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ORIGINAL ARTICLE

Do oculomotor exercises added to classical physiotherapy contribute to pain intensity, range of motion, activation of deep flexor muscle, and function in participants with chronic neck pain?

Kronik boyun ağrılı bireylerde klasik fizyoterapiye eklenen okulomotor egzersizler ağrı şiddeti, eklem hareketi, derin fleksör kas aktivasyonu ve fonksiyonellik üzerine ilave katkı sağlar mı?

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Abstract

Purpose: This study was carried out to compare the effects of oculomotor exercises (OE) combined with a classical physiotherapy (CF) program on pain intensity, range of motion (ROM), activation of deep cervical flexor (DCF) muscles and function in patients with chronic neck pain.
Methods: A total of 48 patients were equally randomized into two groups to receive CF+OE or CF. The protocol was applied for three days in a week for a total of 8 weeks with complete 24 sessions. Numeric Pain Scale used for neck pain intensity, an inclinometer for cervical ROM, biofeedback pressure unit for activation of DCF and Neck Disability Index for evaluating function.
Results: Both groups experienced a significant decrease in neck pain intensity ($p<0.001$) with similarity ($p>0.05$). A significant increase was observed in ROM values in all directions in both groups ($p<0.05$), difference between the groups was found in favor of CF+OE group ($p<0.05$). A significant increase was observed in the activation of DCF muscles and function ($p<0.001$) in both groups. The activation of the DCF ($p<0.001$) and function ($p=0.020$) in CF+OE group was identified to be higher than the CF. OE and CF were found to be effective in the improvement of clinical symptoms in patients with chronic neck pain.
Conclusion: OE added to CF can be chosen for patients with limitation in rotational direction hence it increases activation of DCF due to its proprioceptive training content, and produces more effective results on function.
Keywords: Neck pain, Exercise, Range of motion.

Öz

Amaç: *Bu çalışma, kronik boyun ağrısı (KBA) olan bireylerde klasik fizyoterapi (KF) programı ile okülomotor egzersizlerin (OE) ağrı şiddeti, eklem hareket açıklığı (EHA), derin servikal fleksör (DSF) kaslarının aktivasyonu ve fonksiyon üzerine etkilerini karşılaştırmak amacıyla gerçekleştirildi.*
Yöntem: *48 KBA'lı birey KF ve KF+OE olmak üzere iki gruba randomize edildi. Bireylere, 8 hafta boyunca haftada üç gün, 24 seans uygulandı. Numerik Ağrı Skalası ile boyun ağrısı şiddeti, inklinometre ile servikal EHA, biyofeedback basınç ünitesi ile DSF kasların aktivasyonu ve Boyun Özürlülük İndeksi ile fonksiyon değerlendirildi.*
Bulgular: *Her iki grupta da boyun ağrısı şiddetinde anlamlı azalma elde edildi ($p<0,05$). Bu azalma gruplar arasında benzerdi ($p>0,05$). Her iki grupta tüm EHA yönlerinde anlamlı artış görüldü ($p<0,05$). Gruplar arası fark KF+OE grubu lehine bulundu ($p<0,05$). Her iki grupta da DSF kasların aktivasyonunda ve fonksiyonellikte anlamlı artış gözlendi ($p<0,001$). KF+OE grubunda DSF aktivasyonu ($p<0,001$) ve fonksiyonellik ($p<0,020$) KF'ye göre daha yüksek olduğu görüldü. KBA'lı bireylerde klinik semptomların iyileşmesinde OE ve KF'nin etkili olduğu bulundu.*
Sonuç: *Klasik fizyoterapiye eklenen OE'nin rotasyonel yöndeki hareket kısıtlılıkları belirgin olan hastalarda tercih edilebileceği, proprioseptif eğitim içerikli olması nedeniyle derindeki kasların aktivasyonunu arttırabileceği kronik boyun ağrılı hastalarda fonksiyonellik üzerinde daha etkin sonuçlar oluşturduğu sonucuna varıldı.*
Anahtar kelimeler: *Boyun ağrısı, Egzersiz, Eklem hareket açıklığı.*

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INTRODUCTION

Neck pain is a common musculoskeletal problem in the community, with significant effects on all age groups, including children.[1] The incidence shows an upward trend with increasing age and is more common in women over 50.[2]

The cervical region is an important segment of the spine due to the abundant sensory receptors in the muscles and joints and its central and reflex connections with the visual, vestibular and postural control systems. Proprioceptive sensation of the cervical region is important in head and neck control and coordinated eye movements. Patients with chronic neck pain have impaired postural control, proprioceptive sensation, cervical postural control and eye movements.[3] Atrophy and fatty infiltration, especially in the deep suboccipital muscles, are among the factors that cause a decrease in proprioceptive sensation.[4,5]

