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Original Article

Investigation of the effectiveness of neck stabilization exercises in patients with chronic neck pain: A randomized, single-blind clinical, controlled study

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ABSTRACT

Objectives: This study aims to compare the efficacy of neck stabilization exercises versus a conventional exercise program on pain, range of motion, disability, and depression in patients with chronic neck pain.

Patients and methods: This prospective, single-blind, randomized controlled study included 60 patients with chronic neck pain, 58 (21 males, 37 females; mean age: 36.7±8.5 years; range, 18 to 55 years) of whom completed the study. The patients were randomized into two groups. Patients in one group were given neck stabilization exercises, while the patients in the other group were given conventional neck exercises. Neck pain due to activities of daily living (Visual Analog Scale), neck range of motion in sagittal, transverse, and frontal planes, disability (Neck Disability Index), and depression (Beck Depression Inventory) were evaluated at the beginning, at the end of the treatment, and at the first and third months after the end of treatment.

Results: Significant improvement was achieved in both groups in terms of Visual Analog Scale, Neck Disability Index, neck range of motion in the sagittal, transverse, and frontal planes, and Beck Depression Inventory compared to the beginning of treatment ($p<0.05$). In the stabilization exercise group, statistically significant improvement was found in the range of motion of the neck in the transverse plane ($p<0.05$).

Conclusion: Stabilization exercise programs, which show their effect by maintaining segmental stabilization, postural control, and balance between the superficial and deep muscles of the neck region, contribute to reduced pain in daily activities and improved function similar to conventional exercise programs.

Keywords: Chronic neck pain, conventional neck exercise, neck stabilization exercise.

Neck pain develops in 30 to 50% of adults every year, and in 50 to 85% of these individuals, the pain does not regress completely and becomes chronic.[1] Stiffness and limited range of motion have been reported in patients with chronic neck disorders.[2] Studies have shown that deep cervical muscle group exercises improve neuromotor control and decrease pain and disability.[3,4] In contrast to the improving effect of exercise, psychosocial stress alters neuromotor control. Exposure to psychosocial stressors selectively activates the upper trapezius muscle, causing continuous activation of trapezius motor units even in the absence of physical task demands, and it may contribute to neck pain.[5,6] So individuals with chronic neck pain may

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experience symptoms of depression more frequently than those without pain. Moreover, depression is identified as one of the major determinants of neck pain.[7] Thus, treatment regimens for neck pain should not only target pain symptoms but also aim to prevent depressive disorders.[8]

However, there is moderate evidence that neck stretching and strengthening exercises applied through different methods are effective for chronic neck pain, while stretching and strengthening exercises applied only to the shoulder region neither change pain in the short or long term nor support functional recovery in the long term.[9] There is still no high-quality evidence about the effectiveness of exercises for neck pain, and there is uncertainty about the effectiveness of exercises.[10] The aim of this study was to compare the efficacy of neck stabilization exercises on pain, range of motion, disability, and depression in comparison to a conventional exercise program in patients with chronic neck pain.

PATIENTS AND METHODS

This single-blinded, randomized-controlled, prospective interventional study with a three-month follow-up period was conducted at the Department of Physical Medicine and Rehabilitation of the Dokuz Eylül University Research and Application Hospital between July 2014 and February 2015. A total of 60 patients with neck pain were initially included in the study; however, 58 (21 males, 37 females; mean age: 36.7±8.5 years; range, 18 to 55 years) of these patients could complete the study. Inclusion criteria were as follows: having neck pain for at least three months and the ability to come to the hospital for an outpatient exercise program. Exclusion criteria were as follows: a history of cervical spine injury or surgery, neck pain as secondary to other conditions including neoplasm, neurological diseases or vascular diseases, radiculopathy with neurological deficits, a history of infection or inflammatory arthritis in the cervical spine, physical therapy within last six months, and presence of pain in the shoulder, upper extremity, scapula, or lumbar spine that prohibited exercise. Patients were randomly assigned to four-person blocks using block randomization in either the neck stabilization or conventional exercise group by an independent researcher using a scheme from a random number table, thus ensuring allocation concealment. The two patients that dropped out of the study were in the conventional exercise group. One dropped out due to a job in another city, and the other due to participating in a physical therapy program including therapy agents for recurrence of pain. The study's flowchart showing a diagram of recruitment and follow-up of participants, in

