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Effect of oculomotor exercises in patients with non-specific chronic neck pain and associated visual complaints

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Background: Neck pain is a common musculoskeletal disorder, the most common type being non-specific chronic neck pain. It usually involves postural or mechanical causes. In Individuals with neck pain, a notable prevalence of visual complaints has been predominantly reported. It can be linked to the mismatch in the cervical afferent output.
Objective: This study aimed to assess the effect of oculomotor exercises on neck pain, neck disability, gaze stability and visual complaints among individuals with non-specific chronic neck pain and associated visual complaints.
Methods: A total of 32 individuals with non-specific chronic neck pain and associated visual complaints were equally randomised into two groups. To receive either: stretching to the sternocleidomastoid and anterior scalene along with neck Isometric exercises (Group A, conventional) or the conventional protocol along with oculomotor exercises (Group B, experimental). The protocol was given for three alternate days a week for three weeks, a total of nine sessions. The outcome measures were the Visual Analogue Scale (VAS) for pain, Neck Disability Index (NDI) for disability, Dynamic Visual Acuity (DVA) test for gaze stability and Visual Complaints Index (VCI) for visual complaints.
Results: Significant results were seen for the DVA ($p = 0.002$) and VCI ($p = 0.024$), suggesting improvements in gaze stability and visual complaints using oculomotor exercises.
Conclusion: From this study, we highlighted that oculomotor exercises along with conventional treatment led to improvement in visual complaints and gaze stability in patients with non-specific chronic neck pain and associated visual complaints.

Keywords: Cervical; disability; gaze; mechanical neck pain.

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Introduction

Neck pain may be defined as "an unpleasant emotional and sensory occurrence related with possible tissue damage in the cervical area, which begins from superior nuchal line till the spine of the scapula."[1] It is a common musculoskeletal disorder with a lifetime prevalence between 22% and 70%.[2] In India, since 1990 neck pain has raised by 19.1% by an average of 0.8% a year. The prevalence is seen to be higher in women when compared to men (41.7% versus 34.4%).[2,3]

When symptoms last for more than 12 weeks of initiation, it is considered a chronic condition and is thus referred to as non-specific chronic neck pain.[4] Limited cervical movement and weakness of neck muscles are common symptoms associated with it.[5] Generally, it is diagnosed clinically by excluding the following conditions: cervical osteoporosis, history of trauma, cervical lymphadenopathy, history of inflammatory arthritis, tuberculosis, or any neurological deficit.[6] Also, these patients experience an alteration and deficit of the proprioception of neck muscle which affects cervical joint position sensation and also the motor control of the head.[4]

Individuals with neck pain had a notable prevalence of visual complaints when compared to normal individuals.[7] Vision plays an important role in guiding movements. Eye movement control is thought to be influenced by altered cervical somatosensory inputs. In the patients with chronic neck pain, deficits in oculomotor control like reduced smooth pursuit velocity, alterations in the velocity and latency of saccadic eye movements, and an increase in the cervico-ocular reflex have been observed.[8] Disorders related to vision and musculoskeletal systems are seen to be major public health concerns affecting the large proportion of the general population in their daily life and work.[9]

An increase in the load on the visual system, due to physiological aspects of the near work, not only causes eye problems but also leads to an increase in the musculoskeletal load and symptoms in the scapular/neck area.[10] A study had shown the effect of oculomotor exercises on Dynamic Visual Acuity (DVA) and postural stability in healthy individuals.[11] Another study found a significant effect of oculomotor exercises on DVA in basketball players.[12] In individuals with neck pain, it is important to assess the sensorimotor control disturbances as evidence suggests that these components get affected. While treatment focus should not only be given on musculoskeletal-related complaints, but also on the ones related to the visual system. Thus, the objective of this study was to assess the effect of oculomotor exercises on neck pain, disability and gaze stability in individuals with non-specific chronic neck pain and associated visual complaints.

Methods

Subjects with chronic neck pain were screened from Out Patient Department of Dr. D. Y. Patil College of Physiotherapy, Dr. D.Y. Patil Vidyapeeth, Pune from November 2020 to January 2021. The calculated sample size was 32 using mean difference and SD of DVA value, with an α-error of 0.05 and power of 0.7.[11] Subjects with age between 18 and 34 years, of either gender, those with neck disability index (NDI) scores of a minimum of five points, and those with associated visual complaints according to the Visual Complaints Index (VCI)[13] were included. Individuals with recent cervical fracture, whiplash injury, vestibular disorders, cervical neuropathy, history of neck or eye surgery, any trauma or malignancy were excluded.

The study was approved by the Ethical Committee of the Institute and written informed consent was obtained from all the participants.

Simple random sampling with the lottery method was used by the Principal Investigator for randomisation. Thus, Group A and Group B consisted of 16 subjects each.