Exercise practices majorly influence the treatment of chronic neck pain. The literature reflects that the use of combined exercise approaches consisting of stretching, relaxation, strengthening, posture, range of motion exercises is effective.[6] Although there are studies comparing the effectiveness of oculomotor exercises in participants with chronic neck pain with different control groups, there is no study that compares the effects of oculomotor exercises with classical physiotherapy while showing the dosage and intensities of the exercises.[7,8] Since oculomotor exercises were not composed of 4-content exercise models (saccadic eye movements, gaze stability, head-eye coordination, head repositioning), they were compared with different exercise approaches and the parameters evaluated differed homogeneity was not achieved in the results obtained. However, it is detected that a progressive and dynamic program was not followed in the studies examining the effects of the oculomotor exercise program. Oculomotor exercises were designed based on of the protocol determined by Revel, Andre and Minguet.[3]

Our study revises this protocol, and a dynamic and progressive exercise program combined with a classical physiotherapy program was designed accordingly. Consequently, we think that our study is an original respectively. This study aims to investigate the effects of oculomotor exercises added to the classical physiotherapy program on pain intensity, range of motion, activation of deep cervical flexor muscles and function in participants with chronic neck pain, to evaluate the superiority of the treatment groups over each other, and to provide literature input regarding dosage and intensity.

METHODS

This study was conducted between July 2021 and March 2022. The ethical suitability of the study was approved by the Ethics Committee of the Institute of Postgraduate Education and Research of Cyprus International University with the decision dated 28.07.2021 and numbered 020-736 and the study was carried out by following the principles of the Declaration of Helsinki.

Study design

The study was designed as a prospective, randomized, controlled, single-blind (statistician) clinical trial. Blinding was done to the statistician. Groups were specified as 1 and 2 in the database sent for analysis. It was aimed for the biostatistician to provide unbiased conclusions and comments on the subject.

Participants

Participants who met the inclusion criteria and were consulted by Orthopedic physicians from public and private hospitals were covered in the study. Participants joined the study on a voluntary basis where they were informed verbally and in writing about the aim of the study, treatments to be applied, possible side effects and possible problems, and an informed consent form was signed. The study was carried out in a private Physiotherapy and Rehabilitation center in Nicosia. Participants with ages between 30 and 55, those have a neck pain for at least 3 months, being sedentary (not doing more than 30 minutes of physical activity per day, 3 days a week), having neck pain at rest according to the Numeric Pain Scale intensity of 4 cm or more were included. Participants who having received any physiotherapy program for neck or back pain in the last 6 months, congenital anomalies in the cervical region (such as Klippel-Feil syndrome), structural scoliosis at any level of the vertebral column, neurological deficits, vertebrobasilar artery insufficiency,

having any vestibular problem, diplopia and oculomotor muscle deficiency, cervical costa, history of fracture of cervical vertebrae, color-blind, whiplash injury, having a rheumatic disease, spine surgery from any region, taking any pain medication other than simple analgesics were excluded.

Sampling and estimation of sample size

The power of the study was calculated with the G*power 3.1.9.4 package program. The Independent Student T-test was used to compare the flexion range of motion change (before- after difference value) according to the effect of 2 different physiotherapy program with a power of 0.80, an acceptable type I error of 0.05 and 0.85 effect size (d). Accordingly, it was found appropriate to include 24 people in each group.[9] After the preliminary evaluation, the participants who met the inclusion criteria were divided into Classical Physiotherapy + Oculomotor Exercises (CF+OE) and Classical Physiotherapy (CF) groups by stratified randomization method as per their gender and age. The groups were matched by stratified randomization method based on gender (male/female) and age (below and above 40). An external researcher developed the stratified randomization through Random Software Allocation software. Accordingly, it was concluded that a total of 48 participants, 6 in each group, should be recruited.[10]

Outcome measures

The outcome measures were the Numeric Pain Scale for neck pain intensity, inclinometer for cervical range of motion, biofeedback pressure unit for activation of deep flexor muscles and Neck Disability Index for function. All outcome measures were assessed at baseline (pre-treatment) and at 8 weeks (post-treatment).

