J. Phys. Ther. Sci.
25: 657–661, 2013

Effect of Deep Cervical Flexor Muscles Training Using Pressure Biofeedback on Pain and Disability of School Teachers with Neck Pain

Zaheen Ahmed Iqbal[1)*], Reena Rajan[2)], Sohrab Ahmed Khan[3)], Ahmad H. Alghadir[1)]

[1)] *Department of Rehabilitation Sciences, College of Applied Medical Sciences, King Saud University: Riyadh, Saudi Arabia*
[2)] *Department of Orthopedics, AIIMS, India*
[3)] *Department of Rehabilitation Sciences, Hamdard University, India*

Abstract. [Purpose] The job of secondary school teachers involves a lot of head down posture as frequent reading, assignment correction, computer use and writing on a board put them at risk of developing occupational related neck pain. Available studies of neck pain experienced by teachers are limited. The purpose of this study was to determine whether training of deep cervical flexor muscles with pressure biofeedback has any significant advantage over conventional training for pain and disability experienced by school teachers with neck pain. [Subjects] Thirty teachers aged 25–45 years with neck pain and poor craniocervical flexion test participated in this study. [Methods] A pretest posttest experimental group design was used in which experimental group has received training with pressure biofeedback and conventional exercises while control group received conventional exercises only. Measurements of dependent variables were taken at baseline, and after 2 and 4 weeks of training. Pain intensity was assessed using a numeric pain rating scale and functional disability was assessed using the neck disability index. [Results] The data analysis revealed that there was significant improvement in pain and disability in both the groups and the results were better in the experimental group. [Conclusion] Addition of pressure biofeedback for deep cervical flexor muscles training gave a better result than conventional exercises alone. Feedback helps motor learning which is the set of processes associated with practice or experience leading to permanent changes in ability to respond.
Key words: Neck pain, Disability, Teachers

(This article was submitted Dec. 27, 2011, and was accepted Mar. 2, 2012)

INTRODUCTION

Neck pain (NP) is becoming increasingly prevalent in society. Estimates indicate that 67% of individuals will suffer neck pain at some stage of their life[1)]. NP is a significant health problem not only for adults but also for the young. The onset and course of NP is affected by multiple factors with physical, psychosocial and individual factors interacting in the development of these disorders[2, 3)].

Teaching is one of the professions in which NP is very common. It was found that 69.3% of secondary school teachers suffer from it[3)]. The lifetime prevalence of NP in secondary school teachers is 68.2%[4)]. The job nature of secondary school teachers involves a lot of head down posture, such as in frequent reading, assignment correction, and writing on the blackboard[5)]. Thus, secondary school teachers are at risk of developing occupationally related NP and upper limb pain. High workload, low colleague support, high anxiety and some psychological factors have been found to be significant risk factors for the development of NP in teachers[3)]. The transition from conventional to modern methods of teaching is a major cause of teachers developing NP. Available studies of NP and its causes among teachers are limited. According to one study back pain, neck pain and headache, are the most common ailments of the workers in the school environment[20)]. Another study of nursery school teachers found 26.5% of them complained of neck stiffness[5)].

The learning environment for children is progressively being facilitated by new forms of information technology (IT). Traditional methods of teaching, such as school textbooks, are gradually being enhanced and replaced by new forms of IT such as internet sources and interactive multimedia software. These initiatives have resulted in an increase in the number of classes that involve computing. Several studies have shown associations between physical exposures and neck/upper extremity symptoms during computer work[6, 7)]. Long duration of computer work is associated with prolonged periods of holding a static posture[2)], which is most pronounced in the neck and shoulder region, resulting in increased forward neck flexion and increased static muscle tension in this region[2, 8–10)]. Increased forward neck flexion may result in increased tension in posture, stabilizing muscles as well as increasing compression forces in the articulation of the cervical spine, resulting in a higher

*To whom correspondence should be addressed.
E-mail: z_iqbal001@yahoo.com

risk of work related muscular disorders[2].

The Deep Cervical Flexor muscles (DCF) are considered to be an important stabilizer of the head-on-neck posture. It has been theorized that when muscle performance is impaired, the balance between the stabilizers on the posterior aspect of the neck and the DCFs will be disrupted, resulting in loss of proper alignment and posture, which is then likely to contribute to cervical impairment[10]. Therefore DCF training is recommended for increasing the endurance of these postural muscles, leading to improvement in NP. Research recommends that training that emphasizes the correct use of DCF, before introducing strengthening of the global cervical spine musculature, is more effective in the rehabilitation of the cervical spine than nonspecific strengthening of neck muscles. The craniocervical flexion test (CCFT) regime appears to be an ideal strategy for specifically activating DCFs and reducing augmented activity of the SCM muscle. There is evidence that restoration of the supporting capacity of DCF parallels reduction in neck pain and cervicogenic headache. Hence, DCF muscle training is recommended for the clinical management of neck pain[11].