The intervention given to the groups was as follows and intervention duration for both the groups was three weeks which consisted of nine treatment sessions, three days every week. Progression in the exercises was given on weekly basis. Group A (conventional group) included stretching of anterior scalene and sternocleidomastoid muscle (three repetitions each for 30 s hold), neck isometric exercises for flexion, extension, side flexion and rotation given for week 1: 5 s hold and 5 repetitions, week 2: 10 s hold and 5 repetitions, week 3: 10 s hold and 10 repetitions.

Group B (experimental group) included the conventional protocol along with oculomotor exercises which include saccadic eye movement, smooth pursuit exercise, Adaptation X1 exercise, and Adaptation X2 exercise.[11] The time duration for each exercise was week 1: 30 s, week 2: 1 min, week 3: 2 min. Figure 1 shows the flowchart of the trial design.

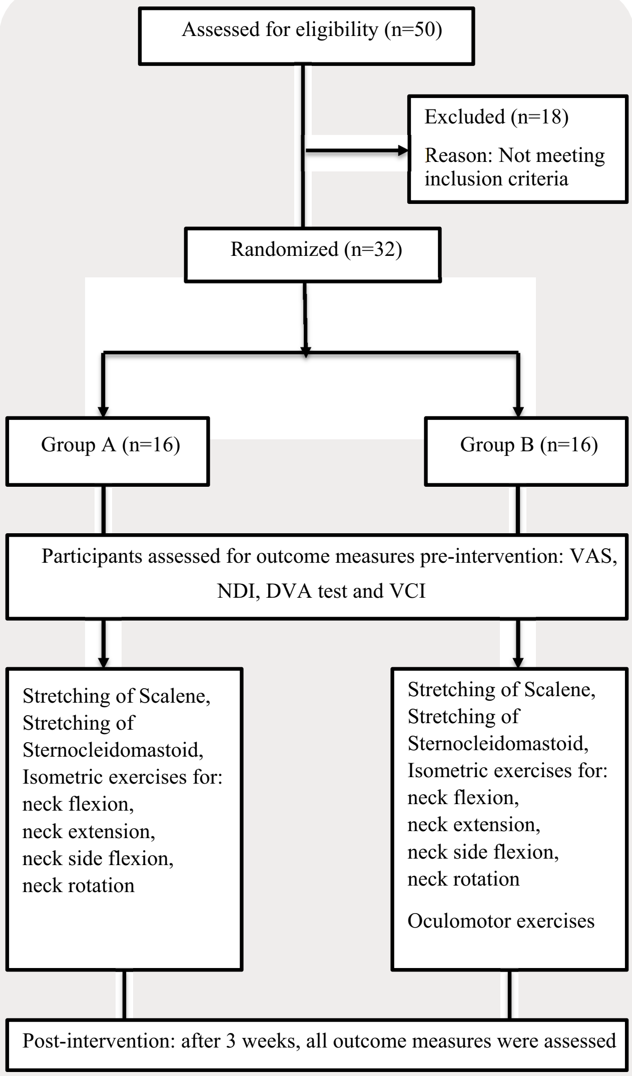

Fig. 1. Flow diagram showing the design trial.

Procedures followed: *Stretching of anterior scalene*: The patient was lying supine with the head off the treatment plinth. The therapist was standing at the head end of the treatment plinth and supported the patient's head with his right hand. The clavicle and first rib were depressed with his left hand. The head and neck were taken into side flexion towards the right side. The neck was then put into extension and the face was rotated to the left side. The position was maintained for 30 s. The same was repeated on the other side. Three repetitions were given on each side.

Stretching of Sternocleidomastoid: The patient was lying supine and the therapist was standing at the head end of the treatment plinth. The therapist used their hand to push the lateral shoulder and clavicle caudally. Using the right hand, the neck was taken into right side flexion and complete left rotation. The position was maintained for 30 s. The same was repeated on the other side. Three repetitions were given on each side.

Isometric Neck Exercises: Patient position was sitting. The procedure is as follows: *Flexion*: The patient was told to place a hand over the forehead, push the head forward on the hand while resisting the head movement with the hand. *Extension*: The patient was told to place a hand on the back of the head, push the head backwards into the hand and resist the head movement with the hand. *Side flexion*: The patient was told to place a hand on the side of the head, push the head towards the hand and resist head movement with the hand. *Rotation*: The patient was told to place hand lateral and superior to the eye, push the hand in an attempt to look to the side where the hand was placed and resist head movement with the hand.

