have been reported in our previous work.[16,17]

Method

Subjects

Fifty-eight female subjects (mean age=37.9 years, SD=10.2 years) with a history of chronic, non-severe neck pain of greater than 3 months ($\overline{X}$=7.9 years, SD=6.4 years) participated in this study. Subjects were recruited by advertisements in the local press. To be included, the subjects had to score ≤15 (out of a possible 50) on the Neck Disability Index (NDI).[18] An NDI score ≤15 indicates mild to moderate neck pain.[18]

Subjects in this category were selected because previous studies investigating motor control deficits in people with neck pain examined patients with similar perceived pain and disability scores. For example, reduced activation of the deep cervical muscles has been observed in people with neck pain with an NDI score of ≤15.[9,19] Moreover, the average NDI score of the patients included in this study is similar to previous exercise trials.[20,21] People with more severe pain were excluded because the endurance exercise regimen may have increased the symptoms of this group.

Subjects also had to have palpable cervical joint tenderness[22] and demonstrate poor performance (unable to achieve 24 mm Hg) on the clinical test of craniocervical flexion as defined by Jull et al.[23] Further details of the test are presented in the "Exercise Regimens" section. Subjects were excluded if they had undergone cervical spine surgery, reported any neurological signs, or had participated in a neck exercise program in the past 12 months.

The mean score of subjects on the NDI was 9.9 (out of a possible 50) (SD=3.1), and the average intensity of neck pain was 4.1±2.1 on a 10-cm numerical rating scale (NRS) anchored with "no pain" and "the worst possible pain imaginable." The subjects with neck pain who participated in this study also formed part of another study.[17] The sample size (26 per group plus a 10% dropout allowance) was based on the difference in fatigue of the cervical muscles between a group of subjects with neck pain and subjects who were asymptomatic (mean difference=0.65 Hz, SD=0.83, power=90%).[24] Thus, the study had sufficient power to detect a difference in the ability of the exercise interventions to change parameters of muscle function, but was not designed to compare the efficacy of the approach to reduce pain and disability.

Ten volunteers (mean age=35.0 years, SD=4.6) formed the control group. The control group subjects were recruited via local advertisements and were free of neck pain, had no past history of orthopedic disorders affecting the neck, and had no history of neurological disorders.

Experimental Procedure

Phase I. Subjects were positioned in front of the computer in sitting with their knees in 90 degrees of flexion and their feet flat on the ground. A plumb line was positioned in the background. The starting position was standardized by placing the subject in an upright posture, which was defined as a vertical pelvic position (no anterior or posterior tilt) with the assumption of a lumbar lordosis and thoracic kyphosis.[23] Subjects were asked to maintain the position while they were distracted by playing the game of Solitaire on the computer for 10 minutes. Subjects used the mouse with their dominant hand and the other hand rested motionless on the desk in front of them.

Postural analysis. Cervical and thoracic posture was measured throughout the 10-minute computer task from a lateral photograph taken with a digital camera (Canon Digital IXUS, 1600 × 1200 pixels)* positioned on a tripod at a distance of 0.8 m. The axis of the lens of the camera was placed orthogonal to the sagittal plane of the patient at a height that corresponded with the seventh cervical vertebra. Anatomical markers were positioned on the tragus of the ear and the spinous processes of the seventh cervical and seventh thoracic vertebrae and were fixed with double-sided medical tape.

The digital technique used to quantify angular displacement in this study has been previously described.[25,26] The technique has been shown to produce reliable angular measurements (intraclass correlation coefficient [ICC](2,2)>.93) and the criterion validity of the technique has been established when compared to the universal goniometer by a nonsignificant ($F=0.02$; $df=1,5$; $P=.887$) mean absolute difference (0.26°) between the 2 measurement techniques.[25] Using this technique, measures of angular displacement in the shoulder, elbow, wrist, and knee joints have demonstrated standard error of measurement values of 0.83, 0.38, 0.37 and 0.50 degree and a minimal detectable change at the 90% confidence interval (CI)[27] of 0.34, 0.23, 0.17 and 0.23 degree, respectively (Russell et al, unpublished data).[25]

The angle of forward head posture was measured from a line drawn from the tragus of the ear to the seventh cervical vertebra subtended to the horizontal (Fig. 1, angle A).[28] The software produced a horizontal line perpendicular to the vertical plumb line captured in the background of the image. Thoracic posture was calculated as the angle between the horizontal line and a line drawn between the seventh cervical spinous process and the seventh thoracic spinous process (Fig. 1, angle B). Changes in angles from an erect starting posture (time 0) to the angles measured at 2-minute intervals throughout the 10-minute task were calculated and expressed relative to the angle at time 0.

