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A randomized clinical trial of TENS and exercise for patients with chronic neck pain

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Objective: To investigate the effect of transcutaneous electrical nerve stimulation (TENS) on acupuncture points and neck exercise in chronic neck pain patients.
Design: A randomized clinical trial.
Setting: Hospital-based practice.
Subjects: Two hundred and eighteen patients with chronic neck pain.
Interventions: Subjects were randomized into three groups, receiving either (1) TENS over the acupuncture points plus infrared irradiation (TENS group); (2) exercise training plus infrared irradiation (exercise group); or (3) infrared irradiation alone (control); twice a week for six weeks.
Outcome measures: The values of verbal numeric pain scale, Northwick Park Neck Pain Questionnaire, and isometric neck muscle strength were assessed before, at the end of the six-week treatment, and at the six-month follow-up.
Results: Results demonstrated that after the six-week treatment, significant improvement in the verbal numerical pain scale was found only in the TENS group (0.60 ± 2.54, $p = 0.027$) and the exercise group (1.57 ± 2.67, $p < 0.001$). Though significant reduction in Northwick Park Neck Pain Questionnaire score was found in all three groups, post-hoc tests showed that both the TENS and the exercise group produced better improvement ($0.38 \pm 0.60\%$ and $0.39 \pm 0.62\%$ respectively) than the control group ($0.23 \pm 0.63\%$). Significant improvement ($p = < 0.001$ to 0.03) in neck muscle strength was observed in all three groups, however, the improvement in the control group was not clinically significant and it could not be maintained at the six-month follow-up.
Conclusions: After the six-week treatment, patients in the TENS and exercise group had a better and clinically relevant improvement in disability, isometric neck muscle strength, and pain. All the improvements in the intervention groups were maintained at the six-month follow-up.

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Introduction

Neck pain is a common musculoskeletal disorder in the general population. In Saskatchewan, Canada, Cote *et al.*[1] reported that the age-standardized lifetime prevalence of neck pain was 66.7%. This pain disorder is costly in terms of treatment, individual suffering, and time loss due to work absenteeism.[2]

Transcutaneous electrical nerve stimulation (TENS) is a common modality for treating musculoskeletal pain.[3] It has been shown by Levin and Hui-Chan[4] to excite large-diameter afferent fibres. Thus, in accordance with the gate control theory,[5] TENS is likely to stimulate the large-diameter afferent fibres, which may reduce the transmission of pain signals through the small nociceptive afferent fibres, thus inhibiting pain discrimination and perception. TENS has been shown to produce antinociceptive effects similar to those of acupuncture[6,7] with a slow onset and a gradual offset that persists after the stimulation stops.[8,9] Moreover, the application is easier and safer than acupuncture. In fact, acupuncture has been reported by individual acupuncturists to have side-effects, with the highest rates being 53% bleeding, 24% pain and 11% aggravation of symptoms when expressed as a percentage of consultations.[10]

Many studies have demonstrated the effectiveness of TENS on various pain conditions, especially on low back pain.[11,12] However, very few studies have been conducted in patients with neck pain. Meyler *et al.*[13] found that 27 out of 39 (69.2%) patients reported reduction of neck pain after TENS, but they did not include a control group in their study. Nordemar and Thorner[14] reported that TENS significantly increased neck mobility compared with wearing a neck collar in patients with neck pain. However, there was no difference in the pain index when it was compared with that of the patients receiving manual therapy. The effects of TENS on neck muscle strength have never been investigated.

It is generally agreed that muscles play an important role in the support and protection of joints. In the past decade, a number of studies have indicated that strengthening of the neck muscles in patients with chronic neck pain results in reduced pain and decrease in disability.[15,16] However, the efficacy of active strengthening exercises in managing chronic neck pain has not been unequivocally demonstrated, since most of the studies did not have a control group and in some studies, only minor or short-term improvements were found with active exercise.[15–17] Indeed, the Philadelphia Panel[18] noted a lack of well-designed randomized controlled trials investigating the efficacy of rehabilitation for chronic neck pain.