Jull et al. endorse a specific craniocervical flexion exercise (CCFEx) protocol in the supine position. This program initially involves retraining a static holding contraction of the target muscles at a submaximal level to improve their tonic postural function. The type of training employed is based on the nature of the dysfunction presenting in these muscles[9, 12], as well as their normal functional role[1]. These exercises constituted the conventional exercises of our study.

The purpose of this study was to determine whether, there is an improvement in pain and disability of school teachers with NP after 4 weeks of deep cervical flexor training with pressure biofeedback.

Significance of study

In India, the teacher is considered equivalent to God. Thus future of students depends more or less on teachers. If teachers suffer, it directly affects the future of students as well. So, we need to make teachers physically, mentally and functionally better so that they can focus on the betterment of students. This study also emphasizes the role of DCF training in decreasing pain and disability among teachers.

SUBJECTS AND METHODS

Thirty teachers (24 females and 6 males) aged group 25 to 45 years participated in this study. The subjects were teachers of the Central Board of Secondary Education affiliated schools who had more than 5 years of experience. The teachers were included if they had a neck pain score on the numeric pain rating scale (NPRS) of greater than 5, mild to moderate disability scores on the neck disability Index (NDI) and poor CCF test results. Subjects were excluded if they had undergone any cervical spine surgery or reported any neurological signs. Subjects with a history of congenital or acquired postural deformity, spinal cord compression, tumor, instability, fracture, inflammatory disease or infection were also excluded.

The proposal for the study was presented before the Review Committee of Hamdard University and received approval.

A pretest, posttest experimental group design was used in the study. After selection, subjects were randomly allocated to one of the two groups with 15 subjects in each: Group A: the experimental group received deep cervical flexor muscles training with pressure biofeedback and conventional exercises. Group B: the control group received deep cervical flexor muscles training with only conventional exercises.

The independent variable in the study was DCF muscles training and the dependent variables were pain (P) on NPRS, and functional disability (D) on NDI.

We used a pressure stabilizer, Pressure Biofeedback Unit (Stabilizer TM, Chattanooga Group, INC., Chattanooga, TN), a height adjustable bed, markers and papers.

A letter was sent to the principals of CBSE affiliated schools with details of the research and their consent was obtained. The study was conducted on school premises in the medical room. The teachers were selected based on inclusion and exclusion criteria. Then, their informed consent was sought. Selected subjects were randomly allocated to the two groups. Subjects were informed about nature and procedure of study and all their questions were answered.

Baseline information of the dependent variables was taken at the beginning of study, on day 1 (P0, D0), before commencement of the training protocol. Data were collected at the end of 2 weeks of training (P14, D14) and at the end of 4 weeks (P28, D38). NPRS and NDI were used to evaluate the level of pain and functional disability, respectively.

Both experimental and control groups performed conventional exercises. In addition the experimental group also performed deep cervical flexor muscles training using pressure biofeedback. The exercise session was conducted under the supervision of the examiner. Subjects were asked not to receive any other specific intervention for neck pain. Training was done for 4 weeks, 4 days a week with 2 minutes rest between sets. Exercise duration did not exceed 20 minutes per day. The CCFT exercise program included 3 sets in a session 10 repetitions per set.

The data was analyzed using SPSS software. The independent t test was used to compare age and baseline values of pain and disability between groups. The paired t test was used to compare pain on NPRS and Disability on NDI within groups. All dependent variables were compared between baseline, their values at 2 weeks and their values at end of 4 weeks. The independent t test was used to compare pain on NPRS and disability on NDI between the groups. The values of both groups, group A and group B, were compared at baseline and for the difference from baseline, at the end of 2 weeks and at the end of 4 weeks. We used 95% CI and the results were accepted as significant if $p < 0.05$.

RESULTS

Thirty teachers, 24 females and 6 males, participated in the study. Subjects had a mean age of 36.33±6.42 in group A and 36.40±5.99 in group B. Subject's characteristics were homogenous at baseline. (All p> 0.05)

NDI: In the comparison of disability, values between the baseline (D0), after 2 weeks (D14) and after 4 weeks (D28), significant improvement was noted in both groups A and B ($p<0.05$). The mean reduction in NDI scores in group A was 6.715±0.67 at p= 0.000, and the mean reduction in group B was 2.207 ± 0.1059 at p = 0.000.