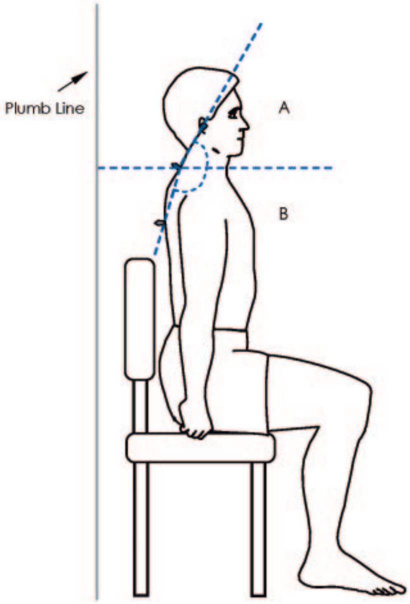

Figure 1.
Cervical and thoracic postural parameters. Subjects were positioned in an upright neutral posture. Anatomical markers were positioned on the tragus of the ear, spinous process of the seventh cervical vertebra, and the spinous process of the seventh thoracic vertebra. The angle of forward head posture (A) was measured from a line drawn from the tragus of the ear to the seventh cervical vertebra subtended to the horizontal. Thoracic posture was calculated as the angle between the horizontal line and the line drawn from the seventh cervical spinous process to the seventh thoracic spinous process (B).

Phase II. Following baseline measurements, the subjects with chronic neck pain were randomized into 1 of 2 exercise groups: a training regimen of the craniocervical flexor muscles or an endurance-strength training regimen for the cervical flexor muscles. The allocation sequence was generated by an independent body and an independent investigator assigned participants to their group. Figure 2 illustrates the progression of subjects through the exercise trial. Postural analysis during the computer task was performed at baseline and in the week immediately after the 6-week intervention period (week 7) for the patient group. The researcher taking the measurements was blinded to subject group for the outcome assessments and statistical analyses.

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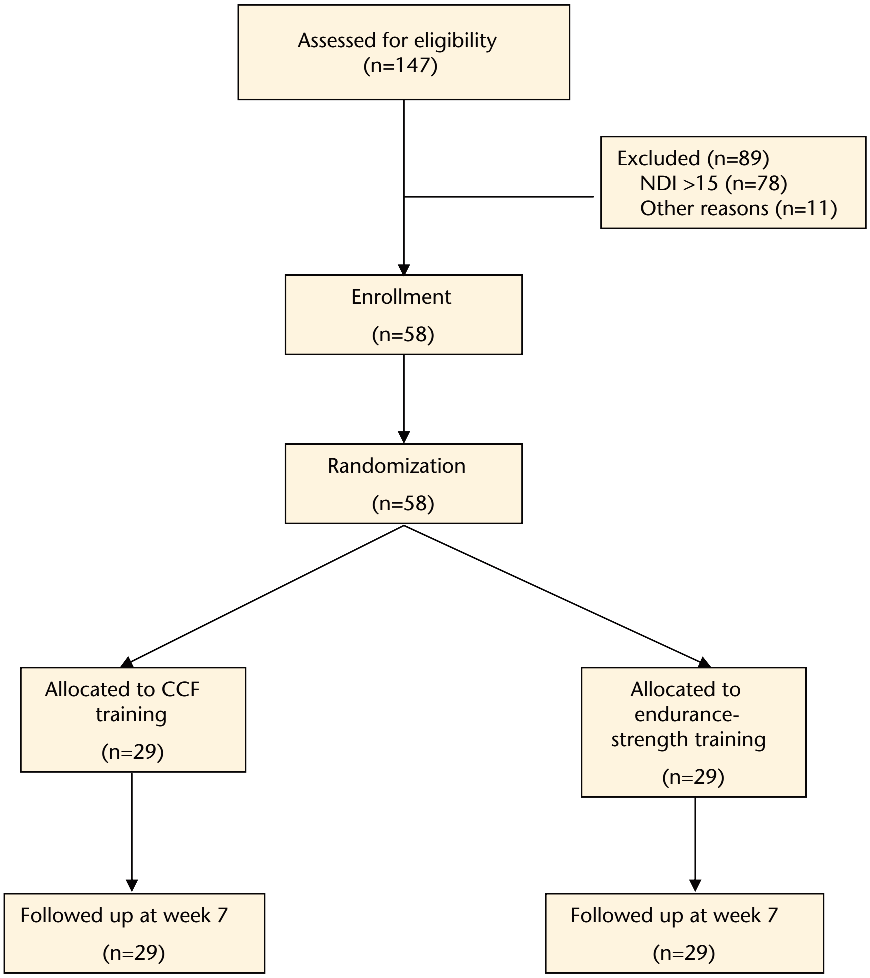

