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REVIEW ARTICLE
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EFFECT OF COMPREHENSIVE OCULAR AND CERVICAL MUSCLE RE-EDUCATION PROGRAM (COCMRP) ON PAIN, DISABILITY AND QUALITY OF LIFE IN PATIENTS WITH NON-SPECIFIC NECK PAIN – A RANDOMIZED CONTROLLED TRIAL

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Abstract
Background: Nonspecific neck pain is an increasingly frequent musculoskeletal condition in the middle-aged group. Recent research highlights sensorimotor control disturbances, head-eye movement control deficit in patients with chronic neck pain. The reason of the long-term neck pain is the incongruence between the sensorimotor conflict from the cortical network areas created by the gaze direction and the sensorimotor feedback. It is therefore possible to alleviate the neck pain by changing the gaze direction and adjusting the sensorimotor incongruence. The aim of the study was to find the effect of Comprehensive ocular and cervical muscle re-education program (COCMRP) on pain, disability and quality of life in patients with non-specific neck pain.
Methodology: After designing the study Institutional Ethical Approval was taken. Consent was obtained from all the participants. 69 samples were screened based on eligibility criteria, 9 were excluded and were further divided into Group A (experimental group) and Group B (control group). Pre-assessment was done at Week 0. The experimental group received the Comprehensive ocular and cervical muscle re-education program for 3 session per week for 8 weeks, receiving total 24 sessions. The control group did their regular exercise program. Post-assessment was done at week **Result:** The Shapiro-Wilk test was used to assess the normality of data distribution. Analysis of variance (ANOVA) was used for comparison of mean at different time intervals. There were non-significant differences between the groups for disability and quality of life at Week 0. (p>0.05) There was a significant difference between the groups for pain, disability and quality of life balance at week 8 (p<0.05).
Conclusion: The study concludes that Comprehensive ocular and cervical muscle re-education program is beneficial in reducing pain, disability and improving quality of life in patients with nonspecific neck pain.
Keywords: pain, disability, gaze stability, cervical mobility, nonspecific neck pain.

1. INTRODUCTION

Nonspecific neck pain (NNP) is musculoskeletal condition affecting 22% to 70% of the population across globe,[1] that is more common in women than in men. Some patients will not experience complete resolution of pain and disability, which can become a more complex chronic pain syndrome. When symptoms carry on for more than 12 weeks, the condition acquires the value of constancy and is termed as chronic nonspecific neck pain. This is associated with high cost for public health and is becoming a socio health problem.[1] The mechanisms underlying recurrence of neck pain may be linked with biomechanical, functional, proprioceptive and postural changes. Control of cervical muscles allows three-dimensional movement of the head whilst maintaining mechanical stability. In addition to their role in movement and support, the cervical muscles are intimately related with reflex systems associated with stabilization of the head and the eyes, vestibular function and proprioceptive systems that serve general postural orientation and stability. [2]

Neck pain is associated with disability and reduced quality of life and in young adults, neck pain has been shown to be a risk factor for reduced general work productivity. The economic consequences of neck pain are significant for both the individual and the society due to costs related to healthcare, insurances, loss of productivity, and sick leave. [3]

The motor control approach has received considerable attention explaining the contributing mechanisms and consequences of mechanical, non-traumatic neck pain.[4] Previous studies have indicated postural control deficits in patients with neck pain, particularly under challenging conditions such as closed eyes or standing on an unstable surface. While cervical proprioception impairment has been suggested as a possible cause, the exact mechanism of postural deficits has never been identified. Impaired proprioceptive inputs from the cervical region have also been suggested to augment mechanical overloading of the neck. Controversial research on proprioceptive acuity and functioning of the cervical spine has been published in the literature. Certain research has indicated that patients with chronic neck pain have impaired cervical proprioception, and that these patients' clinical condition improves when proprioceptive exercises are used. However, other studies have shown that people with chronic neck pain have intact neck proprioceptive accuracy. The central nervous system (CNS) integrates all peripheral inputs, such as proprioception, visual, and vestibular cues, to create an internal reference framework for the body known as body schema. The CNS may adjust for or even overlook inadequate or insufficient cervical proprioceptive inputs associated with CNP by placing greater emphasis on alternative afferent information sources from ostensibly normal ocular and vestibular organs. This could provide an explanation for the postural control that has been reported intact in certain experiments. Individuals who suffer from persistent neck pain may exhibit a significant reliance on their vestibular and/or visual systems for the regulation of their posture, which could suggest an exceptional reliance on these sensory systems as a compensating mechanism. To the best of our knowledge, no study has yet looked at whether treating cervical proprioception during CNP rehabilitation could lessen the relative reliance on different sources of afferent inputs for postural control mechanisms, despite a few studies looking into the impact of cervical proprioceptive training on clinical complaints of these patients. [5]

