J Rehabil Med 2009; 41: 626–631

ORIGINAL REPORT

EFFICACY OF NECK STABILIZATION EXERCISES FOR NECK PAIN: A RANDOMIZED CONTROLLED STUDY

Yesim Dusunceli, MD, Cihat Ozturk, MD, Funda Atamaz, MD, Simin Hepguler, MD and Berrin Durmaz, MD

From the Department of Physical Medicine and Rehabilitation, Medical Faculty of Ege University, Bornova-Izmir, Turkey

Objective: **To determine the efficacy of neck stabilization exercises in the management of neck pain.**

Patients and methods: **Sixty patients with neck pain were randomized to 3 groups, as follows: group 1 – physical therapy agents including transcutaneous electrical nerve stimulation, continuous ultrasound and infra-red irradiation; group 2 – physical therapy agents + isometric and stretching exercises; and group 3 – physical therapy agents + neck stabilization exercises. The exercises were performed as a home training programme following a 3-week supervised group exercise. The patients were evaluated with a visual analogue scale, by intake of paracetamol, Neck Disability Index, Beck Depression Scale and range of motion in the 3 planes at baseline and at months 1, 3, 6, 9 and 12**

Results: **Compared with baseline, all groups showed a significant decrease in visual analogue scale scores during the first 6 months. However, this improvement was maintained only in group 3 at 9 and 12 months, with a significant difference among the groups ($p < 0.05$). During the study, the improvement in disability was marked in group 3 with respect to Neck Disability Index, Beck Depression Scale and range of motion in the frontal plane ($p < 0.05$).**

Conclusion: **This study demonstrates the superiority of the neck stabilization exercises, with some advantages in the pain and disability outcomes, compared with isometric and stretching exercises in combination with physical therapy agents for the management of neck pain.**

Key words: neck pain, exercise, physical therapy modalities, isometric exercise, muscle stretching exercises.

J Rehabil Med 2009; 41: 626–631

Correspondence address: Funda Atamaz, Ege Universitesi Tip Fakultesi, Fiziksel Tıp ve Rehabilitasyon Anabilim Dalı, TR-35040 Bornova-Izmir, Turkey. E-mail: atamaz_02@yahoo.com

Submitted September 3, 2007; accepted April 20, 2009

INTRODUCTION

Neck pain is among the most common pain problems, with a reported prevalence ranging from 22% to 30% (1–3). It is usually accompanied by a substantial effect on daily life that results in extensive use of healthcare resources (3–5). In order to improve patients' functional status and quality of life, it is important to understand which structures are capable of producing pain and disability. Over the past decade, numerous studies have shown an association between reduction in the strength and endurance capacity of the cervical muscles and neck pain (6–8). It has been found that certain muscles in the cervical spine tend to weaken in neck pain; the most common of these being the deep and anterior cervical flexors (7–10). A study of patients with osteoarthritis showed more pronounced fatigue curves for anterior and posterior neck muscles than for the muscles of the control group (11). Studies of patients with cervicogenic headache symptoms have found decreased maximal isometric strength and isometric endurance of the cervical flexor muscles (12).

Thus, in order to gain muscle strength, flexibility and endurance, to restore injured tissues, and to contribute to ability to sustain normal life activities, exercise is one of the most frequently used modalities in the rehabilitation of subjects with neck pain (3).

Exercise programmes for managing neck pain differ with regard to duration, training frequency, intensity, and mode of exercise. Previous studies have shown that isometric exercises and strength training can have positive effects on neck pain (13–15). On the other hand, neck stabilization exercises (NSE) were introduced as a rehabilitation programme to limit pain, maximize function, and prevent further injury (16–18). It is a method of exercise which, like its counterpart in the lumbar spine, is designed to improve the inborn mechanisms by which the cervical spine maintains a stable, injury-free state (18–22). This is accomplished through a series of exercises that are relatively simple with respect to time and equipment, but are physiologically complex. Despite the popularity of stabilization training in the treatment of back and pelvic pain (23–27), there is a lack of well-designed randomized controlled trials to investigate its efficacy for the management of neck pain. The aim of this study was to investigate whether NSE is effective in the management of neck pain when this intervention is added as a supplement to physical therapy agents (PTA), or when it is compared with isometric and stretching exercises (ISE).