Pain intensity

Neck pain intensity at rest and during activity was assessed using the Numeric Pain Scale. "0" indicates no pain while "10" indicates severe pain. During the assessment, the participants were asked to mark the numerical equivalent of the neck pain intensity they felt using the numbers between 0 and 10 on the scale.[11]

Cervical joint range of motion

Active flexion, extension, right-left lateral flexion and right-left rotation range of motion of the cervical region were evaluated with Baseline Bubble Inclinometer. Cervical flexion, extension, and right-left lateral flexion were measured in the sitting position, while right-left rotation range of motion (ROM) was assessed in the supine position. Two inclinometers were used simultaneously for cervical flexion, extension, and right-left lateral flexion measurements to eliminate thoracic region movements and one inclinometer was used for cervical rotation. Measurements were made 3 times in each direction and the best value was used for analysis. For the measurement of cervical flexion ROM, one of the inclinometers was placed at the center point of the participant's head and the other at the spinous process of the T1 vertebra. Both inclinometers were positioned parallel to the sagittal plane. After making sure that the inclinometers pointed to zero, the participants were instructed to "move your chin towards your chest". At the end of the movement, the angular value read on the inclinometer positioned on the head was subtracted from the angular value read on the inclinometer placed on the T1 spinous process and the degree of cervical flexion was recorded. For cervical extension, one of the inclinometers was placed on the center point of the head of the participant and the other on the spina scapula. Both inclinometers were positioned parallel to the sagittal plane. After making sure that the inclinometers showed zero, the participants were commanded to "take your head backwards". At the end of the movement, the angular value indicated by the inclinometer positioned on the head was subtracted from the angular value read on the inclinometer placed on the spina scapula and the degree of cervical extension was recorded. In order to assess the cervical lateral flexion ROM, one of the inclinometers was placed at the center point of the head of the participant and the other at the spinous process of the T1 vertebra. Both inclinometers were positioned parallel to the frontal plane. Guaranteeing that the inclinometers pointed to zero, the participants were instructed to "bring your ear closer to your shoulder without turning your head to the right or left".

At the end of the movement, the degree of cervical lateral flexion was recorded by subtracting the value of the inclinometer placed on the spinous process of the T1 vertebra from the angular value shown by the inclinometer

positioned above the head. The test was performed bilaterally. A single inclinometer was used during the test due to the stability of the trunk from the bed during the cervical rotation evaluation. The inclinometer was placed on the forehead of the participant parallel to the transverse plane while the participants were lying in the supine position. As the inclinometer showed zero, the participants were commanded to "turn your head". The test was performed bilaterally.[12,13] The normal ROM values specified by Bergmann and Peterson were taken into consideration for cervical ROM measurements. These values are 60-90° for flexion, 75-90° for extension, 80-90° for rotation and 45-55° for lateral flexion.[14] Measuring the cervical flexion, extension, lateral flexion, and rotation with inclinometer were found to be reliable with ICCs ranging from 0.89 to 0.94.[15]

Activation of deep cervical flexor muscles

The Craniocervical Flexion Test (CCFT) was developed by Jull, O'Leary and Falla, and is used to assess muscular activation of the deep flexor muscles of the cervical region. The test was performed with a biofeedback pressure unit *(Chattanooga Medical Suplly Inc, Chattanooga, TN.)* The craniocervical flexion test is performed in 5 pressure increments of 2 mmHg (22 mmHg, 24 mmHg, 26 mmHg, 28 mmHg and 30 mmHg) from a pressure of 20 mmHg to 30 mmHg. The pressure unit provides feedback to the person in five progressive stages of the CCFT.[16] The subjects were asked to lie in the supine position with the cervical region in the neutral position and the hands next to the trunk. An inflatable pressure cuff was placed in the suboccipital space during the test. The inflatable pressure cuff was inflated to 20 mmHg to support the cervical lordosis and fill the space between the neck and the test surface. Participants were asked to press their chin towards their neck as if saying "yes" without lifting their head upwards. Activation of the deep cervical flexor muscles causes a pressure change in the manometer. For the individuals to follow this pressure change, the test was applied by showing the manometer to the individuals. Participants were asked to maintain each pressure level for 10 seconds with 10 repetitions. The test of participants who could maintain 10 contractions for 10 seconds was continued, while the test of participants who could not continue was terminated. A rest period of 10 seconds was given between repetitions. Activation score, the maximum pressure level sustained 10 repetitions for 10 seconds, reflects the activation of deep flexor muscles. Prior to the initiation to the test, a sufficient number of trials were performed for all participants to comprehend the test thoroughly.[17] The practitioners demonstrated 'good' inter-rater reliability (ICC for AS 0.57, ICC for PI 0.54) and 'excellent' intra-rater reliability (ICC for AS and PI 0.78) when using the CCFT.[18]

