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Original Article

The effect of neurac training in patients with chronic neck pain

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Abstract. [Purpose] This study aimed to investigate the effects of neurac training on pain, function, balance, fatigability, and quality of life. [Subjects and Methods] Subjects with chronic neck pain who were treated in S hospital were included in this study; they were randomly allocated into two groups, i.e., the experimental group (n = 10) and the control group (n = 10). Both groups received traditional physical therapy for 3 sessions for 30 min per week for 4 weeks. The experimental group practiced additional neurac training for 30 min/day, for 3 days per week for 4 weeks. All subjects were evaluated using the visual analogue scale (VAS), the neck disability index (NDI), the biorescue (balance), the questionnaire for fatigue symptoms (fatigue), and the medical outcome 36-item short form health survey (SF-36) pre- and post-intervention. [Results] The experimental group effectively improved their pain, function, balance, fatigability, and quality of life. [Conclusion] Neurac training is thus considered an effective training program that enhances body functionality by improving pain, function, balance ability, fatigability, and quality of life in patients with chronic neck pain.

Key words: Chronic neck pain, Sling-neurac training, Function

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INTRODUCTION

Neck pain is one of the most common disorders, leading to considerable stress on healthcare systems[1)]. It is estimated that 67% of the population will experience neck pain at some point in their life[2)]. Most people with neck pain complain of inconveniences in daily life, but rarely opt for aggressive treatments, unlike for lower back pain. As a result, neck pain does not fundamentally improve even after 10 years in most cases and results in enormous economic losses each year[3)].

Proprioceptive afferent inputs from neck muscles play a significant role in the control of human posture[4)]. There is growing evidence to implicate the role of the cervical spine in influencing postural control[5)]. Several studies have reported altered postural control in people with neck pain[6–8)]. McPartland et al.[9)] determined a significant correlation between poor balance control and fatty infiltration of the cervical extensor musculature in subjects with neck pain; others have demonstrated the adverse effects of neck extensor muscle fatigue on postural sway[10)]. Chronic pain is a factor that increases muscle fatigue[11)]. Muscle fatigue generated by maintaining muscular contraction to fixed head posture in different positions is known as one of the causes of chronic neck pain[12)]. Neck muscle fatigue caused by chronic pain impairs the balance of upright posture[13)], changes the role of sensory receptors—such as muscle spindles and Golgi tendon organs[14, 15)], and affects joint position sense[16, 17)].

As compared to lower back pain, neck pain tends to become chronic more frequently and is likely to relapse again after therapeutic interventions[18)]. In patients with chronic neck pain, the quality of life decreases, which can lead to serious problems[2)]. Overall, 25% of patients with neck pain experience chronic neck pain, leading to decreased quality of life and socioeconomic damages such as medical expenses[19, 20)].

Among various treatments for reducing chronic neck pain, therapeutic exercise has the strongest evidence[21)]. Several studies in recent years have reported that active therapeutic interventions are more effective than passive therapeutic interventions in neck pain patients[22–24)]. The neurac method is an active rather than a passive treatment approach[25)]. The neurac treatment method with sling exercises focuses on tonic stabilizers largely located near joints that play a crucial role in the feed forward mechanism and is efficient in retraining motor units of muscles and reoperating inhibited actions through dynamic-static contractions of high intensity[26, 27)]. This method utilizes passive fluctuations or mechanical vibrations. Vibratory stimulation can improve muscle contraction by stimulating muscle hypertrophy, thereby affecting the muscle spindles[28)]. Vibrations for a short time period have been reported to be effective in increasing deep muscle strength and muscle stabilization in chronic pain patients[29)].

Therefore, this study investigated the effects of neurac

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training on pain, function, balance, fatigability, and quality of life in patients with chronic neck pain.

SUBJECTS AND METHODS

Participants in this study included administrative staff who had experienced chronic neck pain at least 3 months previously; they were selected from among administrative staffs with high computer usage, in S hospital in Seoul. Patients were randomly assigned to the experimental group (n = 10; male = 2, female = 8) or control group (n = 10; male = 2, female = 8). Subjects were included in the study if they had a neck disability index (NDI) score over 5 and had suffered chronic neck pain at least 3 months previously. Exclusion criteria were patients with acute neck pain, a previous history of neck surgery, presence of other neurological or orthopedic disorders affecting the neck, and those receiving treatment with muscle relaxants.