MATERIAL AND METHODS

Patients

Patients, ranging in age from 18 to 55 years, with neck pain of at least 6-week duration were recruited into the study. Neck pain was defined as non-specific neck pain without specific, identifiable aetiology (i.e. infection, inflammatory disease), but which could be reproduced by neck movement or provocation tests in the location of the dorsal part

of the neck in an area limited by a horizontal line through the most inferior portion of the occipital region and a horizontal line through the spinous process of the first thoracic vertebra (2). Patients were excluded if they had a history of cervical spine injury or surgery, if their neck pain was secondary to other conditions (including neoplasm, neurological diseases or vascular diseases), if they had a radiculopathy presenting neurological deficit or if they had infection or inflammatory arthritis in the cervical spine, if they had received physiotherapy within the 6 months prior to study or poor general health status that would interfere with the exercises during the study. The patients were also excluded if they had pain with any cause in or around the scapula, shoulder, upper extremity and lumbar spine that prevents stabilization of these structures. These exclusion criteria were verified by history and physical examination and by X-ray. The patients were informed about the study, and written consent was obtained from all patients.

Study design and treatments

The study was a randomized, single-blind, prospective study with a 12-month follow-up period. After baseline characteristics (weight, height, body mass index, age, and gender) were recorded, the patients were assigned to one of the 3 following treatment groups on the basis of a computer-generated minimization method (28), taking into account subject's age, gender and degree of neck pain as assessed by visual analogue scale (VAS): group 1: PTA; group 2: PTA + ISE of the cervical, shoulder, chest, and scapular muscles; and group 3: PTA + NSE.

Neck school. All patients participated in a single "neck school" group session of approximately 1 h duration. The purpose was to increase patient understanding of the causes of neck pain, the functional anatomy of the neck/shoulder, and ergonomic principles, including instruction in sitting and sleeping positions. In addition, treatment approaches and exercises were discussed.

Physical therapy agents. These included a combination of conventional transcutaneous electrical nerve stimulation (TENS), continuous ultrasound and infra-red irradiation 5 times a week for 3 weeks with the assistance of the same physiotherapist for all groups during the study. Following infra-red irradiation for 20 min at a 40 cm distance for the neck region (R 125, 250 watt, Philips), TENS was administered at a frequency of 80 Hz with 10–30 mA intensity for 30 min. Four surface electrodes, 5 × 5 cm each, were placed over the painful area in the neck region from a combination therapy unit (Sonopuls 492, Enraf-Nonius) (21). The intensity of TENS was adjusted to produce a tingling sensation that was approximately 2–3 times the patient's sensory threshold. The continuous ultrasound was used with 1.5 W/cm^2 intensity over the neck area for 10 min (Sonopuls 492, Enraf-Nonius).

Neck stabilization training. Neck stabilization training was carried out in groups of 4–5 patients under the guidance of a physiotherapist 3 times a week for group 3. The patients also received a complete set of pre-prepared exercise cards, showing all the exercises, to ensure that the training programme was learned properly.

Sessions began with postural re-education by having the patient sit with front and side mirror views to find a neutral balanced position of the lumbar and cervico-thoracic spine. After a 5–6-min jogging period, stretching exercises of the cervical, shoulder, chest, and scapular muscles (approximately 10 min) were performed in the standing position. Subsequently, cervical isometrics were performed in the supine position with the head supported on a pillow with a towel roll under the neck, and isometric exercises were performed in the seated position by resisting at the forehead (cervical flexion, extension, rotation and side-bending) or off the edge of a table against gravity for 10 sec with 15-sec breaks between holds with 10–15 repetitions in a progressive manner. To train the interscapular, shoulder, and upper extremity musculature, varying degrees of upper extremity movement exercises were performed, progressing from unilateral arm raises, to reciprocal arm raises, to bilateral arm raises (16). For the first week, exercises were carried out in the supine position with 10 repetitions, and then progressed to sitting and standing position with 15 repetitions during the last 2 weeks of group exercise sessions. Also, unilateral arm raises were performed in the kneeling position with the same repetitions. During the resistance exercises, 3 distinct colours of Thera-Band tubing (red, green and blue) representing differing resistances (as kg of force at 100% elongation, 6/2.7, 7/3.1 and 9.5/4.3, respectively) were used in a progressive manner by increasing the density of Thera-Band tubing each week. In addition, dumb-bell exercises for upper extremity and shoulder muscles (seated shoulder presses, lateral and front arm raises, hammer curls) were used for 2 sets of 15 repetitions with weights varying from 1 to 2 kg. A 5-min rest was taken between sets. Patients were instructed to maintain a neutral position at all times during the exercises. Each session lasted from 1 to 1.25 h. At the end of the 3-week group exercise period, the physiotherapist described the home training programme involving stretching and stabilization exercises to be performed 3 times per week, as well as the group exercise period.