Figure 2.
Progression of participants through the exercise trial. NDI=Neck Disability Index, CCF=craniocervical flexor.

Exercise Regimens

The exercise regimens were conducted over a 6-week period and subjects in each group received personal instruction and supervision by an experienced physical therapist once per week for the duration of the trial. None of the exercise sessions were longer than 30 minutes. Subjects were asked not to receive any other specific intervention for their neck pain; however, any medication that a subject was currently taking was not withheld. All subjects were supplied with an exercise diary and requested to practice their respective regimen twice per day for the duration of the trial. The exercise occupied a period of no longer than 10 to 20 minutes per day. The exercises were performed without any provocation of neck pain.

Craniocervical flexor training intervention. Training of the craniocervical flexor muscles followed the protocol described by Jull et al.[23] The exercise targets the deep flexor muscles of the upper cervical region, the longus capitis and longus colli muscles, rather than the superficial flexor muscles, the sternocleidomastoid and anterior scalene, which flex the neck but not the head.[19,29] In addition, the exercise is a low-load exercise in nature to more specifically train the deep cervical flexors, rather than the neck flexors as a whole, which occurs in a head lift exercise. The exercise used an air-filled pressure sensor (Stablizer),[†] which was placed sub-occipitally to monitor the subtle flattening of the cervical lordosis that occurs with the contraction of the longus colli muscle.[4]

The subject was guided by the feedback from the pressure sensor to sequentially reach 5 pressure targets in 2-mm Hg increments from a baseline of 20 mm Hg to the final level of 30 mm Hg. Subjects were instructed to “gently nod their head as though they were saying ‘yes’.” The physical therapist identified the target level that the subject could hold steadily for 10 seconds without resorting to retraction, without dominant use of the superficial neck flexor muscles, and without a quick, jerky craniocervical flexion movement.[23] Contribution from the superficial muscles was monitored by the physical therapist in all stages of the test using observation or palpation.

Training was commenced at the target level that the subject could achieve with a correct movement of craniocervical flexion and without dominant use or substitution by the superficial muscles (sternocleidomastoid, hyoid, and anterior scalene muscles). The subjects were taught to perform a slow and controlled craniocervical flexion action. They then trained to be able to sustain progressively increasing ranges of craniocervical flexion using feedback from the pressure sensor, which was placed behind the neck. For each target level, the contraction duration was increased to 10 seconds, and the subject trained to perform 10 repetitions. At this stage, the exercise was progressed to train at the next target level.

[†] Chattanooga Group Inc, 4717 Adams Rd, Hixson, TN 37343.

Endurance-strength training intervention. The endurance-strength training regimen consisted of a progressive resistance exercise program for the neck flexors. The exercise was performed in supine position, with the head supported in a comfortable resting position. Subjects were instructed to lift up their head so that cervical flexion occurred while maintaining a neutral upper cervical spine position. The subjects slowly moved the head and neck through as full a range of motion as possible without causing discomfort or reproducing their symptoms.

This exercise regimen was a 2-stage program. The first stage was of 2 weeks' duration and the second was of 4 weeks' duration as recommended[30] for initiating a weight program in previously untrained individuals. In stage 1, the subjects performed 12 to 15 repetitions with a weight that they could lift 12 times (12-repetition maximum [RM]) on the first training session and progressed to 15 repetitions and maintained this level for the remainder of the 2-week period.