The experiment was conducted with the approval of the Institutional Review Board of S University. All subjects provided written informed consent prior to study enrollment.

Subjects received traditional physical therapy for 3 sessions for 30 min per week for 4 weeks. The experimental group practiced additional neurac training for 30 minutes per day, for 3 days per week for 4 weeks. The neurac training used the motor control training and myofascial chain training protocols presented in the neurac 1 course materials (redbalance academy neurac 1 course book, Norway).

Neurac training was performed using a sling (Redcord, Norway, 2004) in the supine cervical setting, prone cervical setting, and cervical movements, as presented in Norway Neurac course 1 materials (redbalance academy neurac 1 course book, Norway). The supine cervical setting comprises the subject lying in the supine position, with the head supported by an inelastic sling, wherein the therapist holds the cervical vertebral portion gently with two hands. Two thumbs of the therapist are placed on the sternocleidomastoid muscles and the rest of the fingers hold the back of the cervical vertebral portion. The cervical vertebral portion and back of the head are then pulled gently upwards, and the sternocleidomastoid muscle is pressed 2 mm with the thumb to minimize the lordotic curve of the cervical vertebrae. The subjects were instructed to maintain this small force and relax. The examiner observed whether the patient's chin was elevated minutely toward the upper part.

The prone cervical setting is performed in the prone position. The therapist holds the cervical vertebral portion with two hands gently. Two thumbs are placed on the middle of the back portion and the other fingers are placed on the front portion and sternocleidomastoid muscle; simultaneously, the therapist pulls the cervical vertebral portion upwards. At this time, the lordotic curve of the cervical vertebral portion is reduced and the chin moves slightly upward by 2 mm. The patient was instructed to maintain this small force and relax. In the supine cervical and prone cervical settings, when the compensation of other muscles appeared, applying vibration on sling line. If subjects appealed for a break, the therapist paused for 30 s, known as break time. The Cervical movements of sling training name, depending on the sling and roll of the subject, while supporting the weight of the body, were instructed to the movement of the neck. The subject was instructed to maintain the body in a straight line during the break time.

Motor control training was used in the supine cervical and prone cervical settings, while myofascial chain training was used in cervical movements (cervical retraction, cervical lateral flexion, cervical rotation, and cervical extension).

Outcomes were measured in terms of pain, function, balance, fatigability, and quality of life. Pain was evaluated using the visual analogue scale (VAS). The VAS was used to measure the degree of pain on a scale of 0 to 10 points (10 being the highest pain). Function was evaluated using the NDI. The NDI is a 6-point scale (0, 1, 2, 3, 4, 5), with a score of 0 indicating no pain or disability and 5 indicating insufferable pain or complete disability. Balance was measured by the biorescue test. All subjects were measured when standing for 30 s on two feet with eyes open and eyes closed. All measurements were repeated 3 times after practicing once, and the mean value was determined. The elements measured included the sway area, sway length, and sway velocity; low values indicated good balance abilities. Fatigability was evaluated using the questionnaire for fatigue symptoms standardized by Industrial Fatigue Research Group of Japan Society of Industrial Hygiene. This questionnaire comprised a total of 30 items—including 10 items each for physical fatigue, mental fatigue, and physical fatigue—on a 4-point scale (1, 2, 3, 4) with a total score of 30 to 120, with high scores indicating a high degree of fatigue. Quality of life was evaluated using the medical outcome 36-item short form health survey (SF-36). The SF-36 consists of a total of 8 items, i.e., physical function, role limitation-physical, body pain, general health, role limitation-emotional, vitality, social function, and mental health.

All statistical analyses were performed using SPSS version 19.0 statistical software (SPSS Inc., Chicago, IL, USA). Results are presented as mean ± standard deviation (SD). Prior to training, the normality of the data was assessed with the Shapiro-Wilk test. χ^2 analysis and the Mann-Whitney U test were used to examine the significance of differences for variables. The Wilcoxon Signed Rank test was used to compare pain, function, balance, fatigability, and quality of life before and after the treatments. The Mann-Whitney U test was performed to identify differences between groups. For all tests, statistical significance was set at $p < 0.05$.

RESULTS

A total of 20 subjects participated in this study, with 10 subjects in the experimental group and 10 in the control group. The general characteristics of the study subjects are summarized in Table 1. There were no significant differences in the baseline values between the experimental and control groups.

VAS and NDI scores decreased significantly in the experimental group ($p < 0.05$), with significant differences in the score changes of the two groups ($p < 0.05$) (Table 2).