The sessions of the patients in group 2 began with group exercise periods 3 times per week under the guidance of the same physiotherapist, including 5–6 min jogging and 10 min stretching (the cervical, shoulder, chest, and scapular muscles) in the standing position, and 15 min isometric exercises (cervical flexion, extension, rotation and side-bending by resisting the forehead in the seated position) with a total of 30-min sessions. After a 3 weeks' group exercise programme, they followed a home training programme involving performing the same exercises 3 times per week, learned under the guidance of a physiotherapist.

At the same time, the exercise parameters, including frequency, repetition and resting for each exercise on the pre-prepared cards, were completed by the clinician to ensure exercise prescription in each group. At each visit during the study, the patients were instructed to perform their exercises regularly.

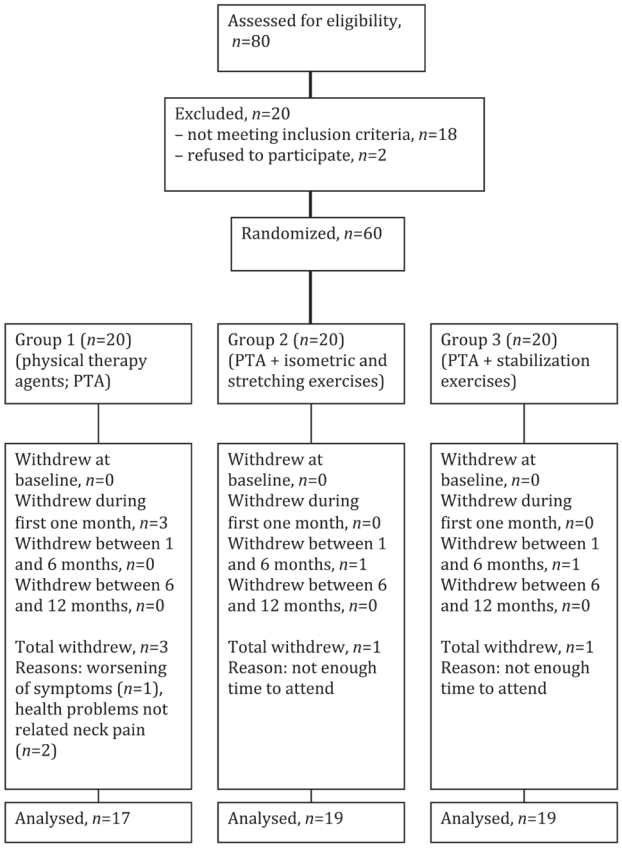

Fig. 1. Participant flowchart and assessment.

Table I. *Patients' demographic characteristics at baseline*

	Group 1 ($n=20$)	Group 2 ($n=20$)	Group 3 ($n=20$)
Women/men, *n* (%)*	12 (60)/8 (40)	14 (70)/6 (30)	14 (70)/6 (30)
Age, years, mean (SD)	53.4 (6.8)	52.50 (5.80)	50.2 (4.8)
Min–max	44–67	45–65	44–62
Duration, month, mean (SD)†	43.2 (40.6)	62.13 (55.66)	45.0 (46.8)
Min–max	3–120	2–180	2–120

One-way analysis of variance (ANOVA) test, *Friedman test. †Duration of neck pain.
SD: standard deviation.

Assessments

Clinical assessments were made at baseline and at months 1, 3, 6, 9 and 12. Pain was assessed with the following parameters: (*i*) a 10-cm VAS (the patients used the VAS to make an assessment of their own pain, with 0 representing no pain, and 10 cm representing severe pain) (29), and (*ii*) paracetamol intake (g/week). The use of non-steroidal anti-inflammatory drugs (NSAIDs) was not permitted during the study period; any pre-treatment with NSAIDs had to be discontinued 7 days prior to the start of the study. If the patient required additional analgesic medication because of neck pain during the study, treatment with paracetamol was permitted, on condition that they noted their paracetamol intake on the study form. At each clinic visit, the study report form was evaluated, and paracetamol intake was recorded as g/week.