The difference between D0 and D14 (D14–D0) for both groups A and B was significant (p=0.015). The difference between D14 and D28 (D28–D14) between the groups was significant (p=0.022). The difference between D0 and D28 (D28–D0) between the groups was significant difference was obtained (p=0.003) (Table 1).

NPRS: In the comparison of pain, the values at baseline (P0), after 2 weeks (P14) and after 4 weeks (P28), showed significant improvements in both groups A and B ($p<0.05$). The mean reduction in NPRS scores in group A was 3.137±0.41 and in group B was 1.797 ± 0.1514.

The difference between P0 and P14 (P14–0) for both groups A and B was significant (p=0.05). The difference between P14 and P28 (P28–P14) between the groups was significant (p=0.04). The difference between P0 and P28 (P28–P0) between the groups was significant (p=0.01) (Table 2).

DISCUSSION

This study was designed to determine the effects of deep cervical flexor muscles training using pressure biofeedback on neck pain and disability experienced by school teachers with neck pain. The results of our study show that there was a significant change in both pain and disability in both the groups after the intervention. However, the experimental group showed better results than the control group in terms of reduction of pain and disability.

The amount of NP and disability were not significantly different between the members of the two groups at the start of the study (baseline measurement). This could be attributed to the same nature of the duties performed by teachers at school.

To our knowledge, this is the first study in which craniocervical flexion training was given to teachers having neck pain. Therefore the lack of literature in this area limited the scope for direct comparison with other studies. The results of our study can be compared to other studies in a general way only, due to differences in treatment protocols, subject population, measures taken, and duration of treatment.

The level of pain decrease in both the groups was significant. This is explained by research on mechanisms of pain reduction through exercises. The increase in endorphins that occurs after training and better neuromuscular control may decrease pain. Muscle contractions activate muscle ergoreceptors (stretch receptors). Afferent from these muscles cause endogenous options to be released and also the beta-endorphins from the pituitary gland. These secretions may cause both peripheral and central pain to be blocked[13]. Neck exercises may allow the musculotendinous proprioceptors to downgrade their stretch reflex responses using operant conditioning techniques and multiple practice sessions. The intrafusal fibers may be reset, discontinuing the cycle of muscle tension, impaired circulation with metabolite accumulation and pain associated with myogenic (myofascial) pain[14].

The neck disability index in our study showed significant changes in both groups. This result may be explained by the reduction in pain intensity which can bring about improvement in disability. Herman et al.[21] also proposed that the relationship between pain and neck disability index is quite strong as pain intensity is one of the ten areas addressed in NDI. A relationship between these variables would be expected.

Literature on NDI reports that the minimal detectable score and the minimal clinically important difference is 5 points. Moreover it is recommended that the NDI be used at baseline and for every 2 weeks thereafter to measure the progress of therapy. This protocol was followed in this study.

Deep cervical flexor training as a treatment for neck pain and resulting disability is based on the rationale that deep cervical flexors, the longus colli muscle in particular, have a major postural function in supporting cervical lordosis, since in the functional mid-ranges of the cervical spine the lose their endurance capacity in patients with neck pain[11, 15]. Therefore, it is thought that pressure biofeedback specifically targets DCF muscles and decreases neck pain.

Our results are supporting the initial hypothesis, are in agreement with those obtained in a randomized controlled trial conducted by Jull et al.[9], to determine the effect of 6 weeks of low-load craniocervical flexion exercise on cervicogenic headache patients. The results showed that the

Table 1. Comparison of NDI between the groups

NDI	GROUP A (Mean±SD)	GROUP B (Mean±SD)	
D0	15.23 ± 5.60	12.93 ± 3.89	*
D14	11.84 ± 4.04	11.95 ± 3.88	
D14	11.84 ± 4.04	11.95 ± 3.88	*
D28	8.51 ± 4.39	10.72 ± 4.01	
D28	8.51 ± 4.39	10.72 ± 4.01	*
D0	15.23 ± 5.60	12.93 ± 3.9	

D 0 Pretest reading on day 1, D 14 reading at the end of 2 weeks, D 28 Posttest reading after 4 weeks A-Experimental group, B-control group *p < 0.05