Function

The Turkish version of the Neck Disability Index was found to be reliable and valid method to evaluate where neck pain affects the ability of the participants' study participation their daily activity performances. The test-retest reliability score was found to be ICC: 0.979.[19] The index consists of 10 questions which each of them having scores from 0 (no pain and functional limitation) to 5 (worst pain and maximum limitation). Patients were asked to tick the most appropriate answer for each question. The scores were summed between 0 and 50. Based on the total score, functional limitation classification was defined as 0-4: no limitation, 5-14: mild limitation, 15-24: moderate limitation, 25-34: severe limitation, 35 points and above completely limited.[20]

Interventions

The participants were divided into 2 groups. They were randomly assigned to CF+OE and CF groups and treatment was started following pre-treatment evaluations. Participants in the CF+OE group were treated 3 days a week for 8 weeks. Participants in the CF group received 12 sessions of treatment in the clinic 3 days a week for 4 weeks. After the week 4, participants were called once a week for exercise follow- up and exercise programs were improved accordingly.

Participants were asked to do their exercises regularly for 3 days a week and follow-ups were conducted by telephone. The same physiotherapist performed all of the treatments on the participants.

Classical physiotherapy program

Both groups had classical physiotherapy program covering TENS, hotpack and classical massage with stretching and posture exercises. Conventional TENS (Chattanooga-Intelect® TENS) was used to apply analgesic current. TENS was applied to the cervical paravertebral region using four 5 x 5 cm adhesive surface

electrodes at a frequency of 80 Hz with a 100 μsec transition time for 20 minutes. The current intensity was adjusted so that the patient would feel tingling without discomfort.[21] All participants were asked to lie in a prone position with arms next to the trunk. A treatment bed that would allow the patient to breathe comfortably and maintain the neutral position of the neck was preferred. Hot pack (standard size 74.5-80°C stored in a hydrocollator tank for 30 minutes) was wrapped with 6-8 layers of towel to prevent the risk of burns and applied for 20 minutes to the cervical and upper back.[22] While the patient was lying in the prone position, classical massage was applied to the upper back and neck area for 20 minutes using the Swedish technique.[23]

Stretching/posture exercises: Such exercises were used as a warm-up cool-down program for 5-10 minutes in the beginning and at end of the treatment for cervical flexor, lateral flexor, pectoral muscles and inferior shoulder joint capsule. Posture exercises were also performed together with stretching exercises. Exercises were progressed in 3 stages. While stretching times were increased in stretching exercises, progression was achieved by increasing the number of repetitions of exercises in posture exercises.

Progression of stretching and posture Exercises: The applications within the scope of classical physiotherapy were performed 3 days a week in both groups. These applications were applied for 8 weeks to the participants in the oculomotor exercise group, while these applications were applied for 4 weeks to the participants in the group that received only classical physiotherapy. For the remaining 4 weeks, the participants in the classical physiotherapy group were instructed to continue stretching and posture exercises at home. For the follow-up of the exercise program, the participants were called to the clinic once a week by the physiotherapist. Participants in the classical physiotherapy group who continued the exercises at home were given an exercise brochure containing images of the exercises.

Classical Physiotherapy + Oculomotor Exercise Group: In addition to the classical physiotherapy program by Revel, Andre and Minguet, and Morimoto, Asai and Johnson et al.[3,24] a special oculomotor exercise program, which was developed with reference to the oculomotor exercise training developed by the University of California, Berkeley was applied for this study. The oculomotor exercises consist of 4 basic contents including saccadic eye movements, gaze stabilization, head/eye coordination and head repositioning exercises.

Saccadic eye movements comprise the movement of the eyes in the horizontal and vertical planes while the head is fixed. Within the scope of our study, 4 saccadic eye movements were performed where in the first one, vertical movement of the eyes was asked while the head was fixed. In the second one, horizontal movement of the eyes was asked while the head was fixed while the participants were asked to ensure vertical movement of the eyes between two target points held in the vertical plane in the third exercise, and in the fourth exercise, horizontal movement of the eyes was asked between two target points positioned in the horizontal plane while the head was fixed. As the second element of the oculomotor exercises, gaze stabilization exercises cover 2 different exercises including moving the head vertically and horizontally while keeping the eyes at a fixed point. Firstly, the participant was asked to move the head vertically (in the direction of flexion and extension) while the target point was fixed. Secondly, the subject was asked to move the head horizontally (in the direction of right-left rotation) with the target point fixed. These exercises were performed with eyes closed in the following stages. The third component of the oculomotor exercises, head-eye coordination exercises, involve following the target with the eyes. In the first stage of this exercise, person is asked to follow the moving object with the eyes and head. The first stage is performed in the vertical plane whereas second in the horizontal plane. The participant was asked to follow the moving target with his/her eyes. In the third stage, a board was prepared for the head and eye coordination to follow the laser target. The participant was asked to follow the lines on the board with the laser placed on the head without touching the lines with laser point.