Disability was assessed using the Neck Disability Index (NDI) (30). At the same time, active range of motion (ROM) of the cervical spine in 3 planes was measured with universal goniometry as a reliable method when the same therapist takes the measurements (31) for all patients. Depression was evaluated using the Beck Depression Scale (BDS) (32).

All assessments were recorded by the same blinded examiner.

Statistical analysis

Treatment groups were compared by one-way analysis of variance (ANOVA). Repeated measurements ANOVA was used to evaluate the clinical assessment parameters over the time of observation. Bonferroni test as a *post hoc* test was used to determine the change between groups when indicated. Statistical analyses were performed with the 10.0 Statistical Package for the Social Sciences (SPSS). All results were expressed as means and standard deviations. A *p*-value below 0.05 was considered to indicate statistical significance.

RESULTS

Fig. 1 summarizes patient recruitment, participation and attrition during the study. No complication occurred as a result of any of the treatments given. No patient who completed the study reported any complaint leading to non-compliance with the home exercise programme at any visit. No patient received any other therapy except for paracetamol during follow-up.

Table II. *Patients' clinical characteristics during the study*

	Group 1 ($n=17$)			Group 2 ($n=19$)			Group 3 ($n=19$)		
	Mean (SD)	95% CI (upper/lower)	*p*	Mean (SD)	95% CI (upper/lower)	*p*	Mean (SD)	95% CI (upper/lower)	*p*
VAS – pain (0–10)									
At baseline	6.9 (1.0)			6.4 (1.6)			6.7 (1.0)		
1 month	5.3 (1.5)	0.9/2.3	0.00*	3.9 (1.9)	1.4/3.5	0.00*	3.3 (1.6)	2.7/4.1	0.00*
3 months	5.6 (1.9)	0.3/2.3	0.01*	4.0 (1.8)	1.8/3.5	0.00*	3.3 (1.5)	2.7/4.0	0.00*
6 months	5.8 (1.4)	0.3/1.7	0.01*	4.0 (2.2)	1.5/3.7	0.00*	3.6 (1.7)	2.3/3.8	0.00*
9 months	6.7 (1.0)	–0.4/0.7	0.58	5.3 (1, 9)	–4.0/4.4	0.93	4.1 (1.6)	1.6/3.5	0.00*
12 months	7.6 (0.7)	–1.2/–0.3	0.00†	5.5 (1.8)	0.2/2.0	0.52	3.6 (1.5)	2.2/3.9	0.00*
NDI									
At baseline	19.1 (5.6)			19.2 (7.)			19.3 (4.9)		
1 month	15.9 (6.4)	0.4/6.0	0.01*	13.8 (8.0)	2.4/8.4	0.11	9.8 (4.5)	7.3/11.6	0.00*
3 months	18.1 (6.5)	–2.0/3.9	0.53	13.5 (7.4)	2.6/7.8	0.01*	9.5 (4.6)	7.8/11.7	0.00*
6 months	17.6 (5.7)	–1.6/3.2	1.00	13.8 (8.0)	2.0/7.7	0.06	11.2 (7.8)	5.2/11.8	0.00*
9 months	18.7 (4.3)	–2.5/2.0	1.00	14.5 (8.3)	1.5/6.8	0.09	12.6 (5.4)	4.3/9.8	0.00*
12 months	21.3 (4.1)	–4.6/–1.1	0.60	17.3 (7.9)	–0.8/3.4	1.00	9.9 (3.1)	7.8/11.7	0.00*
BDS									
At baseline	15.0 (4.5)			14.1 (7.8)			14.0 (4.3)		
1 month	12.9 (5.9)	0.2/4.1	0.62	10.2 (7.3)	1.1/6.8	0.02*	7.5 (3.5)	4.1/8.8	0.00*
3 months	15.6 (6.0)	–2.6/1.4	0.40	10.4 (8)	0.6/6.3	0.38	8.3 (4.8)	3.3/8.0	0.00*
6 months	15.5 (6.4)	–3.0/1.4	1.00	11.3 (8.7)	–0.2/5.3	0.14	8.1 (4.7)	4.1/8.7	0.00*
9 months	17.6 (5.9)	–5.0/–0.7	0.25	12.2 (8.9)	–1.2/5.3	0.69	8.6 (4.6)	3.6/8.2	0.00*
12 months	17.4 (4.8)	–4.5/–0.9	0.13	13.9 (9.5)	–3.3/3.2	1.00	7.8 (3.7)	4.9/8.4	0.00*

*$p<0.05$, repeated measurements analysis of variance.
†$p<0.05$ for worsening of clinical characteristic compared with baseline.
95% CI: 95% confidence interval of the difference; BDS: Beck Depression Scale; NDI: Neck Disability Index; VAS: visual analogue scale.