1. MATERIALS AND METHODS

1.1 Design

Randomized control trial was carried out; participants were divided into 2 groups. It was single blinded study (Participants involved in the group were blinded) the study has begun after the Ethical Clearance from the Institutional ethical committee. The IEC no is **COPT/MPT/2023/01**. Clinical Trials Registry-India (CTRI) registration is done. The CTRI registration no is **CTRI/2023/04/051765.**

1.2 Study Setting: Department of Orthopedic Physiotherapy, Dr. A.P.J Abdul Kalam college of Physiotherapy, Loni.

1.3 Study Duration: Feb 2023 to Jan 2024.

1.4 Sample size calculation

Sample size was calculated using open Epi software, with 95% confidence interval and power of 80%. Grounded on the above-mentioned assumptions, the sample size needed for this study was 60 participants. We added 9 subjects to compensate for any dropout.

1.5 Participant recruitment

All participants were asked to deeply read the study procedures and sign a detailed consent from before starting study procedures. Participants who were pre diagnosed with nonspecific neck pain, with age ranging from 18 to 40 years-old, both male and female, Pain rating 3-5 on VAS scale on activity and Pain less than 3 months, ready to sign the consent were included in the study. The patients suffering from any recent injuries, any type of systemic illness, rheumatic conditions, inflammatory joint disease, tumor, and unhealed fracture and any other spine pathologies were excluded.

1.6 Randomization Allocation

The courts obtained from randomization were maintained in opaque sealed envelope until the intervention begins. The allocation was concealed by sequentially numbered, opaque, sealed envelope (SNOSE).

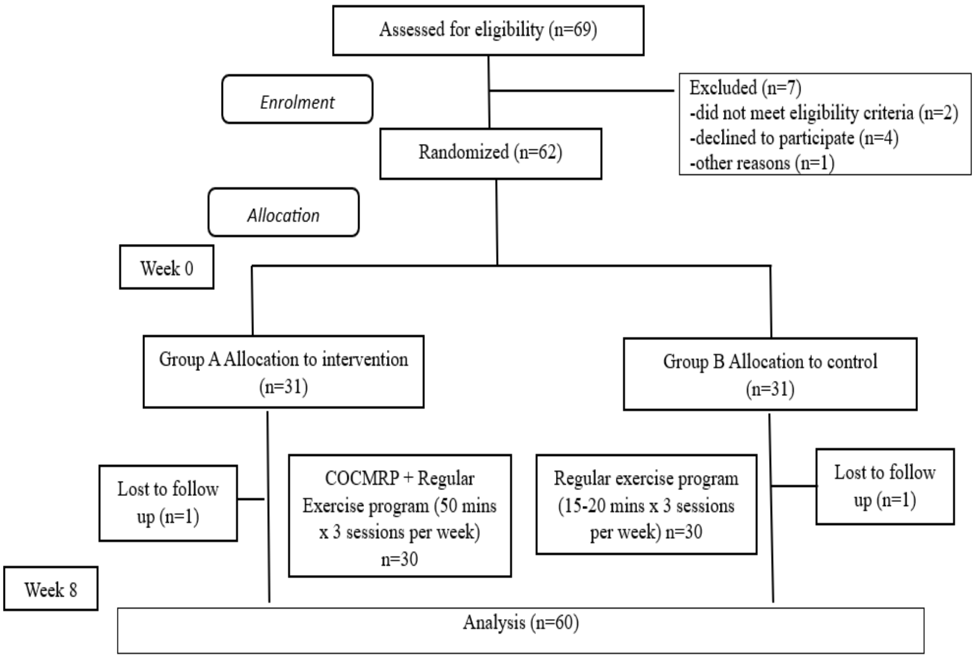


Figure 1: Design and flow of participants through the trial

1.7 Procedure

Following the parameters of usual clinical practice, according to some systematic reviews, the intervention was provided in 24 sessions over 8-week intervention period (three visits per week). The intervention group performed COCMRP, while the control group continued with the regular training program. The sessions were held on Monday, Wednesday, and Friday. Both the groups were assessed at different time interval, baseline at week 0 - week 4 and post assessment was carried out at week 8. Before the intervention protocols, demographic data were collected. Pain was assessed using VAS scale, Disability was assessed using Neck Disability index and quality of life was assessed using SF-12.