In stage 2, the subjects performed 3 sets of 15 repetitions of the initial 12-RM load once per day. One-minute rest intervals were provided between sets. If repetitions were easily achieved, weighted sandbags were applied to the patient's forehead in 0.5-kg increments. If the subject was unable to perform repetitions of the head lift maneuver then the load on the neck flexors was reduced by allowing the subject to perform the task with the upper body (trunk and neck) inclined up from the horizontal so that the subject could perform the required repetitions of the movement.

Data Analysis

Comparison between subjects with neck pain and control subjects. Angle data were expressed as a change from the starting angle at each time interval throughout the 10-minute computer task. A repeated-measures general linear model was used to identify whether change in cervical and thoracic angles across the duration of the task were different between the 2 subject groups. The independent variable was the subject group (between-subjects factor), and the within-subject factor was the time interval of the task (5 measurements).

Change in posture before and after intervention for the exercise groups. Paired sample *t* tests were conducted to determine if NDI and NRS measurements were significantly different before and after the intervention for both exercise groups, and independent sample *t* tests were conducted to compare for group differences. A repeated-measures general linear model was used to compare baseline cervical and thoracic angles between the 2 intervention groups with factors of group (craniocervical flexor training and endurance-strength training) and time (5 measurements).

For the preintervention to postintervention analysis, a repeated-measures general linear model was applied. The independent variables were the 2 intervention groups (between-subjects factor) and the within-subject factor was the time interval of the task (5 measurements). A polynomial or linear trend was fitted to the time factor to explain the relative change in cervical and thoracic angle across the duration of the task. A value of $P<.05$ was used as an indicator of statistical significance.

Results

Comparison of Postural Position Between Subjects With Neck Pain and Control Subjects

Subjects with neck pain demonstrated a significant, progressive increase in change of cervical angle from baseline throughout the 10-minute computer task ($F=19.3$; $df=1,56$; $P<.001$; Fig. 3A). In contrast, for the control subjects, there was no evidence for a change in cervical angle over the 10-minute computer task ($F=1.95$; $df=1,56$; $P=.17$; Fig. 3A). Compared with the starting position, the mean change in cervical angle at 10 minutes was 4.4 degrees (SD=4.1°, 95% CI=3.3–5.4) for the neck pain group and 2.2 degrees (SD=1.6°, 95% CI=1.0–3.4) for the control group.

The subjects with neck pain also demonstrated a significant, progressive increase in change of thoracic angle from baseline across time ($F=45.3$; $df=1,56$; $P<.001$; Fig. 3B). Although less than the subjects with neck pain, the control subjects also demonstrated an increase for the change of thoracic angle ($F=11.4$; $df=1,9$; $P<.01$; Fig. 3B). Compared with the starting position, the mean change in thoracic angle at 10 minutes was 8.2 degrees (SD=4.8°, 95% CI=6.9–9.5) for the subjects with neck pain and 4.8 degrees (SD=3.3°, 95% CI=2.4–7.1) for the control subjects.

Changes in Cervical and Thoracic Angle After Exercise Intervention

Of the 58 participants with neck pain who participated in the exercise interventions, none were lost to follow up assessment. Subject descriptive data are presented in the Table. Baseline characteristics of pain (NRS) and disability (NDI) were not different between the 2 intervention groups ($P>.05$). In addition, preintervention cervical ($F_1=0.28$, $P>.05$) and thoracic ($F_1=2.13$, $P>.05$) angles were not significantly different between the 2 intervention groups. All participants in the endurance-strength training group and craniocervical flexor training group received the full 6 treatments. According to the patient diaries, adherence to exercise was 91.0% (SD=0.12%) for the endurance-strength training group