In the head repositioning exercise, the participant was asked to find the previous position again where a game board was prepared, and a laser pointer was placed on the participant's head at the center "0 point". Then, the participant was instructed to follow

the specified color with the laser with open eyes, and after 5 seconds, the participant was instructed to find the center point and the specified color with closed eyes. The content of the oculomotor exercise program was performed through different positions. Saccadic eye movements and gaze stabilization exercises were followed in supine lying, supported sitting, unsupported sitting, and sitting on soft floor, while head-eye coordination and head repositioning exercises in 4 stages. Individual-specific factors were also taken into consideration during progression follow-up.

Saccadic eye movements, gaze stabilization and head-eye coordination exercises were performed with 10 repetitions. The participant was asked to find a different angle (color) in the head repositioning exercise. Prior to the exercise, the participant was informed and the desired movement was demonstrated by the physiotherapist. The exercises were terminated in case of any complaints such as nausea and dizziness developed during the exercises.

Statistical analysis

Statistical Package for Social Sciences 24 for Windows (SPSS Inc., Chicago, IL, USA) software was used. Frequency tables were used for general information of participants and shown as number of people (N) and percentage (%). The values of quantitative variables by groups were mean (X) and standard deviation (SD) values. Kolmogorov-Smirnov and Shapiro-Wilks tests were applied to the data set to determine the statistical analysis method to be used in the evaluation of the hypotheses for the comparison of the quantitative variables examined in the study according to the groups, and the normality of the data and the homogeneity of the variances were investigated by Levene's Test. Independent Student t Test and Mann-Whitney U Test were used for parametric assumption and non-parametric assumption analyses respectively. Wilcoxon Test was applied to compare the values between the groups before and after treatment. Analysis of categorized variables was done with Fisher exact test. The results were considered statistically significant for $p<0.05$ in the analysis.

RESULTS

Sociodemographic characteristics of the participants are given in Table 1. No difference was found between the groups in terms of the relevant variables ($p>0.05$) given under Table 1.

Pain intensity during rest and activity were similar between the groups before treatment ($p>0.05$). After the treatment, there was a difference in the intensity of pain during activity ($p<0.05$) as shown in Table 2.

The flexion, right and left lateral flexion and rotation range of motion values of the groups were different before the treatment ($p<0.05$). After the treatment, there was a difference between the groups in terms of right and left lateral flexion and left rotation range of motion values ($p<0.05$). Pursuant to Table 2, a significant increase was observed in range of motion values in all directions after treatment in both groups ($p<0.05$).

In both groups, a significant increase in the activation of deep cervical flexor muscles and function was observed after treatment ($p<0.05$). A significant difference was obtained in the activation score between the groups. Accordingly, after 8 weeks of treatment, activation of deep cervical flexor muscles of the patients in the CF+OE group was higher than the patients in the CF group as shown in Table 3.

The difference was generated by subtracting the post-treatment value from the pretreatment value. With regard to the analyses, a significant decrease was obtained in the pain intensity of the two groups at rest and during activity ($p<0.05$). The reduction was similar between the groups ($p>0.05$) as reflected in Table 4.

Where the groups were compared, flexion, right and left rotation range of motion values were found to be statistically different between CF+OE and CF group ($p<0.05$). According to Table 4, flexion, right and left rotation range of motion values showed a significant increase in favor of CF+OE group compared to CF group.

There was a difference between the groups in terms of activation score before and after treatment ($p<0.05$), however after treatment Neck Disability Index results, which were given under Table 4, were similar ($p>0.05$).

The change in the score of the Neck Disability Index was found to be different between the groups ($p<0.05$). Therefore, the function of the patients in the CF+OE group increased more than the patients in the CF group as concluded in Table 4.

DISCUSSION

This study aimed to investigate the effects of oculomotor exercises applied in combination with a classical physiotherapy program on pain intensity, range of motion, activation of deep cervical flexor muscles and function in participants with chronic neck pain, evaluate the superiority of the treatment groups over each other, and provide information to the literature about the dosage and intensity of the exercises.