The present study aimed to investigate the effects of TENS on acupuncture points and a neck exercise programme in patients with chronic neck pain.

Methods

Subjects

A convenience sampling method was used in this study. Patients with neck pain were recruited from the physiotherapy outpatient departments of two local hospitals. The inclusion criteria were: age range 20–70 years, with a history of more than three months of intermittent neck pain, and the ability to read Chinese. Patients were excluded if they had: a previous history of injury to the neck or upper back from T1 to T6, an inflammatory condition (e.g., rheumatoid arthritis), previous surgery to the neck, a history of malignancy, congenital abnormality of the spine, been receiving concurrent treatment (e.g., from a chiropractor or bone setter), other musculoskeletal problems at the same time, and acute neck pain with no freedom of movement. The pathology of patients recruited in the current study was not known.

Documented informed consent was obtained from all subjects and the project was approved by both ethics committees in the university and the hospital.

Randomization

Patients were randomly allocated to the exercise group, TENS group or the control group using a computer-generated minimization method,[19] taking into account subject's age, gender, and degree of disability due to neck pain as assessed by the validated Chinese version of the Northwick Park Neck Pain Questionnaire.[20] A computer program for randomization was installed in a computer. After the senior physiotherapist keyed in the patient's particulars the program automatically

allocated the grouping of the patient according to the minimization theory that yielded the smallest imbalance between the three groups. Computer-based randomization helps to establish allocation concealment, which is an essential part of a randomization trial.

Control group

The control group received only infrared irradiation and advice on neck care two sessions a week for six weeks. The patient sat with the back of the neck exposed and the head supported comfortably over a pillow on top of a small table. The position of the infrared lamp (Hanovia, Model 10, UK) was adjusted so that the centre of the emission coil was directly above and behind the spinous process of the fourth cervical vertebra. The distance between the patient and the lamp was adjusted to produce a feeling of mild comfortable warmth over the back of the neck. The irradiation time was 20 min and the patient was instructed not to fall asleep during that period, and should report immediately if there was any marked change of temperature over the back of the neck.

TENS group

After infrared irradiation for 20 min and advice on neck care, the TENS group received conventional TENS to the neck region for 30 min from a dual-channel portable TENS unit (ITO, model 130Z). Stimulation was given in continuous trains of 150 μs square pulses at 80 Hz. Four surface electrodes, 4×4 cm each, were placed on the following acupuncture points: Ex21, GB21 and LI11 (Figure 1).[21] The intensity of TENS was adjusted to produce a tingling sensation that was approximately 2–3 times the subject's sensory threshold.

Exercise group

After infrared irradiation and advice on neck care, patients in the exercise group underwent an intensive neck exercise programme using the Multi Cervical Rehabilitation Unit, two sessions a week for six weeks, under the supervision of an experienced physiotherapist.[15–22] Following Pollock's[23] method and the exercise protocol of Jull *et al.*,[24] each session lasted for about 35 min. They were also given infrared irradiation for 20 min and advice on neck care.

The exercise programme began with one set (10 min) of activation of the deep neck muscles aimed to enhance their ability for active stabilization of the cervical spine.[24] The patient was then asked to perform 15 repetitions of flexion and extension of the neck using the Multi Cervical Rehabilitation Unit as a warm-up exercise for the superficial neck muscles. The resistance used during the warm-up was set at approximately 20% of the peak isometric muscle strength. After the warm-up, training started and consisted of three sets of variable resistance load, allowing 8–12 repetitions of full flexion and extension within subject's pain tolerance. A 5-min rest between