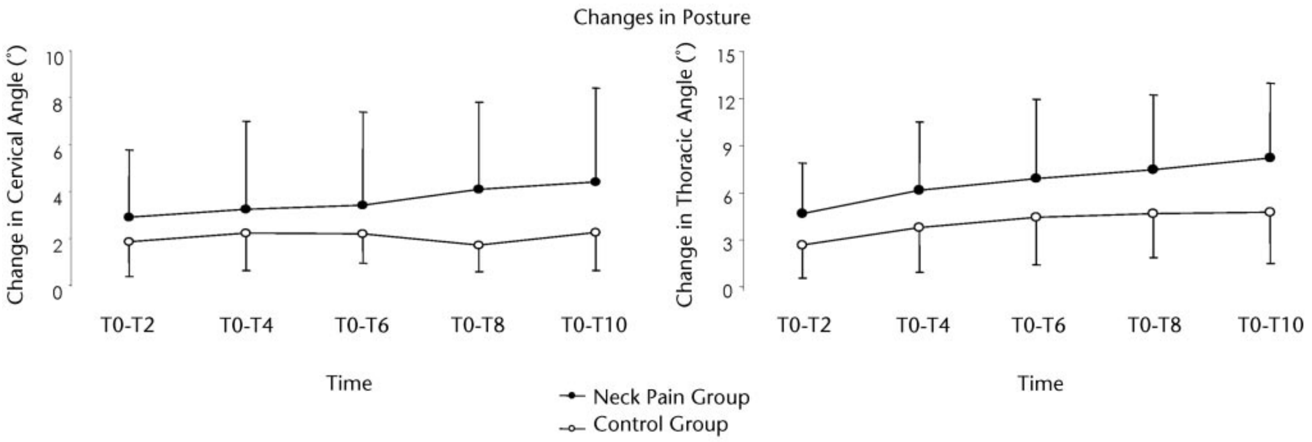

Figure 3.
Group comparisons for change in cervical and thoracic posture. Data (mean and standard deviation) are presented for change in cervical posture (left) and change in thoracic posture (right) for patients with neck pain and for control subjects. Change in angle from an erect starting posture (time 0 [T0]) are expressed relative to the angle measured at 2-minute intervals (T2, T4, T6, T8, T10) throughout the 10-minute task.

and 94.8% (SD=0.06%) for the craniocervical flexor training group. No patients reported any adverse events.

Both intervention groups demonstrated a reduction in average intensity of pain (craniocervical flexor training: −0.9±2.3, endurance-strength training: −1.1±2.8), and NDI score (craniocervical flexion training: −3.5±4.8, endurance-strength training: −2.8±4.0). However, there was no difference between groups for change in pain (NRS) or disability (NDI) ($P>.05$).

Following 6-weeks of intervention, the craniocervical flexor training group demonstrated a significant reduction in the change of cervical angle ($F=7.44$; $df=1,1,1$; $P<.01$; Fig. 4) across the duration of the task when compared with the endurance-strength training group. In addition, both groups improved their ability to maintain an upright posture of the thoracic spine; however, there was no significant difference between the 2 intervention groups ($F=2.55$; $df=1,1,1$; $P>.05$; Fig. 5).

Discussion

The results of this study demonstrated that subjects with chronic non-severe neck pain had a reduced ability to maintain an upright neutral posture when distracted by a computer task. Moreover, exercise targeted at training the craniocervical flexor muscles improved the ability to maintain an upright cervical posture during this task.

Comparison Between Subjects With Neck Pain and Control Subjects

In support of previous findings,[10] subjects with neck pain demonstrated a reduced ability to maintain an upright posture during a computer task. There was a subtle forward drift of the head of a magnitude of 4.4±4.1 degrees in association with a subtle increase in the thoracic flexion curve of 8.2±4.8 degrees in subjects with neck pain. This may reflect impaired endurance of the muscles that would be required to control

Table.
Baseline Characteristics for Patients With Chronic Neck Pain Randomized Into a Craniocervical Flexor Exercise Intervention or an Endurance-Strength Exercise Intervention

	Craniocervical Flexor Exercise Intervention (n=29)			**Endurance-Strength Exercise Intervention (n=29)**		
	Mean±SD	**Median**	**Range**	**Mean±SD**	**Median**	**Range**
Age	37.7±9.9	38.0	22.0–55.0	38.1±10.7	38.0	22.0–55.0
Length of neck pain history (y)	7.5±5.9	7.0	0.5–21.0	8.3±7.0	5.5	1.0–30.0
Neck pain intensity (0–10 cm)	3.6±2.0	3.4	0.7–7.1	4.7±2.0	4.5	1.8–9.0
Neck Disability Index (0–50)	9.8±3.3	10.0	2.0–14.0	10.4±3.4	10.0	3.0–15.0