Oculomotor Exercises: *Saccadic eye movement*: The patient was asked to move the eyes horizontally between two objects while the head remains stationary. The smooth pursuit — The patient was told to move an object horizontally and track it with eyes while keeping the head stationary. *Adaptation* $X1$: The patient was asked to rotate the head while keeping the object stationary and eyes focussing on it. *Adaptation* $X2$: The patient was told to rotate the head while moving the object in the opposite direction with respect to the head and eyes focussing on the object. The object given to focus on was the Identity Card.

Outcome measures

The primary outcome measures used were Visual Analogue Scale (VAS) for pain, Neck Disability Index (NDI) for disability and the DVA test for Gaze stability. Visual Complaints Index (VCI) used for assessing visual complaints was the secondary outcome measure. Both the primary and secondary outcome measures were assessed at baseline (before the treatment) and at 3 weeks (after the treatment).

The VAS is a self-reporting scale comprising of a horizontal line of 10 cm, where the extremes are "no pain" and "extreme pain". The subjects were asked to mark their pain level at a particular time and the distance from the "no pain" mark was measured in millimetres.[14]

The NDI is a self-rated disability scale consisting of 10 sections with each of them having scores from

0 to 5 and a total score of 50 or a percentage out of 100. If a section was missing, then the NDI was scored out of 45 and then converted into the percentage. The interpretation was as follows: 0 to 4 as none, 5 to 14 as mild, 15 to 24 as moderate, 25 to 34 as severe and above 34 is complete.[15,16]

The DVA test was used for assessing gaze stability. It was measured by using the technique as described by Herdman *et al.*[17] and Hillman *et al.*[18] with the help of Microsoft PowerPoint. A total of 10 pieces of paper were created. Each paper had numbers from 12 to 20 font-size which were printed at the centre of the papers. Every font size had 5 numbers each. The patient sat in a chair and these papers were placed at a distance of 70 cm from the patient's eye level. The patient was asked to read the numbers on each page while doing neck rotation. The frequency of neck rotation was maintained by using a metronome at 2 Hz. A total of five seconds were given to read each paper. The percent score was calculated by adding the number of answers and multiplying total number obtained with 2.[19]

The VCI was used as described by Julia Treleaven *et al.* It is a scale containing 16 components related to visual complaints. For each component, intensity and frequency had to be marked. The scoring for intensity was from 1 to 3 indicating 1 as mild, 2 as moderate and 3 as severe while the scoring for frequency was from 1 to 4 indicating 1 as rare, 2 as occasional, 3 as frequent and 4 as always. If any particular symptom was not present, the patients were asked to leave the space blank. The magnitude was the product of intensity and frequency. Thus, the total score out of 192 was given.[11]

Statistical analysis

Data analysis and interpretation were performed using the statistical package of SPSS 17.0. Normality of the data was checked and was concluded as normally distributed if $p > 0.05$ and not if $p < 0.05$. Paired and unpaired t-tests were performed if the data was normally distributed. The significance level was set at $p < 0.05$ at a 95% confidence interval.

Results

Of the 50 participants screened, 18 did not meet the inclusion criteria hence, a total of 32 participants (16 in each group) with non-specific chronic neck pain and associated visual complaints were included in the study. There were no dropouts after randomisation. No significant differences were present for any baseline data (Table 1).

For within group comparison, all variables observed in Group A and Group B had significant ($p < 0.05$) differences which show that either intervention resulted in decreased pain, reduced neck disability, gaze instability or visual complaints (Table 2).

For between group comparisons, Group B had significant results for DVA and VCI with a value $p < 0.05$ (Table 3).

Discussion

It was evident from the study that both treatments were individually effective in reducing pain or decreasing visual complains but more significant improvement in gaze stability and visual complaints

Table 1. Baseline characteristic data of both the groups.

Variable		Group A ($n = 16$)	Group B ($n = 16$)
Age (years) Mean ± SD		24.62 ± 2.15	24.19 ± 2.16
Gender (n %)	Male	25	31.25
	Female	75	68.75
Use of Glasses (n %)	No	75	68.75
	Yes	25	31.25
VAS (Mean ± SD)		57.25 ± 16.7	54.63 ± 14.3
NDI (Mean ± SD)		22.94 ± 8.85	24.19 ± 23.1
DVA (Mean ± SD)		77.38 ± 18.7	80.62 ± 15.1
VCI (Mean ± SD)		23.13 ± 14.1	32.63 ± 22.3

Note: SD: Standard Deviation.

Table 2. Within group pre-post comparison of all the variables.

Variables	Group	Mean difference ± SD	*t*-value	*p*-value
VAS	Group A	18.12 ± 13.33	5.4	0.000*
	Group B	22.81 ± 7.968	11.45	0.000*
NDI	Group A	15.22 ± 8.256	7.24	0.000*
	Group B	14.75 ± 6.308	9.35	0.000*
DVA	Group A	4.62 ± 2.27	8.12	0.000*
	Group B	8.25 ± 4.72	6.98	0.000*
VCI	Group A	8.938 ± 8.42	4.243	0.000*
	Group B	21.44 ± 19.26	4.453	0.000*

Notes: VAS: Visual Analogue Scale
NDI: Neck Disability Index
DVA: Dynamic Visual Acuity
VCI: Visual Complaints Index
SD: Standard Deviation
*Statistically significant ($p < 0.05$).