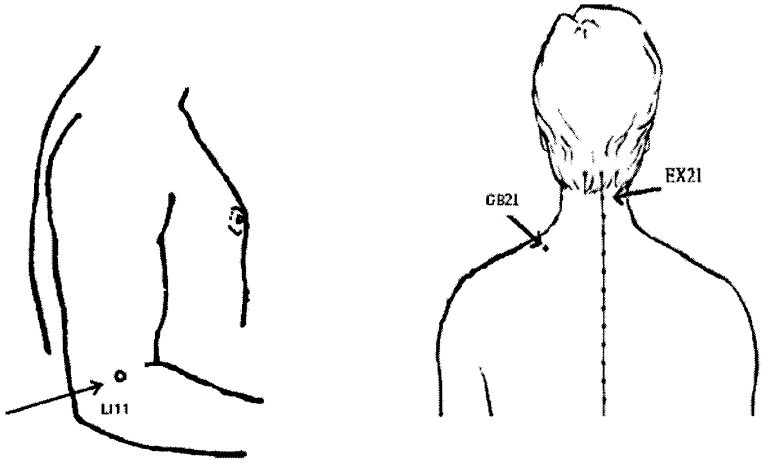

Figure 1 TENS on acupuncture points. From Academy of Traditional Chinese Medicine (1975).

sessions was given.[15,25–27] For the initial training session, the dynamic weight load used for each subject was calculated to be about 30% of the peak isometric muscle strength.[15] The weight load was increased by approximately 5%, when a set of 12 or more repetitions had been achieved.[23]

To activate the deep neck muscles, the patient lay down in the supine position with the weight of the head and the cervical spine supported by towels under the occiput in a neutral position. An air-filled pressure sensor (Stablizer, Chattanooga South Pacific, Australia) was used to monitor the subtle flattening of the cervical lordosis that was expected to occur with contraction of deep neck flexors. The sensor was placed suboccipitally behind the neck and inflated to 20 mmHg. Guided by an experienced physiotherapist, the patient was instructed to slowly nod the head in an action indicating 'yes', so as to raise the pressure to a level that could be held steadily for 10 s, called the 'activation score'.[24] The patient was asked to maintain a 10-s hold at the activation score, with the visual feedback of the pressure sensor for 10 min. A 15-s break was given between each hold, or until the patient felt tired and was unable to control the contraction. Loss of control of the contraction was shown by the loss of pressure as indicated by the air-filled pressure sensor.

Outcome measures

The primary outcome measures of this study were: (1) the verbal numerical pain scale,[28] (2) the neck specific disability scores as measured by the validated Chinese version of the Northwick Park Neck Pain Questionnaire,[20] and (3) the peak isometric strength of the neck muscles in six different directions (flexion, extension, right and left lateral flexions, protraction and retraction) as measured objectively by the Multi Cervical Rehabilitation Unit.[29] Secondary outcomes included percentage of subjects taking medication and sick leave because of the neck pain. Patients were assessed by an independent assessor who was blinded to the grouping at baseline, after the six-week treatment and at the six-month follow-up.

Statistical analysis

Statistical analysis was based on the intention-to-treat approach. A 20% improvement from the baseline values was considered to be clinically relevant.[30] The baseline characteristics of the two intervention groups and the control group were compared by ANOVA. After the intervention, statistical analysis for the difference between the pre- and post-measurements in verbal numerical pain scale, neck pain questionnaire score and isometric neck muscle strength were compared among the three groups, using the repeated-measure ANOVA. Repeated-measure ANOVA was also used to determine whether there was any change in numerical pain scale, neck pain questionnaire score and neck muscle strength after the intervention within each group. Post-hoc tests were used to determine the change between groups when indicated. Cochran'Q tests and chi-squared tests were used for nominal data comparison. Statistical significance was set at the 5% level.

A strength index based on the six baseline measurements of isometric neck muscle strength (including flexion, extension, right and left lateral flexions, protraction and retraction) was found by using principal component analysis with the correlation matrix being the unit of analysis. The resulting components whose eigen values were larger than one were extracted. Then possible interpretation was sought.