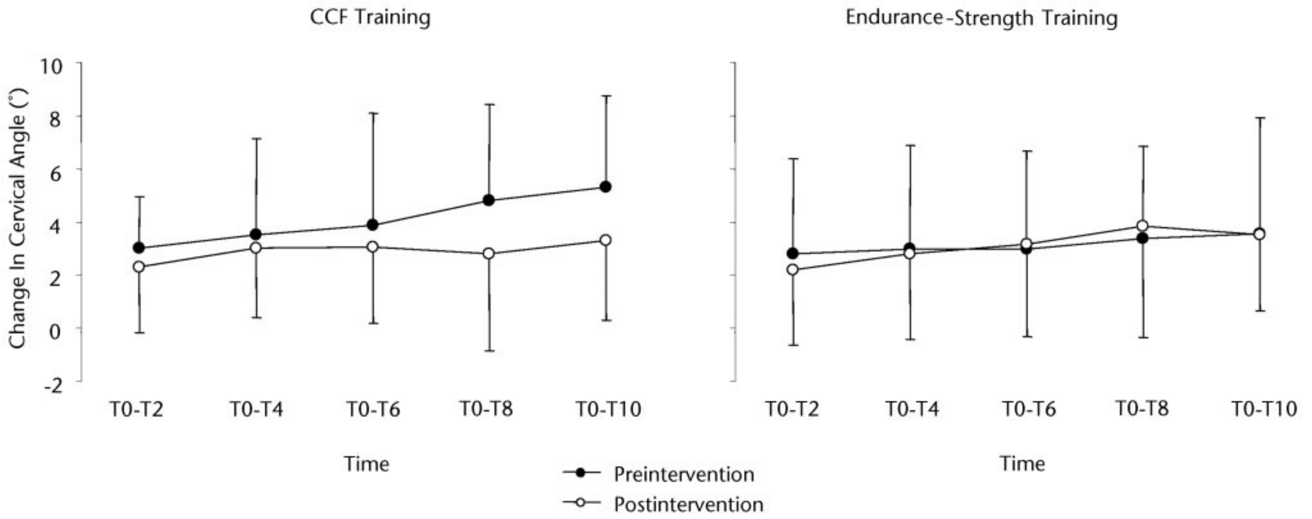

Figure 4.
Group data for change in cervical posture following intervention in patients with neck pain. Preintervention and postintervention data (mean and standard deviation) are presented for change in cervical posture throughout the 10-minute computer task for the craniocervical flexor (CCF) training group and endurance-strength training group. Change in angle from an erect starting posture (time 0 [T0]) are expressed relative to the angle measured at 2-minute intervals (T2, T4, T6, T8, T10) throughout the 10-minute task.

the postural position of the spine during sitting. In agreement with previous research, decreased endurance of the craniocervical flexor muscles has been observed in patients with neck pain at 20% of their maximal voluntary contraction.[31] Other factors such as reduced proprioception resulting in poor head position awareness also may explain the differences observed for the group with neck pain compared with the control group. Evidence of reduced cervical kinesthetic sense has been identified in both people with idiopathic neck pain and people with neck pain following a whiplash injury.[32–34]

A reduced ability to maintain an upright posture of the cervical spine when distracted during sitting might be considered a measure of impairment in the postural supporting mus-