Table 3. Between-group comparison of variables in both the groups.

Variables	Mean difference ± SD	*t*-value	*p*-value
VAS	4.68 ± 10.97	1.208	0.237
NDI	0.46 ± 7.34	0.180	0.858
DVA	3.62 ± 3.7	2.76	0.01*
VCI	12.5 ± 14.8	2.379	0.024*

Notes: VAS: Visual Analogue Scale
NDI: Neck Disability Index
DVA: Dynamic Visual Acuity
VCI: Visual Complaints Index
*Statistically significant.

occur following added oculomotor exercises in chronic neck pain.

A natural view with proper gaze stability depends primarily on stabilisation of the neck and scapular area. Head and neck rotation will cause activation of neck proprioceptors along with Cervico-ocular reflex (controls extraocular muscles for having good vision with head movements) and Vestibule-ocular reflex (helps in gaze stabilisation with head movement).[20] Increased oculomotor loads lead to increased activity of the musculo-skeletal system.[10] Functional impairment in neck muscles due to fatigue or stress can alter the proprioception capability and spindles activity. It will affect the cervical afferent input.[8,21] The mechanoreceptors in cervical region have their central and reflex links to the visual, vestibular and central nervous system.

During the DVA, it was found that most of the subjects were able to read 3 or 4 lines on paper shown. Most of the times, font 12 was not read by the participants with head rotation. Similar results were seen in a study by Roberts *et al.* for participants with non-vestibular dizziness. Those who had normal vestibular function performance didn't vary with the font size.[22] Commonest complaints in visual complain index reported were eye strain and sensitivity to light. Both had improved in intensity and frequency.

Neck pain patients have a reduction of deep flexors and extensors activity with alteration in recruitment of muscles.[21,23] Also, studies have shown increased hypersensitivity for trapezius, levator scapulae and splenius capitis in neck pain.[24] Apart from this, isometric training targeting cranio-cervical muscles have been observed to improve muscle activity causing reduction of pain and disability in patients with chronic neck pain. The load for exercise depends on the amount/grading of pain and disability.[22,25]

A systematic review and meta-analysis reported that, motor control training using cranio-cervical flexion is helpful in reducing pain and disability for non-specific chronic neck pain.[22] Contractile muscular activity during isometrics can activate muscle stretch receptors. This increases the release of opioids and endomorphin from the pituitary gland. The same is responsible for decreasing peripheral and central pain.[26] Contractions of low intensity and small duration recruit high threshold motor units.[27] The reduction in pain after static stretching can be linked to the inhibitory results of the Golgi tendon organ and alterations in the Pacinian corpuscles. These reflexes decrease musculo-tendinous unit tension and therefore reduce sensitivity to pain.[28] This may be linked to the analgesic effect permitting better stretch tolerance. The perceived magnitude of the afferent noxious stimuli is modulated by the nervous system. Also recruiting endogenous mechanisms of pain inhibition or facilitation modulate afferent stimuli of the nervous system resulting in increased pain tolerance.[29]

Study had not found any significant reduction of pain with addition of oculomotor exercises. It has been seen that increased pronociceptive and impaired antinociceptive mechanism occur in non-specific chronic neck pain. This could have resulted in maintenance of chronic pain despite any improvement in function.[30]

Thus, it can be concluded that, both the groups had similar effects in reducing pain and disability. However, the added effect of oculomotor exercises improved the visual complaints and gaze stability in non-specific chronic neck pain patients with associated visual complaints and thus can be used for beneficial effects in the clinical settings. A follow-up study measuring visual fatigue, sensitivity to light in chronic neck pain patients following added oculomotor exercise suggests its future score.

Limitation of the study: The range of motion of the neck was not assessed. Also, the treatment time was already an advantage in oculomotor with conventional exercise group. This advantage had greater impact in third week of treatment. Visual complain assessed as secondary measure was more subjective in nature.

Conclusion

Oculomotor exercises significantly improved the visual complaints and gaze stability in patients with non-specific chronic neck pain and associated visual complaints.

Conflict of Interest

The authors have no conflicts of interest relevant to this paper.

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None.

Author Contributions

The authors Amita Aggarwal, Jidnyasa Thakur and Tushar Palekar did the analysis and interpretation of data, drafted the manuscript and after revision it was critically approved to be published. Conception and design of study was done by Amita Aggarwal and an acquisition of data was done by Jidnyasa Thakur.

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