The subjects were the same groups (exercise and control) of patients as were reported on in our previous study.[31] However, new data were presented in this study that was not presented in the previous one.

Results

Patient characteristics

A total of 218 patients were recruited. Figure 2 summarizes the patient recruitment, participation and attrition during the trial period. The reasons for the withdrawals included insufficient time, dissatisfaction with treatment outcome and worsening of symptoms (Figure 2). No complications occurred because of any of the treatments given. No differences in the baseline values between those who had finished the intervention and those who had withdrawn were noted in pain intensity ($p = 0.75$), neck disability scores ($p = 0.62$) and isometric neck muscle strength ($p = 0.74$).

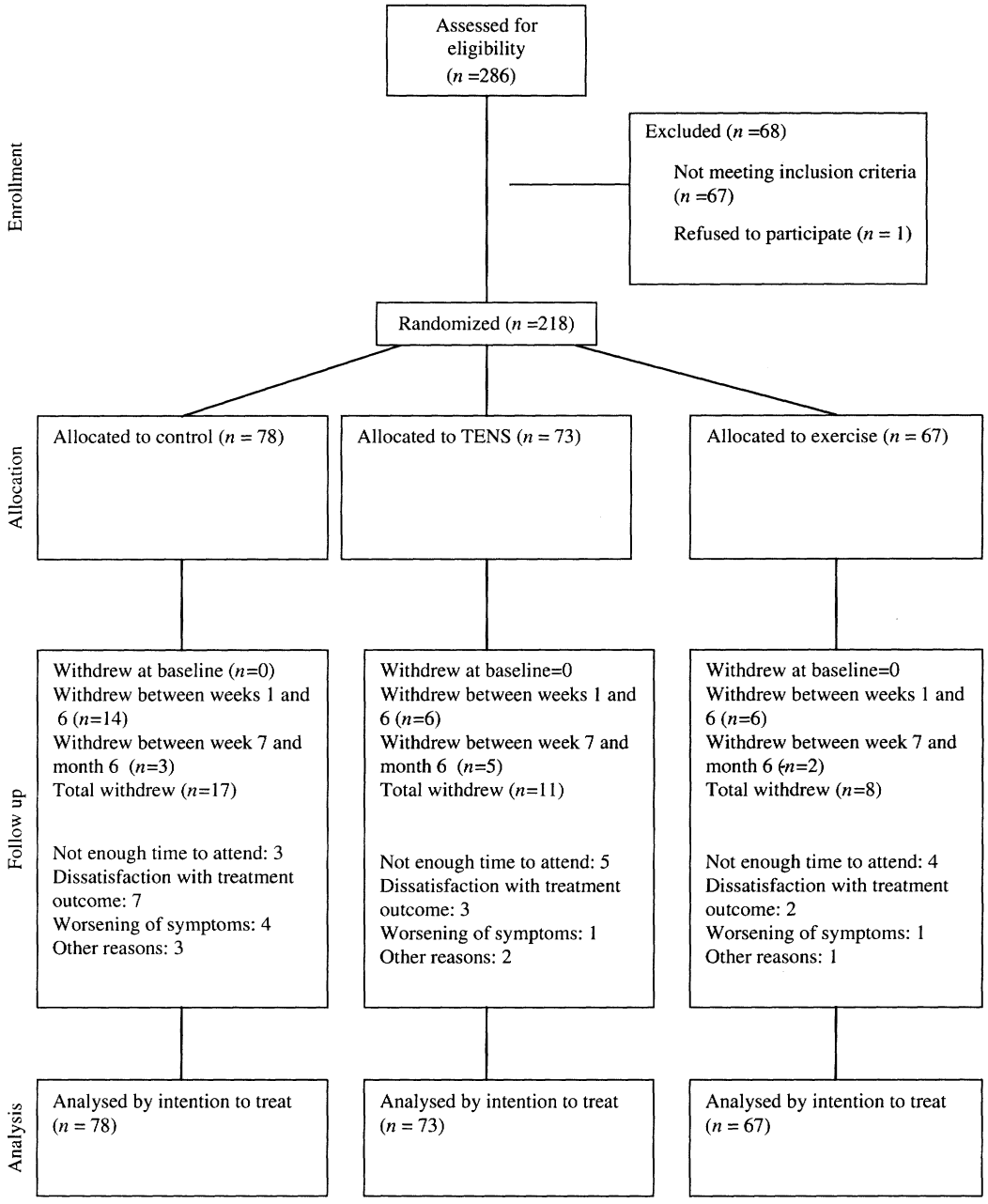

Figure 2 Participant flowchart and assessment.

Baseline characteristics of the subjects in the intervention and the control groups are shown in Table 1. There was no significant difference in age, gender, physical characteristics, history of neck pain and education between patients across the three groups. In particular, no statistically significant differences were observed between the intervention groups and the control group in pain

Table 1 Patient characteristics and baseline measures

	Treatment group			Difference among groups
	Control ($n=78$)	TENS ($n=73$)	Exercise ($n=67$)	p-value
Age (years)	44.31±9.77	42.70±9.77	43.28±9.69	0.60
Range	21–64	20–60	23–59	
Gender (%)				
Male	33.3	32.9	28.4	0.57
Female	66.7	67.1	71.6	0.92
Height (cm)	159.56±8.86	159.33±8.36	159.24±11.58	0.98
Range	123–180	143–178.5	120–185	