Table III. *The groups' intake of paracetamol (g/week) during the study*

Intake of paracetamol	Group 1 ($n=17$) Mean (SD)	Group 2 ($n=19$) Mean (SD)	Group 3 ($n=19$) Mean (SD)	p
1 month	9.9 (6.1)	5.9 (7.5)	5.5 (4.6)	0.071
3 months	11.6 (7.0)	4.7 (6.4)	4.0 (4.2)	0.000
6 months	10.3 (5.4)	6.2 (8.5)	3.1 (4.1)	0.007
9 months	12.8 (6.0)	5.9 (9.9)	3.1 (3.6)	0.000
12 months	15.0 (5.6)	5.1 (7.2)	4.1 (4.1)	0.001

One-way analysis of variance (ANOVA) test, Bonferroni test.
SD: standard deviation.

There were no significant differences among the groups at baseline (Table I).

Compared with baseline, during the first 6 months, a significant decrease was found in the VAS scores in all treatment groups ($p<0.05$) (Table II). However, the improvements in VAS scores were seen only in the patients in group 3 at 9 and 12 months, with a significant difference among the groups ($p<0.05$). Paracetamol intake was significantly higher in group 1 compared with the exercise groups ($p<0.05$) (Table III).

The results of the ROM measurements are presented in Table IV. Although the patients in group 1 showed significant improvement in ROMs in the sagittal and transverse planes only at the first visits, statistically significant increases were found in both exercise groups during the study ($p<0.05$). For the ROMs in the frontal plane, only group 3 showed significant increases at all visits compared with baseline, with a significant difference among the groups ($p<0.05$). A similar trend was seen for NDI and BDS scores. There were significant differences in NDI and BDS scores, which were in favour of group 3 ($p<0.05$) (Table I).

DISCUSSION

This study demonstrated the efficacy of NSE in the management of neck pain when this intervention is used as a supplement to PTA or is compared with ISE. The results showed that, while pain significantly decreased in all treatment groups in the first 6 months, this improvement was maintained throughout the follow-up only in those patients treated with NSE in addition to PTA. Moreover, compared with other groups, the improvement in disability assessment parameter in the NSE group was also indicative of the effectiveness of NSE in the management of neck pain.

Since specific muscle dysfunction appears to be associated with pain, exercises designed to improve spinal stabilization have gained popularity in the conservative treatment of patients with spinal pain; however, to date, the evidence for the effectiveness of this approach is limited. Although Jull et al. (26) showed the effectiveness of cervical stabilization exercises in improving neck pain and cervical muscle performance in randomized trial of patients with cervicogenic headache, in that study, the specific effect of low-load endurance exercises was not compared

