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The Effect of a Proprioceptive Neuromuscular Facilitation Program to Increase Neck Muscle Strength in Patients with Chronic Non-specific Neck Pain

[1]A. Rezasoltani, [1]M. Khaleghifar, [1]A. Tavakoli, [2]A. Ahmadi and [3]H. Minoonejad

[1]Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences
[2]Faculty of Rehabilitation, Iran University of Medical Sciences
[3]Department of Physical Education, Faculty of Physical Education, University of Tehran

Abstract: The aim of this study was to detect and compare the effect of a neuromuscular facilitation exercise (NFE) and traditional neck exercise therapy (TET) on treatment of patients with chronic non-specific neck pain (CNNP). Thirty-one patients (16 males and 15 females) with CNNP participated in this study. Patients were randomly assigned to three groups: group NFE (n = 11), group TET (n = 10) and a control group (n = 10). Ten therapeutic sessions were performed for treatment groups. Neck muscle strength was measured by an isometric neck muscle strength measurement device and neck pain was assessed by visual analogue scale (VAS). The strength of neck extensor and flexor muscles were improved up to 24.6% and 21.5% in NFE group and 13.8% and 11.1% in the TET group respectively. The mean percentage differences in pain were 78.1% in the NFE group and 31.3% in TET group. Only minor changes occurred in the control group (1.5%, 2.6% and 5.9%). NFE program used in this study appeared to be a more effective method than the other one to restore neck muscle strength and to reduce neck pain in patients with CNNP. The NFE program may be a useful method to reduce pain and disability in patients with non-specific neck pain.

Key words: Muscle Strength % Neuromuscular Facilitation % Neck pain % Exercise Therapy

INTRODUCTION

Neck pain has been reported to be a major public health problem [1]. Insufficient cervical muscle strength has been regarded as an important factor to cause chronic neck pain and disability during work, sport or daily activities [2]. It has been determined that the weakness of neck flexor muscles has a positive correlation with the persistence of pain and disability in patients with chronic neck pain [3] whereas Harmes-Ringdahl *et al*. (1986) revealed that excessive forward head and neck flexion for a defined period of time would cause neck pain in healthy people [4]. Some authors concluded that neck pain may also arise from mechanical stress on structures like ligaments and joint capsules. In the case of pain and discomfort, normal muscle performance will decrease via reflex inhibition [5, 6].

In a wrong working position, neck extensor muscles will be excessively stretched during a long period of working with forward position of head and neck [7]. In this case, muscle weakness will be induced as a result of prolonged impairment in the function of proprioceptive receptors and motor controls [8]. The consequent results of this malfunction may appear in muscle strength [9, 10].

At present, the common treatments of neck disorders focus on decreasing pain and disability. There is not sufficient information on how to use of some modalities like mechanical traction, ultrasound, biofeedback, heat therapy, electrical stimulation and combination therapy [11-14]. On the other hand, in a few studies exercise therapy programs have been appeared to have a positive effect on decreasing pain and discomfort in patients with chronic neck pain [15-16].

Neuromuscular facilitation exercise (NFE) is based on some movement patterns to facilitate and correct sensory motor function. It has been suggested that NFE corrects the impaired impulses emerging from proprioceptive receptors in the muscles [17]. Therefore, pain may decrease and the strength of muscles may be improved.

The aim of this study was to detect and compare the effect of two exercise therapy programs (NFE and traditional exercise therapy (TET) programs) on treatment of patients with chronic non-specific neck pain (CNNP).

Corresponding Author: A. Rezasoltani, PhD, Faculty of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran

MATERIALS AND METHDOS

Thirty one patients, including 16 men (mean age: 35.6 years) and 15 women (mean age: 36.9 years) were selected from a population of 130 office workers. All patients had chronic non-specific neck pain for at least 12 months. The patients were all full-time employed office workers at Tejarat Central Bank, Tehran, Iran. None of the patients had sport activities including head and neck exercises. The patients were randomly assigned to three groups. The first group (11 patients) took part in NFE exercise therapy program, the second group (10 patients) took part in TET exercise therapy program and the third group (10 patients) was considered as the control group. The informed consents were filled out by the patients before the study. The study was approved by the Ethical Committee of University of Shahid Beheshti (Medical Sciences), Tehran, Iran.