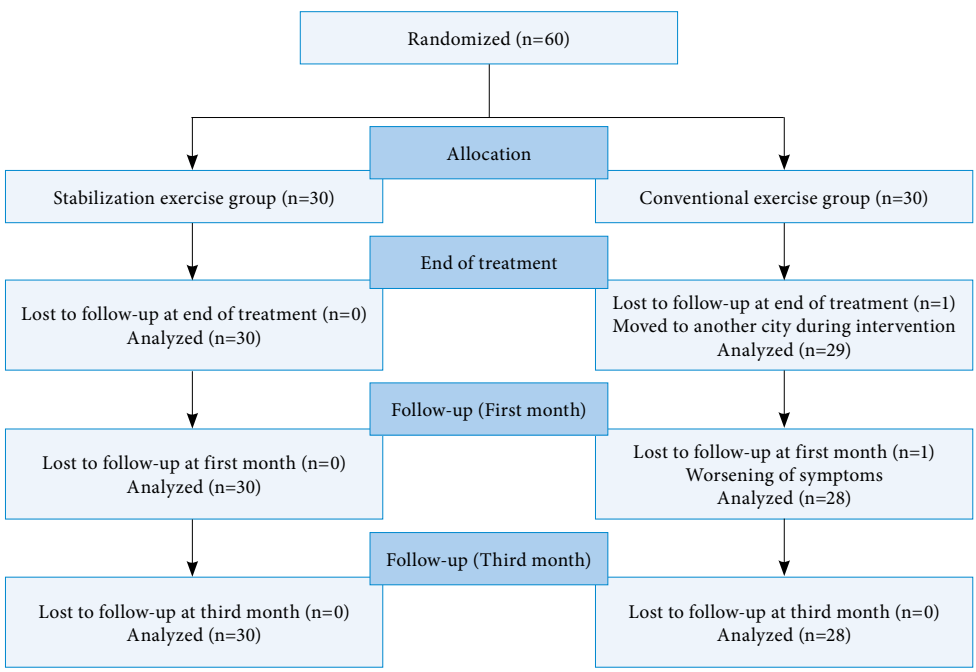

Figure 1. Study flowchart.

adherence with CONSORT guidelines, is depicted in Figure 1. Exercises were carried out in the same treatment groups of four to five patients under the guidance of the same physiatrist at five sessions per week for three weeks in both groups. A schematic exercise sheet was provided to each treatment group before starting. In both groups, information on the causes of neck pain, accompanying and responsible factors for chronic progression of neck pain (for example, posture, ergonomics, muscle strength weakness, overusing certain muscles, using correct muscle groups), and neck protection techniques were provided. Additionally, patients were instructed to use front, back, and side mirror views to maintain a neutral posture in the cervicothoracic and lumbar regions before and throughout the exercises. The conventional exercise group was given 10 repetitions in the first week and 15 repetitions in the following weeks of stretching exercises for the neck, shoulder, pectoral, and scapular muscles and isometric neck exercises (flexion, extension, lateral flexion, rotation). After a three-week group exercise program, patients continued to perform the same exercises five times per week at home.

The patients in the neck stabilization group performed exercises as described by Dusunceli et al.[11] In addition to the stretching and isometric exercises given to the conventional exercise group, the following movements were carried out: deep cervical flexor and extensor muscle strengthening exercises, rotation and lateral flexion strengthening exercises, functional movement pattern exercises, self-mobilization exercises, alternative wall stretching exercises, weighted or weightless posture exercises on a ball providing axial extension, upper extremity, shoulder, and interscapular muscle strengthening exercises with TheraBand (The Hygenic Corporation, Akron, OH, USA) and dumbbells, and dura stretching exercises. They were performed in the supine position with 10 repetitions in the first week and standing in the last two weeks with 15 repetitions. TheraBand exercises were initially performed with a red TheraBand. TheraBand density was then increased progressively once a week with the green and blue TheraBand. Dumbbell exercises (seated shoulder presses, lateral and front arm raises, hammer curls) were initiated at week two with a load of 1 to 2 kg. At the end of the three-week group exercise period, a home program of these exercises to be performed five times per week was initiated.