Table 2. Comparison of NPRS between the groups

NDI	GROUP A (Mean±SD)	GROUP B (Mean±SD)	
P0	6.47 ± 1.36	7.07 ± 1.49	*
P14	4.73 ± 1.22	5.93 ± 1.28	
P14	4.73 ± 1.22	5.93 ±1.28	*
P28	3.33 ± 1.77	5.27 ± 1.34	
P28	3.33 ± 1.77	5.27 ± 1.34	*
P0	6.47 ± 1.36	7.07 ± 1.49	

P 0 Pretest reading on day 1, P 14 reading at 2 weeks and P28 Posttest reading after 4 weeks A-Experimental group, B- control group *p < 0.05

treatment significantly reduced the pain associated with neck movements and joint palpation.

A single case study done by Grant et al.[10], also reported that the endurance of the deep cervical flexors improved and there was a reduction in mechanosensitivity of selected neural, muscular and articular structures of a screen based keyboard operator after four weeks of active stabilization training of the deep cervical flexors and lower scapular muscle group[9].

A possible explanation for our findings is that the factors influencing the school teachers are multifactorial. No one single factor contributes to their pain[3, 16]. Anthropometric variations, the possible adverse developmental effects of prolonged exposure to postural stresses, computer furniture, mental stress and reports of pain and vision factors can all influence school teachers' posture[17]. Most of the teachers complained that they didn't have the time to take care of themselves due to school work[3]. Accordingly a dedicated 20 min for exercises at school itself as a part of their schedule for 4 weeks may have had a good psychological impact on them, indirectly resulting in pain relief apart from the physiological effect. Therefore, a multidimensional approach may be needed if sustainable improvements are to be made including psychological assurance.

The experimental group may have shown better results because doing exercises with constant feedback encourages patients doing the exercise to perform it correctly and gets them more involved in the treatment. There are two types of extrinsic feedback- knowledge of results (KR) and knowledge of performance (KP). Pressure biofeedback is a type of KP, which is given during and after performance of a task and is related to how the task is performed. A therapist provides the information through the apparatus and by attending to the information the patient forms a "closed loop". Feedback helps in motor learning which is a set of processes associated with practice or experience leading to permanent changes in the capability of responding. Patients become more motivated. Biofeedback techniques are used to augment the patient's sensory feedback mechanisms through precise information about body processes that might otherwise be inaccessible. Positive reinforcement is the operative learning model[18].

The treatment duration of the deep cervical flexor training protocol we used in our study was modified to four weeks, four days a week, once a day with every session monitored by a therapist following an original protocol prescribed by Jull et al., which was performed by patients at home with pressure biofeedback, twice a day for 6 weeks and monitored by therapist only once a week[19]. The purpose of modification was to inculcate the treatment protocol in teachers' school timetable and to suit their schedule. Also conducting every session under supervision of therapist was considered more suitable for teachers than unsupervised performance with biofeedback at home. This could have psychologically assured the teachers and contributed to the positive results.

This study may help to prevent neck pain or arrest it in the early stages in the teaching population. It may also improve the functional status of teachers. Once the teachers feel better this would make their job easier and more productive.

Given that computer use in schools is increasing day by day[2, 6], the risk of development of musculoskeletal disorders within the teaching population has also increased resulting in a potentially greater number of disorders. Musculoskeletal disorders have been associated with a decline in productivity in adults and seriously affect work performance. Supposing that these symptoms now emerge earlier in a lifespan than in previous generations, we should expect increasing sick leave and early retirement. This study is a step towards prevention of such possibilities in the future.

This study was performed on limited number of subjects, 15 subjects in each group. Furthermore, subject and researcher blinding was not implemented, and teacher's posture was not included in the study. Also the effect of DCF muscles training on posture and endurance of DCF muscles was not evaluated, and due to limitation of time we could not conduct a follow up of the patients.

To our knowledge, this is the first study in which deep cervical flexor training was used for teachers having neck pain. To give this protocol a more grounded base of practice, further studies need to be carried out on this group with larger samples.

Further studies using 6 weeks or longer duration with subsequent follow up are recommended, and the relationship of forward head posture and NP in this group also needs documentation. Electromyography could be used to provide additional information on muscle activation associated with any observed postural changes. Moreover, future studies could be designed to address the potential contribution of various factors, including musculoskeletal imbalances, that might possibly influence neck pain and forward head posture in this group. More dynamic, objective and functional outcome measures should be taken that better reflect the improvement in the postural endurance of deep cervical flexors resulting from therapy.