Weight (kg)	59.09±9.07	57.90±11.28	59.25±11.07	0.71
Range	37.7–80	38.6–87	40–98	
History of neck pain (%)				
3–6 months	17.9	19.4	18.2	0.83
>6–12 months	16.5	19.4	25.8	0.64
>12 months	66.6	61.2	56.0	0.28
Education (%)				
Primary	28.2	32.8	23.8	0.55
Secondary	57.7	54.3	55.2	0.62
Tertiary	14.1	12.9	21.0	0.57
Verbal numerical pain scale (0–10)	4.26±2.08	4.69±1.78	4.61±1.86	0.33
Disability score (0–4)	1.36±0.54	1.55±0.41	1.39±0.55	0.06
Isometric neck muscle strength	8.68±4.09	8.86±3.85	9.08±4.31	0.84

Data are mean±SD.

intensity ($p=0.33$), neck pain questionnaire scores ($p=0.06$) and isometric neck muscle strength ($p=84$) before the intervention.

Mean values in numerical pain scale, neck pain questionnaire score and isometric neck muscle strength after six weeks of treatment and at six-month follow-up are shown in Table 2.

Changes in verbal numerical pain scale

The average score of the verbal numerical pain scale was significantly reduced by 0.60 ($p=0.027$) and 1.57 ($p<0.001$, Table 3) after the six weeks of treatment within the TENS and the exercise group. In contrast, no significant change was detected within the control group, who had a mean change of only 0.30 ($p=0.475$). However, no statistically significant difference was found among the three groups ($p=0.119$, Table 3) immediately after the treatment stopped. Follow-up assessment at six months demonstrated that the significant reduction in pain was maintained only within the TENS and the exercise group ($p<0.001$), with no significant change ($p=0.196$) found within the control group. Despite this, no statistically significant difference was found among the three groups ($p=0.122$, Table 3).