Prior to the study, a stratified randomization was performed to ensure a homogeneous distribution between the groups and to prevent differences in demographic characteristics from affecting the study results. Equal numbers of men and women and participants with similar mean ages were included in the groups. At the end of the study, a significant reduction in the intensity of neck pain at rest and in activity was obtained in both groups, and this reduction was similar in both groups. When the results were examined in terms of range of motion, a significant increase was observed in the range of motion values in all directions after treatment in both groups. The difference between the groups was found in favor of the oculomotor exercise group. In both groups, a significant increase was observed in the strength of the deep cervical flexor muscles of the participants after treatment. After 8 weeks of treatment, the activation of the deep cervical flexor muscles of the participants in the CF+OE group was found to be higher than the participants in the CF group. An increase was obtained in the function of both groups evaluated by the Neck Disability Index. After the treatment, it was determined that the function of the participants in the CF+OE group increased more than the participants in the CF group.

Studies have shown the effects of various types of exercise approaches such as strengthening, stretching, endurance and motor control exercises in the treatment of chronic neck pain.[25,26] However, in recent years, it has been recommended to create more progressive exercise programs that include stabilization and proprioceptive exercises for the muscles around the neck and scapula. To the best of our knowledge, there are limited studies on this subject in the literature.

Revel, Andre and Minguet that we used for the foundation of our study exercise protocol, compared the oculomotor exercise program with conservative treatment and reported that oculomotor exercises were more effective in reducing pain intensity.[3] In our study, it was observed that oculomotor exercises and approaches applied within the scope of classical physiotherapy had similar effects on pain intensity.

Pain intensity decreased in both groups due to oculomotor exercises decreasing superficial muscle tension through changes in suboccipital muscle spindle activity, stretching exercises included in classical exercises decreasing increased muscle tension and balancing the strength inequality by increasing muscle strength. At the same time, conventional TENS, hot pack and classical massage were applied to both groups as part of the classical physiotherapy program. This result provides further evidence that classical physiotherapy and an oculomotor exercise approach in addition to classical physiotherapy can lead to improvement of clinical symptoms in patients with cervical pain in the treatment of chronic neck pain. It is considered that the key point is to establish correct posture awareness through regular performance and follow-up of exercises that promote correct posture for the cervical region.

In participants with chronic neck pain, an increased muscle tone in muscles such as the upper trapezius, levator scapula and semispinalis and associated muscle pain may limit cervical ROM in all directions (flexion, extension, lateral flexion and rotation).[27] Reduced range of motion is a common problem in people with neck pain. In consideration of our study, the normal ROM measurement values of the cervical region were taken into consideration the values determined by Peterson and Bergmann.[14] Hence, it was observed that participants in both groups had limitation in active joint movements in all directions before the treatment. In the post-treatment evaluation, while the mean values of intra-group ROM increased significantly in both groups the highest increase was observed in the oculomotor exercise group. In particular, the increase in rotation movements was greater in the oculomotor exercise group compared to the

Table 1. Comparison of sociodemographic and clinical characteristics of the participants.

	CF+OE	CF	
	X±SD	X±SD	p
Age (years)	42.9±7.2	43.8±8.3	0.71
Height length (cm)	1.7±0.1	1.7±0.1	0.66
Body weight (kg)	77.7±14.9	72.9±14.1	0.27
Body mass index (kg/m)^2	27.0±4.4	25.5±3.1	0.35
	n (%)	n (%)	
Gender (Female/Male)	12/12 (50/50)	12/12 (50/50)	1.00
Profession			
Officer	10 (42)	12 (50)	
Self Employed	10 (42)	11 (46)	0.36
Teacher	4 (16)	1 (4)	
	X±SD	X±SD	
Total working time (years)	18.2±9.0	20.9±9.2	0.33
Duration of neck pain (months)	102.3±105.7	113.1±89.4	0.48

CF+OE: Classical physiotherapy + Oculomotor exercises. CF: Classical physiotherapy.

Table 2. Comparisons of neck pain intensity and range of motion values before and after treatment.