1.8 Outcome measures

1.8.1 Pain

Neck pain was assessed using 100 mm visual analog scale (VAS) which is valid and reliable (0.81-0.99).[6]

1.8.2 Disability

The neck disability associated with pain was assessed using neck disability index (NDI). It has a high test-retest reliability with an ICC = 0.91.[1]

1.8.3 Quality of life

Quality of life was assessed using SF-12, Internal consistency of the SF-12 component summary scores is generally high [8] (Cronbach's alpha $\geq$0.82 and 0.75, for SF-12 PCS scale and MCS scale, respectively)

1.9 Statistical analysis

Analyses were conducted using IBM, SPSS V.20 software. The Shapiro-Wilk test was used to assess the normality of data distribution. Analysis of variance (ANOVA) was used for comparison of mean at different time intervals. Post hoc test was used to identify between group differences. Quantitative variables were reported as mean and standard deviation. The mean between-group difference between the experimental and control groups were calculated with unpaired data and reported with a 95% confidence interval.

Table no 1: COMPREHENSIVE OCULAR AND CERVICAL MUSCLE RE-EDUCATION FOR PATIENTS WITH NON-SPECIFIC NECK PAIN.

	Progression	**Level 1: Week 1 to Week 3**	**Level 2: Week 4 to Week 6**	**Level 3: Week 7 to Week 8**
Sr. No	**Exercise**	**Procedure**	**Procedure**	**Procedure**
1	**Activation of Cervical muscles**	Patient position supine relaxed with both knees bent & relaxed. A thin layer of towel is placed under participant's head so head in neutral position. 1. Participants do chin tuck by putting the chin closer to sternum. 2. Participants push occiput area with submaximal pressure to the bed Frequency-3 sessions/week Intensity- 10 sec hold with 10 repetitions with 3 sets.	The patient will support head & thoracic vertebrae against wall and to maintain neutrality of the shoulder and jaw joints. Independent isometric exercises of upper cervical flexion were carried out before the lower cervical vertebrae started flexion to give support and feedback. Frequency-3 days in a week Intensity- 10 sec hold with 10 repetitions with 3 sets.	The subject will place forearm vertically on the wall and the scapula will be in middle position in a facing position, and the head will be placed above and behind the shoulders. Then patient will be asked to perform the chin tuck by maintaining the position of the scapula. Frequency- 3 days in a week, Intensity- 10 sec hold with 10 repetitions with 3 sets.
2	**Cervical mobility exercises**	**1. Exercises on cervical mobility** Starting position- Sitting Exercise- The goal is to keep the gaze on a target as far as possible in each of the directions.	**1. Head reposition exercise. (First degree)** Starting position- Standing Exercise- The patient was placed in front of a mirror in the correct position. After memorizing this position, he had to make movements with his eyes closed (flexo-extension, rotations, and lateral-flexions). Without opening his eyes, the patient should try to return to the starting position.	**1. Head reposition exercise (second degree)** Starting position- Standing Exercise- This exercise is the same as the previous exercise except the physiotherapist destabilized the patient.
3	**Cervical Re-education**	**2. Activation of ocular muscles.** Starting Position- Sitting Exercise- Without moving the head, analytical exercises on the maximum amplitude of ocular movement towards the right, left, front, and feet were actively performed, first with the eyes open and then with closed eyes.	**2. Activation of ocular muscles.** Starting Position- Sitting Exercise- Without moving the head, analytical exercises on the maximum amplitude of ocular movement towards the right, left, front, and feet were actively performed, first with the eyes open and then with closed eyes.	**2. Activation of ocular muscles.** Starting Position- Sitting Exercise- Physiotherapist performed a passive mobilization of the cervical spine in rotation and flexo-extension, while the patient maintained the eyes at a fixed point located in the vertical direction. After memorizing this point, the exercise was repeated with eyes closed.