The anthropometric variables of patients have been shown in Table 1. Patients with cervical discopathy or with history of spine surgeries, congenital spinal syndromes, tempomandibular joint disorders, any whiplash injuries, spinal tuberculosis, audio-visual disorders, head and neck cancers and rheumatoid diseases were excluded from the study.

Therapeutic Program for NFE Group: Patients were asked to lie on his back (supine) in a position that their heads and necks were out of bed. They were asked to perform flexion, adduction and external rotation movement of the right shoulder and upper limb simultaneously with the extension and rotation of the head and back toward the opposite side. The exercises were followed by the same pattern for the opposite side (Fig. 1).

They were also asked to perform extension, abduction and internal rotation movements of the right shoulder and upper limb with the head and neck flexion and rotation toward the same side (Figure 2). The patients followed all patterns by their eyes. Each pattern was performed 10 times in a day and for ten therapeutic sessions.

Table 1: The mean (SD) and range of subjects' anthropometric characteristics (n = 31)

Groups	No.	Age (years)	Weight (kg)	Height (cm)	B.M.I
Neuromuscular Facilitation Exercise	11	35.9 (7.7)	70.5 (9.7)	171.4 (6.2)	23.9 (2.8)
Traditional Exercise Therapy	10	35.8(9.6)	66.1(10.4)	164.5 (8.4)	24.4 (3.4)
Control	10	37.1(9.7)	66.4 (13.8)	165.2 (9.1)	24.2 (4.0)

Fig. 1: Subject's position while performing head and neck movements with his right arm in first direction

Fig. 2: Subject's position while performing head and neck movement with his right arm in second direction

Therapeutic Program for TET Group: patients were in a supine position and a rolled towel was put under their neck and they were asked to push the posterior part of their neck toward the towel. They were also asked to perform isometric neck extension exercise by pushing their head and neck against their hands in a sitting position and against the wall in the supine position. Therefore, isometric head and neck exercises were performed in all directions of flexion, extension and side flexions. Each exercise was repeated 10 times a day for ten therapeutic sessions.

Therapeutic Program for Control Group: The patients in control group were given a notebook with some instructions to keep their body, particularly head and neck, in correct postures during daily activities and rest.

All participants (3 groups) performed a strengthening exercise for trunk flexor and extensors muscles.

Muscle Strength Test: The patients sat on a flat chair, hip joints were at 90° of flexion, knees were in a straight position, feet were on the floor, trunk was in a straight position, arms were close to the body and both hands were put on the thighs. Head and neck were also held in a neutral position so that the base of nose, chin and sternal notch could be on the body`s central and vertical

line. Scapula and pelvic regions were tied up firmly around the spine of scapula and crest of ilium by two stabilizers [18].

To test the isometric strength of head and neck extensor muscles, the load cell was put agonist the occipital and to test isometric strength of head and neck flexor muscles, the load cell was set in front of patient`s frontal bone. The amount of patient`s neck muscle strength was recorded twice, three occasions each time and the maximum value was recorded. The reliability and error measurements of the developed device for healthy subjects were detailed in our previous report [18]. In order to compare the inter-tester reliability of neck muscle strength measurement in patients with CNNP, two different therapists with similar education performed the test each time.

We measured pain by visual analogue scale (VAS).

Statistics: A Kolmogorov-Smirnov test was performed to determine the normal distribution of each variable. Common statistical methods were used to compute the mean, standard deviation and range of variables. The mean percentage differences were calculated for the strength of neck muscles and for pain scores between pre and post treatment sessions.

One-way analysis of variance was used to compare the mean percentage differences of neck muscle strength and pain between groups. Pearson product moment test was used to assess the relationship between the mean percentage difference in neck muscle strength and the mean percentage difference in neck pain scores ("#0.05).

An interclass correlation coefficient (ICC2,1) was calculated to determine the inter-tester reliability of measurements. All statistical analyses were performed using SPSS statistical software version 16.0 (SPSS, Chicago, IL, U.S.A.).

RESULTS

The inter-tester reliability of neck muscle strength measurements was high (ICC > 0.91). The mean percentage difference of the strength of neck muscles and the level of neck pain are shown in Table 2. The mean percentage difference indicated an improvement of 21.5% and 24.6% in neck flexor and extensor muscle strength in NFE group and also%11.1 and%13.8 in TET group respectively. In addition, the level of pain reduced%78.1 in NFE group and%31.3 in TET group. Only small changes were revealed in muscle strength and pain measurements in control group.

