ORIGINAL ARTICLE

Comparing Biofeedback With Active Exercise and Passive Treatment for the Management of Work-Related Neck and Shoulder Pain: A Randomized Controlled Trial

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ABSTRACT. Ma C, Szeto GP, Yan T, Wu S, Lin C, Li L. Comparing biofeedback with active exercise and passive treatment for the management of work-related neck and shoulder pain: a randomized controlled trial. Arch Phys Med Rehabil 2011;92:849-58.

Objectives: To compare the effects of biofeedback with those of active exercise and passive treatment in treating work-related neck and shoulder pain.

Design: A randomized controlled trial with 3 intervention groups and a control group.

Setting: Participants were recruited from outpatient physiotherapy clinics and a local hospital.

Participants: All participants reported consistent neck and shoulder pain related to computer use for more than 3 months in the past year and no severe trauma or serious pathology. A total of 72 potential participants were recruited initially, of whom a smaller group of individuals (n=60) completed the randomized controlled trial.

Interventions: The 3 interventions were applied for 6 weeks. In the biofeedback group, participants were instructed to use a biofeedback machine on the bilateral upper trapezius (UT) muscles daily while performing computer work. Participants in the exercise group performed a standardized exercise program daily on their own. In the passive treatment group, interferential therapy and hot packs were applied to the participants' necks and shoulders. The control group was given an education booklet on office ergonomics.

Main Outcome Measures: Pain (visual analog scale), neck disability index (NDI), and surface electromyography were assessed preintervention and postintervention. Pain and NDI were reassessed after 6 months.

Results: Postintervention, average pain and NDI scores were reduced significantly more in the biofeedback group than in the other 3 groups, and this was maintained at 6 months. Cervical erector spinae muscle activity showed significant reductions postintervention in the biofeedback group, and there were consistent trends of reductions in the UT muscle activity.

Conclusions: Six weeks of biofeedback training produced more favorable outcomes in reducing pain and improving muscle activation of neck muscles in patients with work-related neck and shoulder pain.

Key Words: Feedback; Electrical stimulation; Exercise; Neck pain; Rehabilitation; Shoulder pain.

COMPUTER USE DOMINATES work and permeates home and school environments in modern society. It is estimated that 90% of office workers use computers daily, with 40% reporting use for at least 4 hours per day.[1] Such intensive use can greatly increase the risk of musculoskeletal disorders,[1,2] and indeed, prevalence rates of work-related neck and shoulder disorders have increased considerably among office workers over the past few decades.[2] Among the factors that may influence these disorders is the sustained and increased activity of major stabilizing muscles such as the trapezius in maintaining prolonged static posture.[3]

Although research literature[4-8] has supported the positive effects of exercise training and physical activity in managing musculoskeletal disorders, the underlying mechanisms are still not clear. Prolonged computer work may lead to static muscle tension, and this may contribute to fatiguing or overloading of postural muscles, resulting in pain and degenerative changes in these muscles.[3,9,10] If this is the main cause of work-related neck and shoulder pain, then regular exercise or physical activity should help to relieve pain by alleviating static muscle tension. However, many individuals tend to have fairly fixed postural habits, and they may resume work with the same static posture and muscle tension after taking an exercise break. Work in our laboratory[11] has shown that high levels of trapezius muscle activity are elicited as soon as workers place their hands on the keyboard, even before any work begins. These results suggest that habitual maladaptive motor control patterns are crucial mechanisms contributing to the development of work-related musculoskeletal disorders (WMSDs).

Recent research studies have found that biofeedback can be applied to reduce muscular tension in order to treat

List of Abbreviations

ANOVA	analysis of variance
CES	cervical erector spinae
EMG	electromyogram
NDI	Neck Disability Index
RCT	randomized controlled trial
UT	upper trapezius
VAS	visual analog scale
WMSDs	work-related musculoskeletal disorders

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WMSDs. A few studies have examined the effects of biofeedback interventions to modify muscle activation in office workers and influence their symptoms.[12-16] Hermens and colleagues[12-15] have developed a system of myofeedback based on the Cinderella hypothesis, which proposed that pain is caused by an overuse of low-threshold motor units. They designed a biofeedback machine that provides feedback signals when upper trapezius (UT) activity is above a prefixed threshold. In their studies, myofeedback training for 4 weeks (up to 8h/d) produced significant reductions in symptoms, although the effects were not significantly better than those of conventional ergonomic training.[13-15] Faucett et al[16] trained computer users for 6 weeks using a biofeedback training protocol called muscle learning therapy. They reported significant reductions in trapezius and forearm muscle activity as well as significant reduction in symptoms after 18 and 32 weeks.[16] This training has been proposed to enhance the patient's proprioceptive awareness and ability to regulate muscle activity in performing simple tasks at first, and subsequently in more complex work tasks.