The results of this study show that there was significant improvement in pain and disability after 4 weeks of deep cervical flexor training for school teachers with neck pain. Moreover training using both pressure biofeedback and conventional exercises was found to be superior to training which only used conventional exercises.

ACKNOWLEDGEMENT

The Authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding the work through the research group project NO RGP-VPP-209.

REFERENCES

1) Conley MS, Meyer RA, Bloomberg JJ, et al.: Noninvasive analysis of human neck muscle function. Spine, 1995, 20: 2505–2512. [Medline] [CrossRef]
2) Ariëns GA, Bongers PM, Dowes M, et al.: Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Occup Environ Med, 2001, 58: 200–207. [Medline] [CrossRef]
3) Chiu TT, Lam PK: The prevalence of and risk factors for neck pain and upper limb pain among secondary school teachers in Hong Kong. J Occup Rehabil, 2007, 17: 19–32. [Medline] [CrossRef]

4) Hünting W, Grandjian E, Maeda K: Constrained postures in accounting machine operators. Appl Ergon, 1980, 11: 145–149. [CrossRef]
5) Kurumatani N, Iki M, Katagi K: Occupational cervicobrachial disorder (OCD) of nursery school teachers based on subjective symptoms related to OCD. Sangyo Igaku, 1984, 26: 389–396. [Medline] [CrossRef]
6) Bergqvist U, Wolgast E, Nilson B, et al.: Musculoskeletal disorders among visual display terminal workers: individual, ergonomic and work organizational factors. Ergonomics, 1995, 38: 763–776. [Medline] [CrossRef]
7) IJmker S, Blatter BM, van der Beek AJ, et al.: Prospective research on musculoskeletal disorders in office workers (PROMO): study protocol. BMC Musculoskelet Disord, 2006, 7: 55. [Medline] [CrossRef]
8) Harreby M, Neergaard K, Hesselsoe G, et al.: Are radiological changes in thoracic and lumbar spine of adolescents' risk factors for low back pain in adults? Spine, 1995, 20: 298–302. [CrossRef]
9) Jull G, Trott P, Potter H, et al.: A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine, 2002, 27: 1835–1843. [Medline] [CrossRef]
10) Janda V: Muscles and motor control in cervicogenic disorders: assessment and Management. In: Physical therapy of the cervical and thoracic spine. 2nd ed. New York: Churchill Livingstone, 1994 pp 195–216.
11) Falla D, Jull G, Russel T, et al.: Effect of neck exercise on sitting posture in patients with chronic neck pain. Phys Ther, 2007, 87: 408–417. [Medline] [CrossRef]
12) Jull G, Falla D, Treleavan J, et al.: A therapeutic exercise approach for cervical disorders. In: Grieve's Modern Manual Therapy– The Vertebral Column. Edinburgh: Churchill Livingstone; 2004 pp 451–469.
13) Floras TP: Endorphins and Exercise- Physiological mechanism and clinical implication. J Med Sci Sports Exerc, 1990, 22: 417–428.
14) Hutton RS, Atwater SW: Acute and chronic adaptation of muscle proprioceptors in response to increased use. Sports Med, 1992, 14: 406–421. [CrossRef]
15) Watson DH, Trott PH: Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance. Cephalalgia, 1993, 13: 272–284. [Medline] [CrossRef]
16) Ono Y, Imaeda T, Shimaoka M, et al.: Association of length of employment and working conditions with neck, shoulder and arm pain among nursery school teachers. Ind Health, 2002, 40: 149–158. [Medline] [CrossRef]
17) Grimes P, Legg S: Musculoskeletal Disorders (MSD) in school students as a risk factor for adult MSD: a review of the multiple factors affecting posture, comfort and health in classroom environments. J Human-Environ Syst, 2004, 7: 1–9. [CrossRef]
18) Sullivan SB, Schmitz TJ: Physical Rehabilitation: Assessment and Treatment. 4th ed., Philadelphia: F. A. Davis Co., 2001, pp 2010–2015.
19) O'Leary S, Jull G, Vicenzino B, et al.: Specificity in retraining craniocervical flexor muscle performance. JOSPT, 2007, 37: 3–9. [Medline] [CrossRef]
20) Nikolovski D, Saric-Tanaskovic M: Risk factors and health condition of workers in school environment. Srp Arh Celok Lek, 2006, 134: 113–118. [Medline]
21) Hermann KM, Reese CS: Relationship among selected measures of impairment, functional limitation and disability in patient with cervical spine disorders. Phys Ther, 2001, 81: 903–914. [Medline]