		CF+OE	CF	
		X±SD	X±SD	p
Pain intensity (cm)				
Before treatment	At rest	5.8±1.4	5.6±1.5	0.61
	In activity	6.7±2.3	7.1±1.8	0.55
After treatment	At rest	1.1±1.2	1.4±1.2	0.35
	In activity	1.2±1.4	2.2±1.5	0.02*
Range of motion (°)				
Before treatment	Flexion	37.8±9.8	44.5±9.5	0.03*
	Extension	57.5±14.2	58.6±8.9	0.88
	Lateral flexion - right	33.9±8.6	39.1±7.3	0.03*
	Lateral flexion - left	37.0±5.6	42.3±8.3	0.01*
	Rotation- right	65.1±17.8	78.2±8.7	0.01*
	Rotation - left	69.3±15.1	78.2±11.6	0.03*
After treatment	Flexion	50.9±8.3	50.8±7.7	0.97
	Extension	64.4±9.0	68.7±4.6	0.06
	Lateral flexion - right	46.0±4.3	48.6±4.8	0.02*
	Lateral flexion - left	45.8±4.1	50.6±4.6	0.04*
	Rotation- right	81.5±10.9	87.1±4.7	0.09
	Rotation - left	82.2±9.1	87.9±3.7	0.02*

* p<0.05. CF+OE: Classical physiotherapy + Oculomotor exercises. CF: Classical physiotherapy.

Table 3. Intergroup comparison of activation score and neck disability index scores before and after treatment.

	CF+OE	CF	
	X±SD	X±SD	p
Activation score (mmHg)			
Before treatment	2.7±1.3	3.7±1.4	0.02*
After treatment	6.4±1.7	4.8±1.3	0.04*
Neck Disability Index (score)			
Before treatment	15.0±7.0	12.8±4.4	0.18
After treatment	2.7±2.6	4.2±2.9	0.05

* p<0.05. CF+OE: Classical physiotherapy + Oculomotor exercises. CF: Classical physiotherapy.

Table 4. Comparison of pain intensity, cervical range of motion, activation score, and neck disability index scores differences before and after treatment.

	CF+OE		CF		
	X±SD		X±SD		
Pain intensity (cm)					
At Rest	-4.6±1.8	a	-4.2±1.3	a	0.11
In Activity	-5.5±2.0	a	-4.9±2.0	a	0.38
Range of motion (°)					
Flexion	13.1±10.0	a	6.3±5.9	a	0.01*
Extension	7.0±8.4	a	10.1±8.0	a	0.20
Lateral flexion - right	12.0±7.0	a	9.5±6.2	a	0.17
Lateral flexion - left	8.9±6.0	a	8.3±7.1	a	0.48
Rotation- right	16.5±11.2	a	8.9±8.9	a	0.01*
Rotation - left	12.8±7.8	a	9.7±11.2	a	0.04*
Activation score (mmHg)	3.8±1.5	a	1.1±1.0	a	0.01*
Neck Disability Index (score)	-12.3±6.3	a	-8.6±4.0	a	0.02*

* p<0.05. a: p<0.05, before and after treatment. CF+OE: Classical physiotherapy + Oculomotor exercises. CF: Classical physiotherapy.

classical physiotherapy group only. We think that this may be due to the fact that oculomotor exercises are performed more in the horizontal plane. This result is consistent with the results of Revel, Andre and Minguet.[3]

Passive applications such as TENS, hot pack, classical massage applied to both groups provided a relaxation effect on the muscles, which resulted in a decrease in pain intensity and reduced movement limitations by facilitating joint movement. In addition to passive applications, the effect mechanisms of exercise on pain are known. Exercises reduce muscle spasm by elongating tense muscles and improve postural control. As a result, an increase in ROM occurs. In a study comparing the effects of standard procedure and stretching exercises in addition to standard procedures on range of motion in participants with non-specific mechanical neck pain, 8 weeks of treatment was applied, active cervical range of motion exercises and passive cervical mobilization were applied to the standard procedure group, while the other group was given stretching exercises to the anterior, middle and posterior scalene muscles, upper trapezius, pectoralis minor and interspinous muscles. Pursuant to study outputs, it is shown that adding stretching to

standard procedures may be more effective than the standard procedure alone in improving cervical extension, right rotation and lateral flexion active range of motion.

In 2020, 44 participants were included in a randomized clinical trial comparing the effectiveness of head-eye proprioception exercises with multimodal physiotherapy approaches in patients with chronic neck pain. Both groups in the study received multimodal physiotherapy (TENS, classical massage and warm application) and the other group received head-eye proprioception exercises in addition. At the end of the study, the increase in joint space was found to be statistically significant in favor of the head-eye proprioception exercise group for all evaluated directions. Cervical proprioceptive exercises have been shown to provide a good coordination between cervical superficial and deep muscle activity and to improve the pain threshold in the upper trapezius, levator scapula and splenius capitis as effective mechanisms to increase cervical range of motion.[28]

According to the study data and the results of clinical efficacy, the positive effects of both groups on the range of motion after the treatment show that classical methods and oculomotor exercises with classical methods can be preferred in participants with chronic neck pain in the clinic. However, the improvement in rotational joint movements was found to be higher in the oculomotor exercise group compared to the other groups. This result can be explained by the fact that the oculomotor exercise protocol includes more rotational movements of the head and eyes than the other exercise groups. As a clinical reflection of this result, the oculomotor exercises that we have developed may be preferred if the rotational limitations occur.