Changes in neck pain questionnaire score

After six weeks of treatment, significant improvements in the Northwick Park Neck Pain Questionnaire scores were found within each of the three groups ($p<0.001$ to $p=0.003$, Table 3). Further analysis demonstrated significant difference among three groups ($p=0.016$). Both the TENS group and the exercise group had a significantly better improvement in Northwick Park Neck Pain Questionnaire score than that of the control group, respectively ($p=0.034$ and $p=0.02$). Follow-up assessment at six months demonstrated that these significant differences were maintained among the three groups ($p=0.046$, Table 3). More specifically, the exercise group had

Table 2 Mean values in numerical pain scale, neck pain questionnaire score and isometric neck muscle strength after six weeks of treatment and at six-month follow-up

Outcome measure	Control	TENS	Exercise
After six weeks of treatment			
VNPS	3.96±2.18	4.36±2.04	3.04±1.87
NPQ mean	1.13±0.56	1.17±.051	1.00±0.42
Neck muscle strength	9.93±4.89	10.28±4.78	11.36±5.82
At six-month follow-up			
VNPS	3.61±2.06	3.40±2.35	3.06±2.09
NPQ mean	1.16±0.56	1.19±0.53	1.02±0.58
Neck muscle strength	9.83±4.74	10.04±4.65	11.0±5.01

VNPS, verbal numerical pain scale; NPQ, Northwick Park Neck Pain Questionnaire.
Data are mean±SD.

a significantly better improvement than that of the control group ($p = 0.019$).

Changes in isometric neck muscle strength

Principal components on the strength measurements identified only one component with an eigenvalue greater than one. The first principal component had an eigenvalue of 3.615 that accounted for about 60% of the total variation. The component score coefficient for the six measurements (flexion, extension, right and left lateral flexions, protraction and retraction) was respectively 0.249, 0.240, 0.139, 0.155, 0.245 and 0.231. Since the coefficients were of similar magnitude, for the ease of interpretation, the average of the six strength measurements was taken as a strength index for subsequent analysis.

Significant improvement in isometric neck muscle strength was observed in all the three groups after six weeks ($p < 0.001$ to 0.03), but no statistically significant difference was found among the three groups ($p = 0.36$, Table 3). The significant improvement was maintained after six months only in the exercise ($p < 0.001$) and the TENS groups ($p = 0.009$), but not within the control group ($p = 0.084$). However, the difference among the three groups was not statistically significant (Table 3).

Changes in self-report on medication for neck pain

The number of patients reporting medication usage for the past two weeks decreased significantly from the baseline to the six-month follow-up in both the TENS (from 26 to 17, $p = 0.030$) and the exercise group (from 20 to 12, $p = 0.035$). In contrast, no significant change was found in the control group (24–21, $p = 0.21$, Table 4). Nevertheless, no significant differences were found between groups ($p = 0.93$).

Table 3 Mean improvement in numerical pain scale, neck pain questionnaire score and isometric neck muscle strength after six weeks of treatment and at six-month follow-up

Outcome measure	Mean improvement±SD (*p*-value of within-group comparison)			Between-group difference[b]
	Control	TENS	Exercise	*p*-value
After six weeks of treatment				
VNPS	0.30±2.48 (0.475)	0.60±2.54 (**0.027**)[a]	1.57±2.67 (< **0.001**)[a]	0.119
NPQ mean	0.23±0.63 (**0.003**)[a]	0.38±.060 (< **0.001**)[a]	0.39±0.62 (< **0.001**)[a]	**0.016**[a]
Neck muscle strength	1.25±3.94 (**0.03**)[a]	1.42±3.90 (**0.02**)[a]	2.28±4.22 (< **0.001**)[a]	0.36
At six-month follow-up				
VNPS	0.65±2.76 (**0.196**)	1.29±2.30 (< **0.001**)[a]	1.55±2.69 (< **0.001**)[a]	0.122
NPQ mean	0.20±0.66 (**0.010**)[a]	0.36±0.63 (< **0.001**)[a]	0.37±0.68 (< **0.001**)[a]	**0.046**[a]
Neck muscle strength	1.15±3.98 (0.084)	1.18±4.17 (**0.009**)[a]	1.92±4.15 (< **0.001**)[a]	0.268

VNPS, verbal numerical pain scale; NPQ, Northwick Park Neck Pain Questionnaire. Results based on analysis by intention-to-treat.
[a]Bold type indicates $p < 0.05$.
[b]Between-group comparison by ANOVA.