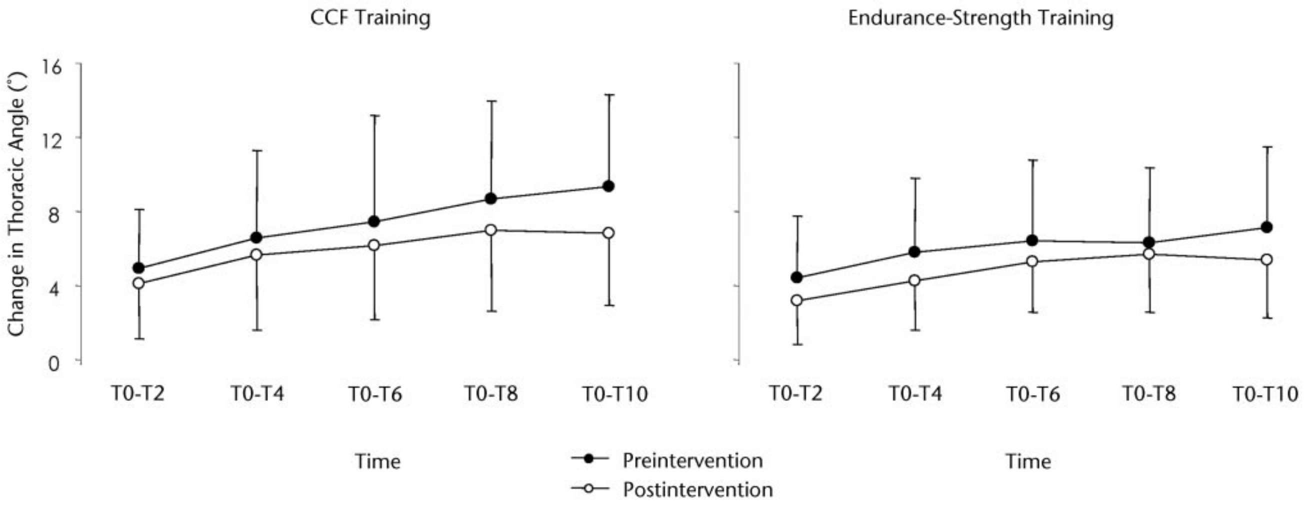

Figure 5.
Group data for change in thoracic posture following intervention in patients with neck pain. Preintervention and postintervention data (mean and standard deviation) are presented for change in thoracic posture throughout the 10-minute computer task for the craniocervical flexor (CCF) training group and the endurance-strength training group. Change in angle from an erect starting posture (time 0 [T0]) are expressed relative to the angle measured at 2-minute intervals (T2, T4, T6, T8, T10) throughout the 10-minute task.

cles during a functional task, an outcome that can be easily replicated clinically.

A sustained forward flexion posture of the spine has been associated with increased cervical compressive loading and a creep response in the connective tissue.[35,36] It would not be unreasonable to consider that a sustained forward head posture associated with prolonged sitting could aggravate, if not initiate, neck pain. There is some evidence that has linked prolonged static posture with increased muscle loading and subsequent risk for the development of symptoms in the upper body.[37,38]

Although both the subjects with neck pain and the control subjects demonstrated progressive change in thoracic posture throughout the 10-minute computer task, this change was greater for the subjects with neck pain. The observation that thoracic angle increased progressively in the control subjects throughout the task in the absence of a change in cervical posture was somewhat surprising, but could indicate earlier fatigue in the trunk extensors than in the neck muscles. Further investigation of this finding is necessary.

Effect of Exercise on Control of Posture During Sitting in Subjects With Neck Pain

Following a 6-week intervention with either craniocervical flexor training or neck flexor endurance-strength training, the participants with neck pain improved their ability to maintain an upright posture of the thoracic spine during the 10-minute computer task. This improvement could be attributed to factors such as task familiarity or increased postural awareness; however, only the group that received the specific craniocervical flexor training improved their ability to maintain an upright position of the cervical spine. Craniocervical flexor training involves performing and holding inner range positions of craniocervical flexion, the anatomical action of the deep cervical flexor muscles. This training has been shown to increase the activation of these muscles.[16] The improved ability to maintain an upright position of the cervical spine, which was observed for the craniocervical flexor training group, may reflect an improved endurance of the deep cervical flexor muscles, which was identified during the functional task of sitting. This improvement occurred even though there was no exercise instruction on postural correction in sitting. This finding supports our previous suggestion that inadequate control of the head in prolonged sitting may be a functional correlate of deep cervical muscle impairment.

Moreover, craniocervical flexion directly activates the deep cervical flexor musculature,[19,39] which have a relatively high density of muscle spindles.[2] Improved cervical kinesthetic sense following craniocervical flexor training[40] also may explain the improved ability to maintain an upright position of the cervical spine.

It is notable that the endurance-strength regimen did not influence postural parameters of the cervical spine. Although there is some evidence to suggest that an endurance-strength regimen for the neck flexor muscles reduces neck pain,[17,41,42] improves strength,[17,42] and reduces fatigue of the sternocleidomastoid and anterior scalene muscles,[17] it does not appear to improve the ability to maintain an upright posture of the cervical spine in a sitting task.