Demographic characteristics of the patients, including age, sex, body mass index (BMI), education, and duration of symptoms, were recorded, and outcome measurements were taken at baseline, at the end of treatment, and one and three months after the end of treatment by a researcher blind to group allocation. The primary outcome measures were neck pain and disability. Neck pain associated with daily life activities was assessed by the Visual Analog Scale (VAS) with a 0-10 numerical rating scale. Paracetamol intake (tablet/week) was also evaluated and recorded. Usage of nonsteroidal anti-inflammatory drugs was forbidden during the study. A modified version of the Neck Disability Index (NDI) was used to evaluate disability.[12] Neck Disability Index has a total of 10 sections with six possible answers in each section. Each section is scored out of five (with the no disability response given a score of 0), giving a total score for the questionnaire out of 50. Higher scores represent greater disability. Turkish validity and reliability were performed by Kesiktaş et al.[13] The secondary outcome measures were depression and range of motion of neck pain in the sagittal, frontal, and transverse planes. Active range of motion in frontal, sagittal, and transverse planes of the cervical spine was measured using a universal goniometer. Beck Depression Inventory (BDI) was used to evaluate the levels and changes in severity of depressive symptoms due to its widespread use, good sensitivity, and specificity for patients with chronic pain.[14] Beck Depression Inventory is a 21-item self-report questionnaire that evaluates the presence of different symptoms of depression and the severity of each symptom. Each question has four different options, the lowest possible score for each question is 0, and the highest score is 3. High scores indicate the presence of depression as well as its increasing severity.[15] Beck Depression Inventory was adapted into Turkish by Hisli[16] in 1988, which has acceptable reliability and validity.

Statistical analysis

Data were analyzed using IBM SPSS version 24.0 software (IBM Corp., Armonk, NY, USA). Categorical variables were compared using the chi-square test. Continuous variables were presented using mean ± standard deviation, median, and min-max values. The normality of the continuous variables was evaluated using the Kolmogorov-Smirnov test. When evaluations are made with repeated measurements in the case and control groups, the effect of change in time can be at different levels. ANOVA test was used in repeated measurements to evaluate intra-group, between-group and group time interactions in repeated measurements. Interaction effects and parametric assumptions were

controlled in 4×2 factorial ANOVA models. If the ANOVA model main effect F value was statistically significant, multiple comparison analyses were performed with the post hoc Bonferroni test. For all analyses, a p value of <0.05 was considered statistically significant.

RESULTS

In follow-up, it was found that compliance with the home exercise program assured by questioning during their visit was good. No medications were used except for paracetamol. There was no significant

TABLE 1
Baseline demographics and clinical characteristics

	Stabilization exercise (n=30)		Conventional exercise (n=29)		
	n	Mean±SD	n	Mean±SD	p
Age (year)		34.8±9.3		38.8±6.9	0.064[a]
Body mass index (kg/m²)		24.2±4.2		26.4±2.7	0.026[a]
Duration of neck pain (month)		25.7±34.6		25.6±23.5	0.994[a]
Sex					0.712[b]
Male	10		11		
Female	20		18		
Educational level; primary school	2		3		0.682[c]
Educational level; at least secondary school	28		26		
Visual Analog Scale (0-10)		6.0±1.8		7.2±1.2	0.004[a]
Range of motion sagittal‡		64.0±15.2		57.2±20.5	0.152[a]
Range of motion frontal§		63.2±18.5		58.0±14.2	0.237[a]
Range of motion transverse†		115.2±24.0		106.5±30.8	0.232[a]
Neck disability index		24.5±12.0		31.6±13.0	0.032[a]
Beck depression inventory		11.0±10.5		12.4±8.7	0.597[a]

SD: Standard deviation; a: Independent samples t-test; b: Chi-square test; c: Mann-Whitney U test; ‡ Flexion and extension summed; § Left and right flexions summed; † Left and right rotations summed.

TABLE 2
Comparison of the range of motion between baseline and follow-ups

Dependent variables	Stabilization exercise (n=30) Mean±SD	Conventional exercise (n=28) Mean±SD	p full model* p within group p between group p time x group interaction	Post Hoc testε
ROM sagittal degree‡				Tb<Te
At baseline (Tb)	64.1±15.3	57.5±20.9	<0.001	Tb<T1
End of treatment (Te)	75.2±20.3	71.7±16.5	<0.001	Tb<T3
1 month (T1)	88.2±11.1	81.6±10.4	0.083	Te<T1
3 months (T3)	85.9±13.3	81.7±1.3	0.796	Te<T3
ROM transverse degree†				
At baseline (Tb)	115.2 ±24.1	106.57±31.4	<0.001	Tb<Te
End of treatment (Te)	136.3±19.0	121.9±27.0	<0.001	Tb<T1
1 month (T1)	143.3±17.9	131±29.2	0.031	Tb<T3
3 months (T3)	141.5±17.7	129.9±22.5	0.733	Te<T1
ROM frontal degree§				
At baseline (Tb)	63.2±18.5	57.8±14.5	<0.001	Tb<Te
End of treatment (Te)	71.3±18.4	67.0±12.8	<0.001	Tb<T1
1 month (T1)	77.5±10.9	72.6±12.9	0.062	Tb<T3
3 months (T3)	80.1±15.7	72.7±10.4	0.877	Te<T1
End of treatment (Te)	1.7±4.3	0.9±2.1		Te<T3

SD: Standard deviation; ROM: Range of motion; * Repeated measure ANOVA; ‡ Degree of flexion and extension summed; § Degree of left and right flexions summed; † Degree of left and right rotations summed; ε Bonferroni post hoc test comparisons.