Table IV. *The patients' range of motion in 3 planes*

ROMs	Group 1 ($n=17$) Mean (SD)	95% CI (upper/lower)	p	Group 2 ($n=19$) Mean (SD)	95% CI (upper/lower)	p	Group 3 ($n=19$) Mean (SD)	95% CI (upper/lower)	p
Sagittal plane‡									
At baseline	99.7 (12.5)			102.5 (10.1)			98.5 (12.5)		
1 month	107.6 (13.9)	–14.0/–1.9	0.01*	120.85 (9.2)	–23.3/–13.4	0.00*	117.5 (9.10)	–25.8/–12.2	0.00*
3 months	105.88 (13.8)	–12.7/0.4	0.06	118.3 (9.6)	–22.5/–11.9	0.00*	119.3 (12.13)	–27.4/–14.2	0.00*
6 months	105.5 (10.8)	–11.0/1.8	0.15	118.0 (12.2)	–22.2/–11.6	0.00*	118.0 (9.33)	–25.5/–12.2	0.00*
9 months	102.81 (9.9)	–7.5/3.7	0.49	114.3 (10.3)	–18.0/–8.5	0.00*	120.1 (8.93)	–27.3/–14.6	0.00*
12 months	99.4 (10.9)	–2.9/5.9	0.48	111.5 (11.0)	–15.6/–5.2	0.00*	119.2 (9.01)	–26.0/–14.0	0.00*
Frontal plane§									
At baseline	61.2 (12.1)			59.6 (12.4)			64.0 (9.2)		
1 month	66.4 (11.0)	–9.7/–0.9	0.44	74.7 (10.0)	–21.1/–9.1	0.00*	72.8 (7.7)	–12.3/–5.3	0.00*
3 months	65.7 (10.2)	–9.0/–0.2	0.46	71.6 (10.0)	–18.1/–8.7	0.00*	75.9 (4.9)	–16.5/–7.3	0.00*
6 months	64.5 (7.3)	–7.2/–3.1	0.45	70.0 (9.4)	–18.0/–5.7	0.02*	75.4 (7.7)	–15.1/–6.4	0.00*
9 months	61.8 (10.2)	–5.6/6.8	0.47	66.3 (9.7)	–14.3/–2.0	0.28	73.1 (9.0)	–11.6/–5.2	0.00*
12 months	57.3 (7.6)	1.8/8.4	0.48	63.5 (8.4)	–10.3/–0.3	0.57	75.0 (6.4)	–14.1/–6.5	0.00*
Transverse plane†									
At baseline	104.7 (12.3)			105.9 (14.4)			106.4 (11.6)		
1 month	117.1 (21.6)	–19.7/–5.1	0.02*	134.8 (12.7)	–35.4/–22.4	0.00*	133.6 (14.6)	–33.9/–20.6	0.00*
3 months	119.2 (15.0)	–22.7/–6.3	0.04*	129.5 (12.8)	–32.2/–16.9	0.00*	136.7 (16.3)	–37.7/–23.0	0.00*
6 months	113.6 (12.8)	–15.9/–2.0	0.40	127.2 (15.7)	–30.4/–14.3	0.00*	136.8 (14.6)	–36.4/–24.4	0.00*
9 months	107.6 (9.0)	–8.5/2.6	0.83	129.0 (12.2)	–33.6/–14.5	0.01*	136.8 (16.1)	–37.9/–22.8	0.00*
12 months	103.1 (9.1)	–3.9/6.9	0.01**	123.5 (13.0)	–26.5/–10.6	0.04*	137.2 (13.8)	–37.5/–24.1	0.00*

*$p<0.01$, repeated measurements analysis of variance.
**$p<0.05$ for worsening of clinical characteristic compared with baseline.
‡Flexion and extension summed, §Left and right flexions summed, †Left and right rotations summed.
95% CI: 95% confidence interval of the difference; ROM: range of motion; SD: standard deviation.

with general exercises. Therefore, the theory that stabilization exercises will be more effective than other exercise regimes in patients with neck pain is not yet fully proven to date.

In our study, the advantages of stabilization exercises over the ISE or PTA alone was observed especially for the results of the NDI over the 1-year follow-up period, suggesting that stabilization exercises may be more effective in improving disability. Since disability, the mechanism of which is not yet elucidated, is usually accompanied by a substantial effect on daily life, resulting in an extensive use of healthcare resources (3, 5), to improve the patient's disability or enable them to return to normal activity may be the main aim of any treatment approach. With regard to our results, NSE may be a better approach to meeting this purpose.

We examined the active ROM of the cervical spine, and the results showed that only the NSE group achieved a statistically significant increase in the 3 plane measurements during the follow-up, supporting the finding above that NSE was more effective compared with ISE or PTA alone. On the other hand, the ISE group showed a significant increase in the sagittal plane and transverse plane ROMs at all visits and in the frontal plane during the first 6 months, while no significant improvement was observed in those patients treated with PTA alone. Even though some studies have found no correlation between ROM and symptomatic improvement in any of the treatment groups (10, 33), our results support that cervical spine function can improve with exercise therapy, in accordance with other training reports for neck pain patients (13, 34).

In our study, pain relief was observed on the VAS throughout the follow-up by patients treated with NSE together with PTA, whereas patients in the other groups showed a significant relief of pain in the first 6 months. However, we cannot demonstrate the role of PTA in the pain relief because there was no control group. Although similar effects, especially for TENS, were observed in previous studies of patients with neck pain (35, 36), the reduction in pain in the first 6 months could be partly or simply a result of spontaneous recovery or of increased paracetamol intake. It should be noted, however, that our main purpose was to determine the efficacy of NSE for neck pain, not to gather evidence to support the clinical use of the physical modalities. On the other hand, a wide array of these modalities is commonly used in clinical practice as a part of physiotherapy for neck pain. One of their benefits can be a powerful effect whereby both the therapist and the patient have faith in the treatment, as reported previously (37). Considering this to be beneficial, we used these modalities in our study in order to ensure patients' compliance with the exercise programme. We also used other beneficial methods, such as pre-prepared exercise cards, as described previously (38, 39). Our results showed that we were successful in ensuring compliance, as only 2 patients discontinued therapy during the period of 1 year. However, this finding contributes to the observation that a limitation of the study may be whether a 3-week group exercise programme was long enough for a supervised exercise programme.