Sway area in the eyes open condition showed no significant improvement in either group, and no significant differences were noted in the score changes of the two groups. However, sway area in the eyes closed condition showed

Table 1. The subjects' characteristics

	Experimental group (n = 10)	Control group (n = 10)
Gender (male/female)	10 (2/8)	10 (2/8)
Age (years)	38.10 ± 12.25	35.20 ± 10.08
Height (cm)	164.50 ± 9.87	164.80 ± 9.89
Weight (kg)	57.40 ± 8.70	56.70 ± 8.00

Values are expressed as mean ± SD.

Table 2. The visual analogue scale and the neck disability index scores at pre- and post-training

		Experimental group	Control group
Visual analogue scale scores (VAS)	Pre-training	4.95 ± 1.55	4.91 ± 1.26
	Post-training	2.56 ± 1.32	4.85 ± 1.49
	Difference	2.39 ± 0.51*	0.06 ± 0.73
Neck disability index scores (NDI)	Pre-training	12.50 ± 4.55	12.00 ± 4.47
	Post-training	7.10 ± 4.18	11.60 ± 3.95
	Difference	5.40 ± 1.65*	0.40 ± 1.90#

Values are expressed as mean ± SD. *, A significant change between the pre- and post- sling-neurac intervention; #, a significant difference between the experimental and control groups ($p < 0.05$).

Table 3. The biorescue test scores at pre- and post-training

		Experimental group	Control group
Sway area (Eyes open)	Pre-training	34.60 ± 19.32	26.63 ± 29.43
	Post-training	26.03 ± 13.61	22.96 ± 18.82
	Difference	8.57 ± 11.93	3.66 ± 17.28
Sway area (Eyes closed)	Pre-training	51.05 ± 36.08	37.04 ± 36.24
	Post-training	24.77 ± 10.68	61.71 ± 67.39
	Difference	26.28 ± 31.20*	−24.67 ± 55.34#
Sway length (Eyes open)	Pre-training	8.45 ± 2.90	6.64 ± 1.36
	Post-training	6.36 ± 1.11	6.70 ± 1.64
	Difference	2.09 ± 2.74*	−0.06 ± 2.02
Sway length (Eyes closed)	Pre-training	9.44 ± 2.84	7.48 ± 1.29
	Post-training	7.00 ± 1.33	7.53 ± 1.44
	Difference	2.44 ± 2.62*	−0.05 ± 1.60#
Sway velocity (Eyes open)	Pre-training	0.24 ± 0.06	0.21 ± 0.02
	Post-training	0.20 ± 0.04	0.22 ± 0.04
	Difference	0.04 ± 0.05*	−0.01 ± 0.04#
Sway velocity (Eyes closed)	Pre-training	0.28 ± 0.07	0.24 ± 0.05
	Post-training	0.23 ± 0.05	0.25 ± 0.05
	Difference	0.05 ± 0.05*	−0.002 ± 0.05#

Values are expressed as mean ± SD. *, A significant change between the pre- and post- sling-neurac intervention; #, a significant difference between the experimental and control groups ($p < 0.05$).

Table 4. The questionnaire-based fatigue symptom scores at pre- and post-training

		Experimental group	Control group
Fatigue symptom scores	Pre-training	64.80 ± 10.17	65.30 ± 19.54
	Post-training	51.40 ± 7.41	63.80 ± 18.32
	Difference	13.40 ± 6.19*	1.50 ± 3.81#

Values are expressed as mean ± SD. *, A significant change between pre- and post- sling-neurac intervention; #, a significant difference between the experimental and control groups ($p < 0.05$).

Table 5. 36-Item Short Form Health Survey (SF-36) scores at pre- and post-training

		Experimental group	Control group
SF-36 scores	Pre-training	53.85 ± 18.92	58.25 ± 11.69
	Post-training	69.38 ± 13.41	59.04 ± 13.02
	Difference	−15.53 ± 7.96*	−0.79 ± 4.69#

Values are expressed as mean ± SD. *, A significant change between the pre- and post- sling-neurac intervention; #, a significant difference between the experimental and control groups ($p < 0.05$).

significant improvement in the experimental group ($p < 0.05$), with a significant difference in the score changes of the two groups ($p < 0.05$). While sway length in the eyes open condition showed significant improvement in the experimental group ($p < 0.05$), no significant difference was observed in the score changes of the two groups. In contrast, sway length in the eyes closed condition showed significant improvement in the experimental group ($p < 0.05$), with a significant difference in the score changes of the two groups ($p < 0.05$). Sway velocity in the eyes open as well as eyes closed conditions showed significant improvement in the experimental group ($p < 0.05$), with a significant difference in the score changes of the two groups ($p < 0.05$) (Table 3).