TABLE 3
Comparison of outcome measurements

Dependent variables	Stabilization exercise (n=30) Mean±SD	Conventional exercise (n=28) Mean±SD	p full model* p within group p between group p time x group interaction	Post Hoc test$^{\varepsilon}$
VAS (0-10)				
At baseline (Tb)	6.0±1.9	7.2±1.2	<0.001	Tb<Te
End of treatment (Te)	4.2±1.7	4.8±1.8	<0.001	Tb<T1
1 month (T1)	3.3±1.9	4.0±1.4	0.865 β	Tb<T3
3 months (T3)	3.4±1.8	4.4±1.9	0.601	
BDI				
At baseline (Tb)	11.1±10.6	12.6±8.9	<0.001	Tb<Te
End of treatment (Te)	6.5±7.5	10.5±8.0	<0.001	Tb<T1
1 month (T1)	6.1 ±7.1	7.7±6.0	0.137	Tb<T3
3 months (T3)	4.6±4.2	7.7±5.5	0.345	Te<T3
NDI				
At baseline (Tb)	24.5±12	31.4±13.2	<0.001	Tb<Te
End of treatment (Te)	14.7±7.8	20.4±9.4	<0.001	Tb<T1
1 month (T1)	13.1±12.7	18.6±11.8	0.342 β	Tb<T3
3 months (T3)	13.6±10.4	17.3±8.6	0.740	
Paracetamol intake (tablet/week)				
At baseline (Tb)	1.4±4.0	1.5±3.5	0.102	
End of treatment (Te)	1.7±4.3	0.9±2.1	0.100	
1 month (T1)	0.9±2.9	0.6±1.9	0.570	
3 months (T3)	0.7±2.8	0.3±0.9	0.718	

SD: Standard deviation; VAS: Visual Analog Scale; BDI: Beck depression inventory; NDI: Neck disability index; β Comparison of the measurements of three differences between the four measuring points; ε Bonferroni post hoc test comparisons.

difference in age, sex, duration of pain, and education level among the two groups (p>0.05). Body mass index was significantly higher in the conventional neck exercise group (p=0.026). In the beginning, there were no differences between groups in terms of range of motion in the three-plane measurements and depression scores (p>0.05); however, pain and disability scores were higher in the conventional exercise group (p<0.05) as displayed in Table 1. In both groups, significant improvement was established when compared to the beginning of treatment, including improvements in neck pain, the NDI, range of motion of the neck in the sagittal, transverse, and frontal planes, and the BDI (p<0.05). No significant statistical difference was found between groups in the use of paracetamol during the study period (p>0.05). A comparison between groups of the measurements of the three differences between the four measuring points was conducted due to meaningful variances in pain and disability among patients. No significant difference was found in neck pain, disability (NDI), the BDI, and range of motion of the neck in sagittal and frontal planes (p>0.05; Table 2 and Table 3). In the stabilization exercise group, statistically significant improvement was found in the range of motion of the neck in the transverse plane (p<0.05), as shown in Table 2.

DISCUSSION

For patients with chronic neck pain, decreased isometric flexion, rotation, and extension in neck muscle strength was discovered and should be taken into account when planning a rehabilitation program.[17] In addition, altered neuromotor control is reported as a consequence of decreased deep neck flexor activity and increased superficial muscle and cocontraction activity in place of coordination.[18] In our study, we investigated the effectiveness of mobility exercises and stabilization exercises, such as cervical extensor, rotator, and deep flexor muscle strengthening, in addition to conventional exercises (isometric and stretching exercises) on chronic neck pain patients. In the present study, pain, disability, depression, and the active range of motion of the cervical spine showed statistically significant improvement in both groups. In the stabilization exercise group, the increase in transverse plane

active range of motion was more significant than in the conventional exercise group. Among both sets of patients, individual and group exercise programs under physiatrist guidance were effective in providing similar improvement. Results comply with previous studies.

Ghaderi et al.[19] reported significantly decreased pain and disability in the deep flexor muscle training group and progressive resistive exercise group, with no differences between groups. Borisut et al.[4] revealed that pain and disability improved more in the strength-endurance, craniocervical flexion, and a combination of strength-endurance and craniocervical flexion exercise groups than in the control group, with no differences in disability among the three exercise groups. Chung and Jeong[20] explained that both neck isometric exercises and craniocervical flexion exercises achieved improvements in pain, NDI, and active range of motion in all three planes after 8 weeks. However, findings showed the superiority of craniocervical flexion exercises in the active range of motion and pain.