4	**Oculomotor exercises and gaze stability exercises**	**3. Saccadic eye movements** Starting position- Sitting Exercise - The targets will be held in the subject's hand approximately thirty centimetres away from the subjects' eyes. Subjects will direct to move the eyes horizontally between two immobile targets while keeping the head still.	**3. Mirror twist** Starting Position- Standing Exercise- Maintain gaze and head stability on the spot while rotating the body beneath.	**3. Washing Hair - Extension** Starting Position- Standing Exercise- Extend head and neck and touch back of head with both hands.
		4. Smooth pursuit exercise Starting position- Sitting Exercise - Subject will be instructed to move the target horizontally and tracking it with the eyes while keeping the head still.	**4. The Pedestrian** Starting Position- Standing Exercise- Walk forwards maintaining gaze and head stability while rotating body beneath.	**4. Sit and Reach** Starting Position- Sitting Exercise- Reach forward while keeping the gaze still on the targeted object by therapist.
		5. Adaptation X1 Starting position- Sitting Exercise - Subject will be instructed to move the head horizontally while keeping the stationary target in focus.	**5. Crossing the road** Starting Position- Standing Exercise- Walking the length of a room, alternately focussing upon the left and right-side walls.	**5. Stand and Reach** Starting Position- Standing Exercise- Reach forward while keeping the gaze still on the targeted object by therapist
		6. Adaptation X2 Starting position- Sitting Exercise- Move the head and target in opposite directions horizontally while tracking the target with the eyes.	**6. Walk Past** Starting Position- Standing Exercise- Look at a point on the wall, maintain eye and head stable while walking to comfortable end range cervical rotation, then turn and walk back in the opposite direction.	**6. Walk Past - Extension** Starting Position- Standing Exercise- Look at a point where the wall and ceiling meet, maintain eye and head stable while walking to comfortable end range combined cervical extension and rotation, then turn in the opposite direction.
5	**Postural Stability exercises**	**7.** Walk straight comfortably with eyes open on normal surface while looking up-down. Distance: 30 yards, Repeat Twice	**7.** Walk straight comfortably with eyes open/ close on normal surface while looking up-down Distance: 30 yards, Repeat Twice each	**7.** Walk straight comfortably with eyes open/ close on normal surface while looking up - down and looking right- left. Distance: 30 yards, Repeat Twice each
		8.Walk straight comfortably with eyes open while balancing pillow on head. Distance: 30 yards, Repeat Twice	**8.** Walk straight comfortably with eyes open/close while balancing pillow on head. Distance: 30 yards, Repeat Twice each	**8.** Walk straight comfortably with eyes open/close while balancing pillow on head while looking right- left. Distance: 30 yards, Repeat Twice each
	Volume	Frequency: 3 sessions per week Repetitions: 3 X 2 sets	Frequency: 3 sessions per week Repetitions: 5 X 2 sets	Frequency: 3 sessions per week Repetitions: 5 X 2 sets

NOTE: Duration of one session will be 50-60 minutes. All exercises are performed alternatively with both sides if required.

2. RESULTS

At the baseline, there were non-significant differences between the groups in age, height, weight, BMI as p>0.05. The demographic and physical characteristics of participants at the baseline are shown in Table 2.

TABLE 2: There is no significant difference found in baseline characteristics between 2 groups for age height, weight and BMI.

Characteristics	Experimental (n=25)	Control (n=25)
Age, mean (SD)	19.9 (1.32)	19.3 (0.69)
Height, mean (SD)	156 (5.12)	155 (4.89)
Weight, mean (SD)	57.7 (4.13)	57.1 (5.29)
BMI, mean (SD)	23.4 (1.14)	23.5 (1.21)

TABLE 3: Conventional group exercises

Conventional treatment	Volume
Hot water fomentation	5-7 minutes
Isometric Strengthening exercises.	10 sec hold x 5 reps
Neck range of motion exercises.	