There has been little research directly comparing the effects of biofeedback with the effects of traditional physiotherapy approaches such as active exercise and passive treatment modalities. Traditionally, passive physiotherapy involving electric stimulation and/or heat therapy has been commonly used to provide symptomatic relief in patients with neck and/or shoulder pain. Transcutaneous electric nerve stimulation has been shown to be effective in relieving musculoskeletal pain,[17,18] but it is not clear whether habitual muscle tension during work can also be corrected through such pain-relieving treatment. When patients are satisfied with temporary symptomatic relief through passive treatment, the problem will often recur if postural or muscle activation habits do not get corrected. Hence, educating patients to correct their maladaptive posture and muscle control during actual work tasks is very important.

A few reports of randomized controlled trials (RCTs) have compared the effects of exercises with those of manual therapy,[19] strength training,[20,21] and education,[22,23] with varying degrees of effectiveness reported for exercise therapy and electric modalities. However, in most studies, the outcome measure is pain, and there is no evaluation of the effects of different interventions on motor control mechanisms during functional tasks.[24] Evaluating the effects of treatment on motor control mechanisms may be a critical issue to address in designing effective therapeutic interventions, because the musculoskeletal problems may develop from the work habits.

It is important to compare the effects of biofeedback aimed at retraining muscle activation levels during realistic work situations with the effects of performing active exercises during work breaks, as well as with the effects of passive modalities in the clinic aimed at symptomatic relief. This study tested the hypothesis that by reducing muscle activity in the neck and shoulder postural stabilizing muscles, biofeedback training would be more effective than the other approaches.

METHODS

Study Design

The study was an RCT with 4 groups: a biofeedback group, an active exercise group, a passive treatment group, and a control group.

Participants

The participants were recruited from 2 universities in Hong Kong and Guangzhou, China, and from nearby outpatient clinics between January 2008 and June 2009. A full description of the study, including the randomization process, was given to each patient. The study was approved by the review boards of both participating institutions, and informed consent was obtained from all participants. The inclusion and exclusion criteria were determined with reference to those of past RCTs evaluating similar interventions.[13-15] The inclusion criteria were as follows: (1) daily computer user; (2) a past and present history of computer-related neck and shoulder discomfort; (3) had worked on a computer for at least 5 years; (4) had no more than 3 months out of work, except for vacations, during the previous 5 years; (5) neck and/or shoulder pain on at least 30 days during the previous 1 year; (6) working for at least 20 hours a week; (7) less than 3 additional body regions with complaints on more than 30 days in the previous 1 year; and (8) had experienced neck and/or shoulder pain in the previous 7 days. Participants were excluded if they (1) had experienced pain in more than 3 body regions, (2) had severe arthritis or joint disorders, (3) had experienced neck and/or shoulder pain on fewer than 8 days during the previous 1 year, (4) were taking muscle relaxants, (5) had tumors or inflammatory diseases, or (6) reported other complaints in the upper extremities apparently not related to computer work.[13-15]

Randomization

Eligible subjects were assigned to 1 of the 4 groups on the basis of a simple, computer-based randomization strategy.

Interventions

Participants did not receive any other form of specific intervention for their neck and shoulder pain during the course of the study. Each participant was given a standard instruction booklet about the principles of office ergonomics. Those in the 3 intervention groups were also supplied with training diaries in order to monitor their compliance with the assigned intervention program. All participants were required to record their daily neck and shoulder pain scores using a numeric scale from 0 to 10 (0, no pain; 1, minimal pain; 10, extreme/intolerable pain).

Biofeedback training. Participants in the biofeedback group were instructed in how to use a portable biofeedback machine, the Promethus system,[a] on the bilateral UT and were asked to use it for 2 hours daily while performing computer work. During each session, a pair of surface electrodes was placed on each of the left and right UT muscles. The surface electromyography signals collected by the biofeedback machine during the session were stored and later downloaded to a laptop computer. A threshold amplitude was preset by the experimenter, and electromyographic signals above the threshold would trigger an auditory feedback signal warning the subject to try and reduce the UT muscle activity, which they were taught to achieve by slightly depressing the shoulders or by sitting quietly with the eyes closed and the shoulders relaxed.

The participants were instructed in how to apply the electrodes reproducibly and how to use the biofeedback machine properly while performing their regular computer work. They were instructed to apply the biofeedback machine for 2 hours a day and 2 days a week as a minimum. The actual amount of time was recorded in the training diary. During the first training session, the participants performed 10 minutes of typing work in order to set the baseline threshold amplitude. Each subject