Griffiths et al.[21] studied craniocervical flexion exercises in addition to general neck exercises and found improvement in disability and pain outcomes without significant differences between groups. Gupta et al.[22] made a comparison between deep neck cervical exercises and conventional exercises that include only isometric movements in dentists with chronic neck pain at the end of treatment without follow-up. They observed that deep cervical training was more effective than cervical isometric training in improving pain and disability outcomes, though pain and disability were reduced in both groups. Abdel-aziem and Draz[23] compared the effects of deep neck flexor exercises with isometric, stretching, and scapulothoracic exercises, which were combined with physical therapy agents. They reported VAS and disability significantly lower in the deep neck flexor exercise group. Dusunceli et al.[11] designed a study investigating stabilization exercises in combination with physical therapy agents. They found a significant improvement in pain, disability, and depression in both the physical therapy agent combined with conventional exercise and stabilization exercise groups. They also reported on the advantages of combined stabilization exercises in depression, disability, and frontal plane range of motion outcomes at all visits. Unlike the studies of Abdel-aziem and Draz[23] and Dusunceli et al.,[11] we found no significant difference in disability between groups in favor of stabilization exercises. Baseline disability was higher in the conventional exercise group so this may have affected the results.

Few studies investigated the effects of exercises targeting weakened deep neck muscles on depression. In addition to the aforementioned studies of Dusunceli et al.[11] and ours, Yesil et al.[24] reported that performing neck stabilization exercises alone or in combination with electrotherapies resulted in a significant improvement in BDI scores. However, they did not investigate the effect of conventional exercises in their studies. Kaka et al.[25] observed significant improvement in depression levels in all three intervention groups (stabilization exercise, dynamic exercise, stabilization plus dynamic exercise). It should be noted that although both studies aimed to strengthen the deep cervical flexors, the design of the stabilization exercises in Kaka et al.'s[25] study differed from our study.

In our study, we found that BMI was higher in the conventional exercise group despite randomization. Rasmussen-Barr et al.[26] reported no relation between BMI and recovery from persistent neck pain. Wertli et al.[27] discovered that obesity had no association with neck pain patients' baseline disability or estimated disability at the end of treatment. In contrast to this data, an approximately 20% increased risk of chronic neck and shoulder pain was identified in obese individuals.[28] Although there is contradictory information on associations between BMI and neck disorders, a statistically significantly higher BMI in the conventional exercise group may have influenced the results of this study.

No other studies were found in a similar design exercise protocol without a combined treatment approach comparing conventional neck exercises with stabilization exercises, making this investigation essential. Longer-term studies are required to further demonstrate the difference between the two approaches. In our study, although the results were obtained quite effectively by using two-way ANOVA, in which model within-subject and between-subject effects were analyzed together, the lack of a priori power analysis on this model and the relatively small sample size of this study are two limitations of the study. One other limitation is that other conditions that may be associated with depression were not considered, although the patients did not have scores indicating severe depression in the evaluation of the depression

scores obtained from the BDI. In the neck stabilization exercise group, patients were taught to activate only the deep flexor muscles without the involvement of the superficial flexor muscles. The lack of biofeedback devices that can assist patients in the activation of deep flexor muscles may have reduced the effectiveness of stabilization exercises. Biofeedback devices may not always be accessible and usable for daily exercises.

In conclusion, both conventional and stabilization exercise programs are effective in reducing chronic neck pain. Stabilization exercise programs show efficacy through maintaining segmental stabilization, postural control, and a balance between the superficial and deep muscles of the neck region. Stabilization exercise programs thus contribute to reduced pain in daily activities and improvement of function similar to conventional exercise programs.

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Ethics Committee Approval: The study protocol was approved by the Dokuz Eylül University Non-Interventional Clinical Research Ethics Committee (Date: 10.07.2014, No: 2014/24-08). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Conceptualization: H.A., Ö.Ş.; designing: H.A., Ö.Ş., P.K.; supervision: H.A., S.M.D., Ö.Ş., P.K.; statistical analysis: P.K.; interpretation of data: P.K., Ö.Ş., H.A.; randomization: Ö.Ş.; exercise guidance: H.A.; acquisition of data: S.M.D.; searching literature: H.A., Ö.Ş.; writing of the manuscript: P.K., Ö.Ş., H.A.; criticial review P.K., Ö.Ş., H.A., S.M.D.

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