We assessed depression in our patients using the BDS in order to understand the factors that contribute to pain sensitivity and disability. It has been reported that depression is the most common condition among patients with neck and back pain, with a reported prevalence of 2.5–15.7% (40–42). In our study, while total score levels of BDS showed mild to moderate depression for all patients at baseline, in accordance with these reports, normal mood condition as shown by BDS scores ranging from 5 to 9, was observed only in the patients in group 3 after the treatment, with a significant difference among the groups. This finding again pointed to the efficacy of NSE in the treatment of neck pain, supporting other results.

Our study has several limitations. Firstly, it can be argued that the number of patients studied was relatively small. The small sample size limits the strength of the analyses, which makes it difficult to assess the true magnitude of the differences between groups. Despite the fact that our results were similar to previous data (13, 14, 17, 35), this study may be considered a pilot study. For this reason, evidence from large randomized controlled clinical trials is needed to demonstrate the clinical efficacy of NSE in patients with neck pain. Secondly, because there was no group consisting of NSE alone, we cannot conclude whether NSE without PTA has similar effects on improvement in neck pain. Although there were significant differences between groups treated with NSE + PTA or PTA alone for most of the outcome parameters in our study, this fact suggests that further trials may be needed to elucidate the effect of NSE. As another limitation, it can be concluded that the drop-out rate was relatively high in group 1, who were treated with PTA, and intent-to-treat (ITT) analysis might be used to improve methodological quality. Besides the well-known fact that everyone who begins treatment is considered to be part of the trial for the purposes of ITT analysis, it is often incorrectly described and its application may be flawed (38, 39). According to some reports, the application of ITT can be performed only where there is complete outcome data for all randomized subjects or all patients are followed until death or the end of the trial (38, 39). However, we could not use this method in our study due to the fact that we had no follow-up data for lost patients after baseline.

In conclusion, this study shows that a combination treatment of NSE + PTA is the more effective intervention for the management of neck pain, with some advantages in the outcomes for pain and disability over the combination of ISE + PTA, or PTA alone. However, further controlled studies of NSE without PTA on large populations are required in order to establish its definitive effectiveness.

REFERENCES

1. Andersson HI, Ejlertsson G, Leden I, Rosenberg C. Characteristics of subjects with chronic pain, in relation to local and widespread pain report. A prospective study of symptoms, clinical findings and blood tests in subgroups of a geographically defined population. Scand J Rheumatol 1996; 25: 146–154.
2. Bovim G, Schrader H, Sand T. Neck pain in the general population. Spine 1994; 19: 1307–1309.
3. 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 2003; 28: 292–297.