Table 4 Number and percentage of patients (A) using medication for the past two weeks because of neck pain and (B) taking sick leaves for the past three weeks

	Control			TENS			Exercise		
	Week 0	Week 6	Month 6	Week 0	Week 6	Month 6	Week 0	Week 6	Month 6
(A) Using medication	24 (30.8%)	18 (23.1%)	21 (26.9%) $p = 0.21^a$	26 (35.6%)	17 (23.3%)	17 (23.3%) **$p = 0.03^a$**	20 (29.9%)	11 (16.4%)	12 (17.9%) **$p = 0.03^a$**
(B) Taking sick leave	13 (16.7%)	5 (6.4%)	7 (9.0%) $p = 0.08^a$	11 (15.5%)	2 (2.7%)	4 (5.5%) **$p = 0.03^a$**	11 (16.4%)	1 (1.5%)	2 (3%) **$p = 0.01^a$**

Percentage of patients in parenthesis.
[a]*p*-value of within-group difference between month 6 and week 0. Bold type indicates $p < 0.05$.

Changes in number of subjects taking sick leave because of neck pain

From the baseline to the six-month follow-up, there was a significant decrease in the number of subjects who had taken sick leave because of neck pain for the past three weeks, from 11 to 4 in the TENS group ($p = 0.03$), and from 11 to 2 in the exercise group ($p = 0.01$, Table 4) but not in the control group ($p = 0.08$). However, no significant difference was found among the three groups ($p = 0.22$).

Discussion

The patients in our study came from two typical physiotherapy outpatient departments from two different regions of Hong Kong. Therefore, they should be a reasonably representative sample of patients with chronic neck pain in the city. As almost all eligible patients (99.5%) agreed to participate, nonresponse bias should be small. Moreover, the three groups were homogeneous in terms of physical characteristics, history of neck pain and education at the baseline (Table 1). This helped to strengthen the internal validity of the study.

The subjects were the same groups (exercise and control) of patients as were reported on in our previous study.[31] However, new data were presented in this study that was not presented in the previous one.

Improvement in verbal numerical pain score

In contrast to the lack of significant within-group difference in the control subjects, there was significant improvement in patient's subjective report of pain in the TENS group and the exercise group, and this was maintained even after six months. Meyler *et al.*[13] also demonstrated a reduction of neck pain with the use of TENS. However, there was no control group in their study. Hence, the reduction in pain could be partly or simply a result of spontaneous recovery. Several studies had also showed that intensive training of the neck muscles for 6–12 weeks resulted in a significant reduction of self-reported neck pain.[15–17,32] However, none of them had incorporated a control group in their protocol.

The design of the present study is such that the observed improvement could be attributed to the effect of the TENS and the exercise programme without being confounded by the possibility of spontaneous recovery. Although there was no significant difference between the groups, as was noted by previous investigators,[15,16] the tendency was in favour of the intervention groups. Moreover, the improvement in the exercise group was better than that in the TENS group and the improvements were clinically significant.