It is known that the deep cervical flexor muscles play an important role in the support of cervical lordosis. M. longus colli, which belongs to the deep cervical flexor muscle group, is the most important muscle involved in segmental stabilization due to its dense proprioceptors and its close relationship with the cervical vertebrae.[29] There are studies showing that deep cervical flexor muscle activation is decreased in participants with neck pain.[14,30] Therefore, functional restoration of the deep cervical flexors is clinically important in the treatment of neck pain.[31]

In studies comparing asymptomatic participants aged 18-68 years with participants with neck pain due to different causes, the mean activation score of asymptomatic participants was 7.6±2.1.[15] The pre-treatment activation score values of the participants included in our study were below the averages reported in asymptomatic participants.

At the end of 8-week exercise training, a significant increase in activation score was obtained in both groups, and this increase was in favor of the oculomotor exercise group. During oculomotor exercises, deep muscles are activated respectively. However, stretching and strengthening exercises applied within the scope of classical physiotherapy are not based on stabilization. Therefore, oculomotor exercises added to classical physiotherapy had a greater effect and led to a greater improvement in deep cervical flexor muscle strength. We think that the addition of oculomotor exercises to the rehabilitation program will be useful in creating more effective and permanent effects for postural alignment in patients with chronic neck pain.

The relationship between neck pain and functional disability has been shown by studies.[32] In our study, significant improvements in cervical function were found in both groups after treatment. When oculomotor exercises were compared with the classical physiotherapy group, it was observed that more improvement was obtained in the oculomotor exercise group.

In a study comparing cervical proprioception exercises with craniocervical flexion exercises, it was concluded that both groups had similar effects in reducing the loss of function related to the cervical region.[32] In a study comparing cervical proprioception exercises with medical treatment, it was reported that the cervical proprioception group had a greater effect on functional improvement.[7] Again, in a study examining the effect of cervical proprioception exercises on functional disability, it was randomized that eye-head-neck coordination exercises may help to reduce functional disability in participants with chronic neck pain.[8] A study conducted in 2018 with 64 participants with chronic neck pain. TENS current was applied to these participants with ultrasound and significant improvements were

obtained in Neck Disability Index scores. They reported that the classical physiotherapy approaches applied reduced functional disability.[33] These results support the effects of only the classical physiotherapy group on function.

In studies conducted in participants with cervical disorders, loss of strength and decreased endurance in deep cervical flexors have been reported as the cause of neck pain.[30] It has been reported that the decrease in muscle tension caused by neck pain is an important factor to improve postural control. This may lead to normalization of proprioceptive information in the muscles in the cervical region and may reduce sensory incompatibility, but further studies on this subject are needed. Our study was designed to support these recommendations.

Effective results can be obtained in patients with chronic neck pain with oculomotor exercises and classical physiotherapy program, which is applied 3 days a week for a total of 8 weeks and whose exercise intensity progresses progressively.

With oculomotor exercises, more improvement was obtained in the ability of patients to perform daily tasks related to neck pain. This functional improvement may be due to the fact that neck and eye movements included in oculomotor exercises are used more in daily life. Moreover, a greater increase in neck joint movements in the oculomotor exercise group supports this view.

Limitations

This study does not evaluate the mid- and long-term follow-up results of two different treatment program. Mid- and long-term results may provide clinicians and researchers with a higher level of outcome about the duration of treatment efficacy.

Conclusion

Within the perspective of this study, oculomotor exercises and classical physiotherapy alone were found to be effective in improving clinical symptoms in patients with cervical pain. positive effects on range of motion were obtained after treatment in both treatment groups. It was concluded that oculomotor exercises can be preferred in patients with significant movement limitations in the rotational direction due to the additional contributions provided by oculomotor exercises, since they include head and eye rotational movements, and oculomotor exercises with proprioceptive training content that increase the activation of deep muscles should be included in the treatment plan of participants with chronic neck pain. Since neck and eye movements are frequently used in daily life activities and oculomotor exercises are based on this content, we believe that it would be useful to use them to obtain more effective results on function in patients with chronic neck pain.

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