4. Rempel DM, Harrison RJ, Barnhart S. Work-related cumulative trauma disorders of the upper extremity. JAMA 1992; 267: 838–842.
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. 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.
7. Chiu TT, Sing KL. Evaluation of cervical range of motion and isometric neck muscle strength: reliability and validity. Clin Rehabil 2002; 16; 851–858.
8. Ylinen J, Salo P, Nykanen M, Kautiainen H, Hakkinen 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.
9. Janda V. Muscles and motor control in cervicogenic disorders: assessment and management. In: Grant T, editor. Physical therapy for the cervical and thoracic spine. Melbourne: Churchill Livingstone; 1994, p. 195–216.
10. Gogia P, Sabbahi MA. Electromyographic analysis of neck muscle fatigue in patients with osteoarthritis of the cervical spine. Spine 1994; 19; 502–506.
11. Silverman J, Rodriquez AA, Agre JC. Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain. Arch Phys Med Rehabil 1991; 72; 679–681.
12. Ylinen J, Takala EP, Nykanen M, Hakkinken A, Malkiw E, Pohjolainen T, et al. Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial. JAMA 2003; 289: 2509–2516.
13. Chiu TTW, Lam TL, Hedley AJ. A randomized controlled trial on the efficacy of exercise for patients with chronic neck pain. Spine 2004; 30; E1–E7.
14. Sweeney T. Neck school: cervicothoracic stabilization training. Occup Med 1992; 7: 43–54.
15. Andersen LL, Kjaer M, Søgaard K, Hansen L, Kryger AI, Sjøgaard G. Effect of two contrasting types of physical exercise on chronic neck muscle pain. Arthritis Rheum 2008; 59: 84–91.
16. Saal JA. The new back school prescription: stabilization training. Part II. Occup Med 1992; 7: 33–42.
17. Stuge B, Laerum E, Kirkesola G, Vollestad N. The efficacy of a treatment program focusing on specific stabilizing exercises for pelvic girdle pain after pregnancy: a randomized controlled trial. Spine 2004; 29: 351–359.
18. Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. Spine 2001; 26: E243–E248.
19. Arokoski JP, Valta T, Airaksinen O, Kankaanpää M. Back and abdominal muscle function during stabilization exercises. Arch Phys Med Rehabil 2001; 82: 1089–1098.
20. Monticone M, Barbarino A, Testi C, Arzano S, Moschi A, Negrini S. Symptomatic efficacy of stabilizing treatment versus laser therapy for sub-acute low back pain with positive tests for sacroiliac dysfunction: a randomised clinical controlled trial with 1 year follow-up. Eura Medicophys 2004; 40: 263–268.
21. Basford JR. Physical Agents. In: Rehabilitation medicine: principles and practice. 3rd edn. DeLisa JA, Gans BM, editors. Philadelphia: Lippincott-Raven Publishers; 1998, p. 483–503.
22. Carlsson AM. Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale. Pain 1983; 16; 87–101.
23. Kose G, Hepguler S, Atamaz F, Oder G. A comparison of four disability scales for Turkish patients with neck pain. J Rehabil Med 2007; 39: 358–362.
24. Youdas JW, Carey JR, Garrett TR. Reliability of measurements of cervical spine range of motion – comparison of three methods. Phys Ther 1991; 71: 98–104.
25. Beck AT, Steer RA. Internal consistencies of the original and revised Beck Depression Inventory. J Clin Psychol 1984; 40: 1365–1367.
26. Jull G, Trott P, Potter H Zito G, Niere K, Shirley D, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. Spine 2002; 27; 1835–1843.
27. Jordan A, Mehlsen J. Ostergaard T. A comparison of physical characteristics between patients seeking treatment for neck pain and age-matched healthy people. J Manipulative Physiol Ther 1997; 20: 468–475.
28. Mealy K, Brennan H, Fenelon GCC. Early mobilization of acute whiplash injuries. Br Med J 1986; 292; 656–657.
29. Viljanen M, Malmivaara A, Uitti J, Rinne M, Palmroos P, Laippala P. Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. BMJ 2003; 327: 475.
30. Chiu TT, Hui-Chan CW, Chein G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. Clin Rehab 2005; 19: 850–860.
31. Meyler WJ, de Jongste MJ, Rolf CA. Clinical evaluation of pain treatment with electrostimulation: a study on TENS in patients with different pain syndromes. Clin J Pain 1994; 10; 22–27.
32. Moffett J, McLean S. The role of physiotherapy in the management of non-specific back pain and neck pain. Rheumatology 2006; 45: 371–378.
33. Sluijs EM, Kok GJ, van der Zee J. Correlates of exercise compliance in physical therapy. Phy Ther 1993; 73: 771–782.
34. Alexandre NM, Nordin M, Hiebert R, Campello M. Predictors of compliance with short-term treatment among patients with back pain. Rev Panam Salud Publica 2002; 12: 86–94.
35. Demyttenaere K, Bruffaerts R, Lee S, Posada-Villa J, Kovess V, Angermeyer MC et al. Mental disorders among persons with chronic back or neck pain: results from the world mental health surveys. Pain 2007; 129; 332–342.
36. Rajala U, Keinanen-Kiukaanniemi S, Uusimaki A, Kivela SL. Musculoskeletal pains and depression in a middle-aged Finnish population. Pain 1995; 61: 451–457.
37. Simon GE, Von Korff M, Piccinelli M, Fullerton C, Ormel J. An international study of the relation between somatic symptoms and depression. N Engl J Med 1999; 341: 1329–1335.
38. Lachin JM. Statistical considerations in the intent-to-treat principle. Control Clin Trials 2000; 21: 167–189.
39. Hollis S, Campbell F. What is meant by intention to treat analysis? Survey of published randomised controlled trials. BMJ 1999; 319; 670–674.