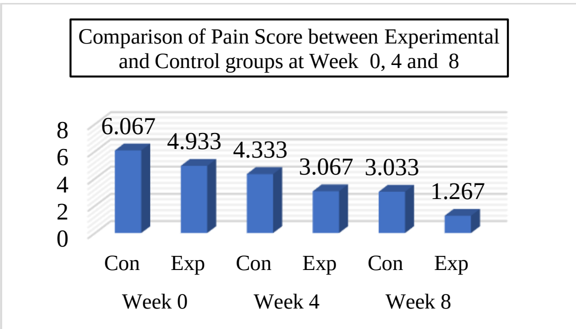
Duration 10-15 minutes, frequency of 3 days per week

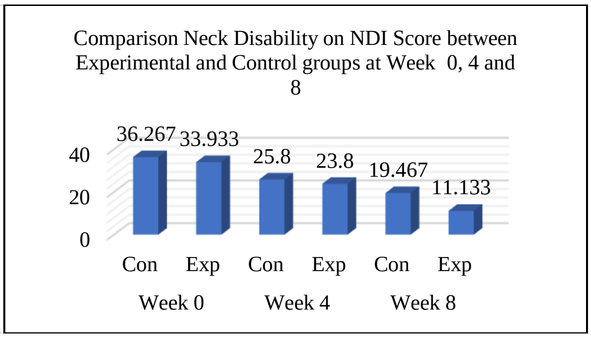
TABLE 4: Mean (SD) of groups

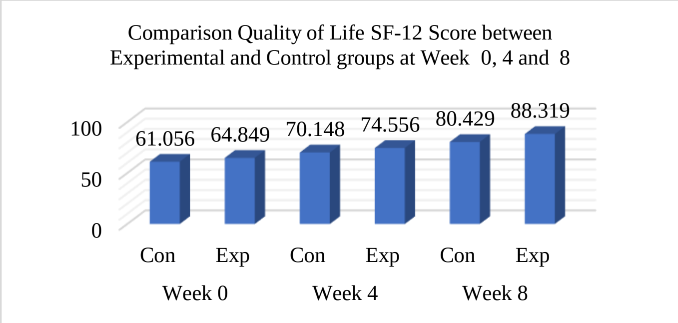
Outcome	Groups					
	Week 0		Week 4		Week 8	
	Exp	Control	Exp	Control	Exp	Control
Pain	4.933(0.64)	6.067(1.23)	3.06(0.64)	4.33(1.24)	1.26(0.58)	3.03(0.96)
Disability	33.93(7.45)	36.26(3.55)	23.8(6.95)	25.8(2.42)	11.13(3.91)	19.46(1.96)
Quality of life	64.84(8.92)	61.05(7.25)	74.5(7.80)	70.1(7.12)	88.31(5.88)	80.42(7.30)

TABLE 5: Mean (SD) within-group difference and between-group difference.

Outcome	Within groups				Between Groups	
	Week 8 minus week 0		Week 8 minus week 4		Week 8 minus Week 0	Week 8 minus Week 4
	Exp	Control	Exp	Control	Experimental minus Control	Experimental minus Control
Pain	-3.67(-0.06)	-3.03(-0.27)	-1.8(-0.06)	-1.3(-0.28)	-0.64(0.21)	-0.5(0.22)
Disability	-22.8(-3.54)	-16.8(-1.59)	-12.7(-3.04)	-6.34(-0.46)	-6(-1.95)	-6.36(-2.56)
Quality of life	23.47(-3.04)	19.26(0.05)	13.81(-1.92)	10.32(0.18)	3.87(-3.09)	3.49(-2.1)







3. DISCUSSION

This study aimed to estimate the effect of Comprehensive ocular and cervical muscle re-education program on pain, disability and quality of life in patients with nonspecific neck pain. COCMRP focused on activation of cervical muscles, cervical mobility exercises, cervical re-education, gaze stability and oculomotor exercises, proprioception training and postural stability exercises. The goal is to investigate the differences between reliance of the postural control system on the afferent signals from proprioceptive, visual and vestibular systems in patients were evaluated. Additionally, we investigated whether specific proprioceptive training for subjects with Chronic nonspecific neck pain (CNSNP) would yield better outcomes compared to routine physiotherapy for improvement of postural control besides pain, disability and quality of life. It has been hypothesized that CNSNP is due to incongruence between sensory feedback signals and visuosomatic feedback signals in the relevant cortical areas and that prolonged conflict results in long term plasticity in the relevant cortex which leads to difficulties in treatment.[8] Proprioception plays a crucial in maintaining posture and stability of the cervical joints during static and dynamic situations.[9] Extensive literature indicates that Golgi Tendon Organ (GTOs) and muscle spindle mainly contribute to neck proprioception, while the contribution of joint and cutaneous receptors are minimal.[10] The density of muscle spindles is distributed diversely across cervical muscles and is particularly high in the small suboccipital muscles, which implies their roles in the fine motor control of neck.[11]