Table 2: The Results of ANOVA concerning the mean percentage difference of cervical extensor and flexor muscle strength in different groups (n=31)

Groups	Neck extensor muscle strength	Neck flexor muscle strength	Pain
NFE	%24.6*	%21.5*	-%78.1*
TET	%13.8*	%11.1*	-%31.3*
Controls	%1.5	%2.6	-%5.9

* Indicates significant difference (P<0.05).

There was a significant and negative correlation between the mean percentage differences of the strength of neck extensor muscles and neck pain ($p < 0.001$, $r = -0.79$) and the strength of neck flexor muscles and neck pain ($p < 0.001$, $r = -0.40$) in treatment groups.

Also there was a significant and positive correlation between the mean percentage difference of the strength of neck flexor and the strength of neck extensor muscles ($p < 0.001$, $r = 0.81$).

DISCUSSION

Pain and muscle weakness may be two common symptoms of cervicalgia in patients with CNNP. In treatment of CNNP patients, exercise therapy programs usually are simply instructed to strengthen and stretch neck muscles and also to correct poor head and neck postures [11-16, 19]. On the other hand, there are not many studies in which certain exercise therapy programs have been used to suppress pain and to improve neck muscle function in patients with neck pain. In a follow-up exercise therapy program for chronic neck pain, Ylinen *et al*. (1994) reported that exercise therapy program was an efficient program to treat patients with chronic neck pain [3].

Among different exercise therapeutic programs, NFE programs include different patterns of movements and provide proper neuromuscular function via the stimulation of proproceptive system. The patterns of movement are rotational, multi-axial and multidirectional in NFE programs [20]. These movements are more effective than single axial movements and are used to increase joint range of motion, muscle endurance and muscle harmony [21, 22].

The result of this study indicated that exercises based on neuromuscular patterns were more effective than traditional exercise therapy to increase the strength of neck muscles and to decrease neck pain in patients with chronic non-specific neck pain.

In fact, the proprioceptive function of cervical muscles plays an important rule in producing a sufficient neck muscles contraction to keep head and neck in an upright position [23]. Insufficient function of proprioceptive system may be the result of adaptation of this system in respond to a prolonged wrong posture.

Hodges and Moseley (2003) indicated that proprioceptive muscle dysfunction leads to a delay in eccentric muscle contraction in patients with chronic non-specific back pain [24]. On the other hand, pain and inflammation will inhibit the function of gamma motor neurons and consequently muscle performance [25].

Revel *et al*. (1994) revealed that patients suffering from neck pain had also impairment in the function of proprioception of neck muscles. The authors explained that propioceptive exercise may have an inhibitory effect on pain and discomfort in patient with chronic neck pain. It has also been indicated that proper function of proprioception system had an important role in cervicocephalic kinesthesia and learning ability to correct head and neck posture. As a result, exercises which are based on the properioceptive patterns may correct the impaired properioceptive signals and improve cervicocephalic kinesthesia [26].

The results of our study also indicated that neck pain decreased and neck muscle strength increased in TET group who performed isometric exercise of head and neck. Randolv *et al*. (1998) used two exercise therapy programs (a light and a moderate strengthening exercise) for two groups of patients with chronic neck pain. Their exercises included resistive exercises of head and neck against the wall for both head and neck flexion and extension plus shoulder girdle exercise in one group and only resisted exercise of head and neck in the other group. Their results showed a significant reduction in pain in both groups and also an increase in isometric strength of neck flexor and extensor muscles up to%26 and%27 in the first group and%22 and%44 in the second group [27].

One possible reason to express the pain reduction and the muscle strength increase in TET group may be due to an increase in muscle blood flow. Larson *et al*. (1999) reported a lack of blood flow in trapezius muscle of the painful side in patients with chronic neck pain [28]. Kadi *et al*. (2000) revealed that strengthening exercises would increase neck muscle strength and reduce pain in patients with chronic neck pain [29].

CONCLUSION

Neck muscle exercise therapy with stimulating neuromuscular proprioception method as used in our study appeared to be a useful method to decrease pain and increase muscle strength, so using this method to rehabilitate patients suffering from chronic neck pain is recommended.

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