Improvement in the Northwick Park Neck Pain Questionnaire score

Our results showed statistically significant improvement in the Northwick Park Neck Pain Questionnaire score after six weeks of treatment in all three groups. A number of studies demonstrated similar within-group findings.[15,30] In a recent randomized clinical trial, Bronfort *et al.*[16] compared the relative efficacy of neck exercise and spinal manipulation for managing patients with chronic neck pain. Substantial improvement in the Neck Disability Index was observed in the different groups of patients, but no significant between-groups difference was reported ($p = 0.45$). In contrast to these findings, our study demonstrated that the TENS and the exercise group had significantly better improvement ($p = 0.034$ and $p = 0.02$) in Northwick Park Neck Pain Questionnaire score than the control group after six weeks of treatment. It should be noted that although statistically significant, the improvement in Northwick Park Neck Pain Questionnaire score in the control group might not be clinically relevant, as it was less than 20%. At six months, the improvement was maintained in all three groups, with the exercise group showing a better improvement than the control group ($p = 0.019$). Similar results in the follow-up assessments were demonstrated in some other studies;[15,30] however, they did not provide possible reasons for the improvement to be maintained. Because the Northwick Park Neck Pain Questionnaire assesses different aspects of neck pain, and consists of pain intensity, daily activities, work and social activities,[33] we suggested that the improvement in this score might be due to the combined effects of reduction in neck pain and improvement in neck muscle strength as shown in our study. Both factors could have contributed to the improvement in the activities of daily living.

Changes in isometric neck muscle strength

After six weeks, patients in all the three groups had significant improvement in their isometric neck muscle strength. However, the improvement in the control group is not clinically significant and it was not statistically significant at the six-month follow-up (Table 3). It is interesting to note that even patients in the control group had some improvement in their isometric neck muscle strength after the six-week treatment. Some previous studies have also demonstrated strength increase in the cervical musculature even after passive treatment such as massage and stretching.[15,34] Jordan *et al.*[15] suggested that the gain in strength in these subjects was probably a result of increased confidence. Similarly, Al-Obaidi *et al.*[35] suggested that an improvement in the cognitive perception of pain, and the fear-avoidance belief about physical activities might contribute to the improvement of isometric muscle strength in patients with chronic back pain. Future trials investigating the effect of fear-avoidance behaviour in patients with neck pain is indicated.

No previous study on the effect of TENS on isometric neck muscle strength was found, so no comparison can be made. We hypothesized that the improvement in strength after the six-week treatment and at the six-month follow-up is most likely due to the reduction in pain brought about by TENS, leading to more proper use of the neck muscles. Further investigation is required to elucidate this.

Changes in medication because of neck pain

Self-reported medication usage for the past two weeks decreased significantly in both the TENS and the exercise groups but not in the control group. There was no previous literature reporting the effect of TENS on the medication used in patients with neck pain, so no comparison could be made. Previous studies also reported a decreased medication usage in the exercise group, but no significant difference was found between groups.[15,16,30] It should be noted that comparing the results of different studies is problematic because the baseline disabilities could be different.

Clinical messages

- After six weeks' treatment, patients in the exercise and the TENS group had a better and clinically relevant improvement in pain, disability scores and isometric muscle strength than those in the control group.
- All the improvements in the intervention groups were maintained at the six-month follow-up.

Sick leave

There was a significant decrease in the number of subjects taking sick leave due to neck pain in the TENS and the exercise groups. No similar data were reported in previous studies. If treatment with TENS and exercise training could reduce absenteeism due to neck pain, then the economic impact should be noted. However, Deyo *et al.*[36] and Hazard *et al.*[37] suggested that return to work and absenteeism could be strongly influenced by factors unrelated to patient's health and treatment. Further study is needed to investigate the validity and sensitivity of return to work and absenteeism as an outcome measure in the rehabilitation of patients with neck pain.

Results of this study may suggest that the exercise group had better improvement than the TENS group, especially in terms of pain reduction. However, there was no statistical difference between the two groups in any of the outcome measures. The present authors believe that all inferences for effectiveness should be based only on the results of contrast between the intervention and the control group.

Limitations of the present study

As only patients with chronic neck pain (more than three months of neck pain) were recruited in this study, the above findings could only be applicable to patients within this category. Note that the pathology of patients recruited in the current study was not known. Patients with different pathologies may have different responses to the treatment programme. Further studies may be needed to elucidate the effect of TENS and exercise in neck pain patients with different pathologies. The time spent in the exercise and the TENS groups was longer than that in the control. This may affect the outcomes of the study. Moreover, the cost effectiveness of the interventions needs to be evaluated in future studies.

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