Initially we added cervical muscle activation which has shown that it was more beneficial than strength-endurance training of the cervical muscles in reducing pain intensity and functional disability in patients with neck pain in the recent studies.[12] Moreover, these exercises may benefit to reestablish the cervical region sensorimotor control and enhance its neuromuscular function. As one probable explanation for exercise's pain-relieving impact, mechanoreceptors such as the muscle spindle, Golgi tendon organ, and joint proprioceptors are stimulated during training. Signals from these receptors release endogenous opioids and trigger the pituitary gland to generate endorphins. There is evidential support specifically for 'novel motor skill training' such as deep neck flexor training in pain and that addressing impairments appears to lead to some improvements in pain and disability [13] from a reasoning perspective the impairment-based approach perhaps fails to address both important and specific aspects of motor skill learning, namely a) the goal orientated nature of functional movement b) the focus of attention during tasks and c) that training gains are task specific.[14]

Pain:

The program has shown significantly improved pain intensity at rest, flexion, lateral flexion and right rotation motion and the isometric muscle endurance of neck pain patients.[9] Patients with chronic pain have been linked to decreased cerebral activity during motor imagining of the afflicted limb. The abnormal process by which
Cervical motion issues that cause neck pain to persist can be classified as follows. First, neck pain and restricted range of motion are caused by organic abnormalities of the neck, such as cervical spondylosis deformans and cervical intervertebral disc displacement. When cervical mobility is prolongedly inhibited,

compensatory motion to lessen pain may occur. These compensatory muscular contractions may result in excruciating neck muscle spasms. This viscous loop modifies motor programming in cortical motor processing and enhances compensatory movements. [7] Our recent results, where the GDR task produced a sequential reduction in reaction times for proper detection of another, are probably going to have similar positive impacts. Improvement in chronic neck discomfort was correlated with the direction in which the person looked and with strong correlates of faster reaction times and more accurate responses. Subjects were immediately able to visualise the direction of sight and induce exact motor imagery of the neck based on action observations of the experimenter's neck rotations. Neck-specific motor representations in the cortex may be activated and neural motor images may be produced by action observations of neck rotations in a healthy experimenter without neck illness. [14]

Disability:

Intervention resulted in a reduction in disability, which confirms the properties of active neck exercises and highlights the importance of exercise as a component of treatment for the management of patients with chronic neck pain. [13] After 8 weeks of initiating the treatment there was decrease in the neck disability score in experimental group. Improvement in muscle endurance or performance is concurrent with restoration of muscle balance with optimal flexibility of tight muscles and improved strength in weak and inhibited muscles. In muscles, increased extensibility of muscles is linked with increased torque production. It has also been reported that the physiological basis behind the increase in muscle strength is associated with the use of feedback training that could be due to an increase in the average firing rate, motor unit recruitment, and increased synchronization of the active motor unit. [14, 16, 17]

Quality of life:

Quality of life measured by the SF-12 which shown improvement in experimental group. The physical component summary was 2.6 (or 7.7%) and 5.1 (12.9%), which was lower than changes observed in other studies for cervical spine fusion treatment in degenerative neck pain patients equal to an increase of 4.1 points or for lumbar spinal fusion with estimated 4.9 points. Descriptive data from the surgical patients however show that the baseline PCS was approximately 25 points which is significantly less than in our patients (PCS about 40 points) indicating that these patients needed more improvement before considering this an important change.[15]

4. CONCLUSION

Neck pain remains a leading cause of disability and recent work suggests that active rehabilitation approaches such as proprioceptive training of the neck have potential to improve outcomes. On comparison of both groups, it was found that the Comprehensive ocular and cervical muscle re-education program is beneficial in reducing pain, disability and improving quality of life in patients with nonspecific neck pain.

5. CLINICAL IMPLICATION

We recommend that Comprehensive ocular and cervical muscle re-education program can be used as one of the therapeutic interventions in treatment of patient's nonspecific neck pain.

6. LIMITATION

The results are difficult to generalize and interpret because of small sample number even though the sample size was statistically calculated. Posture change progresses slowly therefore long-term training intervention is required for continues treatment however the study was conducted within short period of 8 weeks and follow up was not performed therefore, the long-term effects are unknown.

7. FUNDING: None

8. CONFLICT OF INTEREST: There is no conflict-of-interest between the authors.

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