The maintenance of cervical postural angle with the craniocervical flexor training during the 10-minute distraction task reached statistical significance when compared with the endurance-strength regimen. Nevertheless, it can be questioned whether the subtle maintenance of postural angles is clinically meaningful. This question cannot be answered directly in this study. However, the magnitude of change in cervical posture following craniocervical flexion training is similar to the magnitude of difference observed between the subjects with neck pain and the control subjects in the first phase of this study. Furthermore, such subtlety in head drift was also observed by Szeto et al[43] in their comparison of computer workers with and without neck pain. The outcomes of both studies suggest that, in sitting working postures, subtle changes in posture over time, possibly reflective of poor muscle control as proposed in this study, might be very relevant to the function of office workers with neck pain. The possible associations between functional working postures and neck pain justifies further research towards meeting the challenge of prevention of neck pain in office workers, which is recognized as a significant contemporary problem in the workforce.[44]

Change in Pain and Perceived Disability

Following 6 weeks of exercise, a significant reduction in average intensity of pain (NRS) and perceived disability (NDI score) was identified for both training groups. Although only the craniocervical flexor training group showed a significant improvement in their ability to maintain an upright position of the cervical spine, this was not associated with a greater reduction in pain or perceived disability compared with the endurance-strength regimen group. However, because a sustained forward flexion posture of the spine has been associated with compressive loading of the cervical tissues,[35,36] improved cervical posture during sitting may have an additional long-term benefit of reducing recurrent episodes of neck pain. This is of particular relevance given the high recurrence rate of neck pain.[45] Further research is now warranted to examine whether an improved ability to maintain an upright position of the cervical spine following specific exercise intervention is maintained in the long term and the effect that this may have on the recurrence rate of neck pain.

Methodological Considerations

This study used photographic analysis to describe change in cervical and thoracic posture using anatomical markers. Although photographic analysis has shown to be a reliable tool for quantifying change in cervical angle,[46] precise conclusions about the anatomical alignment of the spine as identified on radiographs cannot be inferred from variation in surface measurement.[47] Despite this limitation, this study demonstrates that postural analysis during a common functional activity in sitting may provide a useful measure to quantify postural changes during tasks and to monitor the effects of rehabilitation.

Only posture of the cervical and thoracic spine were analyzed in this study. In future studies, electromyography could be used concurrently to provide additional information on muscle activation associated with the observed postural changes.

Additional methodological aspects may include the duration of the computer task used in this study (10 minutes). However, the duration of the task was sufficient to demonstrate differences between subjects with neck pain and control subjects. Finally, it must be noted that it is not known whether the improvements in postural endurance that were observed following 6-weeks of exercise intervention would be maintained in the long term. Additional research is warranted to address these issues.

Conclusion

Subjects with chronic neck pain demonstrated a reduced ability to maintain an upright neutral posture when distracted by a computer task. Following intervention with an exercise program targeted at retraining the craniocervical flexor muscles, subjects with chronic neck pain demonstrated improved ability to maintain a neutral cervical posture during prolonged sitting. This most likely reflects an improvement in the endurance of the muscles that control the postural position of the neck during function.

Dr Falla, Dr Jull, Dr Vincenzino, and Dr Hodges provided concept/idea/research design and fund procurement. Dr Falla, Dr Jull, Mr Russell, and Dr Hodges provided writing. Dr Falla provided data collection, and Dr Falla, Mr Russell, and Dr Hodges provided data analysis. Dr Falla and Dr Jull provided project management. Dr Jull and Dr Hodges provided facilities/equipment. Mr Russell provided consultation (including review of manuscript prior to submission). The authors thank Amy Fagan from The University of Queensland, Australia for assistance with data collection.

Dr Falla is supported by the National Health and Medical Research Council of Australia (ID 351678). This study was funded by a grant (ID 252771) received from the National Health and Medical Research Council of Australia.

Ethical approval for the study was granted by the Institutional Medical Research Ethics Committee of The University of Queensland, and all procedures were conducted according to the Declaration of Helsinki.

This article was submitted January 9, 2006, and was accepted December 19, 2006.

DOI: 10.2522/ptj.20060009

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Physical Therapy
Journal of the American Physical Therapy Association

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PHYS THER. 2007; 87:408-417.
Originally published online March 6, 2007
doi: 10.2522/ptj.20060009