The fatigue symptom scores decreased significantly in the experimental group ($p < 0.05$), with a significant difference in the score changes of the two groups ($p < 0.05$) (Table 4). The SF-36 scores increased significantly in the experimental group ($p < 0.05$), with a significant difference in the score changes of the two groups ($p < 0.05$) (Table 5).

DISCUSSION

This study was performed to confirm the effects of neurac training—an active therapeutic intervention focusing on retraining tonic stabilizers—on several dependent variables chosen on the basis of previous reports.

This study showed that neurac training for 4 weeks decreased pain and NDI in the experimental group. Yang et al.[30] reported that neurac training for two weeks is effective in reducing pain and enhancing function in patients with cervical radiculopathy. Our results were consistent with this study as well as with those of previous studies, demonstrating that active treatment helps in reducing subjective symptoms in patients with chronic neck pain[20], with sling exercise therapy being the active exercise form[27]. This reduction in subjective symptoms was also considered to result in decreased dysfunction.

Our study confirmed the effects of neurac training on improving balance disorders caused by neck pain. Brummnage et al.[31] reported that vibration applied to patients with lumbar pain restored the position sense in the lumbosacral part. Fontana et al.[32] noted that when vibrations of low frequency were applied to the entire body, the proprioceptive sense of the lumbosacral area recovered. Choi et al.[33] observed that sling treatment with vibration is an activity that affects large trunk muscles in contrast to sling treatment without vibration. Further, Kirkesola et al.[27] reported that when vibrations were applied to patients with neck pain, the force steadiness of neck muscle increased. Such vibrations applied to muscles and tendons are thought to affect the afferent nerve pathways[34]. Neurac training is a weight-bearing exercise using suspension units or a sling system[27]. The closed chain exercises used in weight bearing exercise provide improved proprioception and kinesthetic feedback[35]. In this study, neurac training applied to the experimental group showed improvements in balance ability; this was considered to increase neck muscle activation and improve proprioception. Further, due to the high density of muscle spindles in the neck[36, 37], the applied vibrations to these muscle spindles were considered to contribute to the recovery of proprioception. We believe that the recovery of proprioception affects the improvement in balance ability in patients with chronic neck pain.

This study also confirmed the effects of neurac training on fatigability and showed a significant difference in fatigue symptoms before and after the experimental treatment as well as between the two groups. Falla et al.[38] reported that endurance-strength training reduces fatigue and increases cervical flexion strength in women with chronic neck pain. Our results using neurac training for 4 weeks were consistent with this finding. However, an objective follow-up study is required for analyzing the changes in muscle fatigability using electromyography, since muscle fatigue was measured in this study using a subjective survey-type questionnaire for fatigue symptoms specifically developed for Japan.

In previous studies concerning quality of life, exercise has been repeatedly demonstrated to be an intervention that promotes the quality of life, because the adaptation of everyday life through exercises enhances quality of life[39]. In our study, neurac training significantly improved quality of life in the experimental group, which was consistent with previous results regarding the relationship between exercise and quality of life. The reduction in pain, dysfunction, fatigability shown earlier were considered to be responsible for the improvements in quality of life in these patients. Many items on the SF-36, i.e., physical function, body pain, physical role limitation, and vitality, improved significantly with neurac training, indicating that this therapy led to positive changes in physical health but not in mental health, which includes various emotional and psychological factors. Jeon[40] showed that the mental health of seniors who participated in exercise was better than those who did not. This contrast is considered to be because the study period was short and the number of exercises was not high. Further, subjects who participated in this study were office workers, and the multiple factors that affect mental health were not thoroughly controlled.

This study has certain limitations. However, the findings of this study cannot be wholly generalized because of the small number of subjects. Further analyses are required to clarify the objective improvements in balance, proprioception, and muscle fatigability with the neurac training intervention; we expect to use wavelet analysis and electromyography for such follow-up studies.

In conclusion, this study proved the positive effects of neurac training on pain, function, balance, fatigability, and quality of life in patients with chronic neck pain, suggesting that this intervention may be effective in the clinical setting.

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