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Research Article

Effect of Sensorimotor Training on Joint Position Sense Among Subjects with Non-specific Neck Pain

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Abstract

Neck pain is one of the most significant health problems worldwide. Non-specific neck pain (NSNP) is the most common and the 4th leading cause of musculoskeletal disorder worldwide. It is estimated that about 70% of the population experiences neck pain throughout the life, with an annual incidence of 15% to 50% [1]. It has been well established that NSNP is not only the risk factor for developing severe spinal pathologies and functional disability but that it is also associated with decreasing the quality of life and productivity of workers [2].

Keywords: Neck Pain; Joint Position Sense (JPS); Joint Position Error (JPE)

Introduction

Non-specific neck pain (NP) is defined as pain in the posterior and lateral aspect of the neck between the superior nuchal line and the spinous process of the first thoracic vertebra with no signs or symptoms of major structural pathology and no or minor to major interference with activities of daily life as well as with the absence of neurological signs and specific pathologies; such as: traumatic sprain and fracture, tumour, infectious or inflammatory cervical spondylolysis, etc [3]. The NSNP is also described as pain present in the anatomical region of the neck without radiating to the upper limbs [4].

The number of prevalent cases of neck pain worldwide was estimated to be 288.7 million [5]. About 80% of the general adult population suffers neck pain during their lifetimes, and 30–50% has neck pain annually [6]. Neck pain is estimated to affect 10% to 20% of the population every year (with a global point prevalence of 4.9%) and up to two thirds of people at some point in their life [7].

Neck pain often presents with various sensorimotor symptoms [8,9]. The cervical spine has numerous mechanoreceptors responsible for proprioceptive input. These receptors have central and reflex connection to the vestibular and visual systems and the central nervous system [10]. Three reflexes also influence sensorimotor control are Cervicocollic reflex, Cervico-ocular reflex and Tonic neck reflex [11]. Three pillars of sensorimotor impairment are Proprioception, Eye movement control and Balance and postural stability [12].

Sensorimotor training is a special programme aimed at restoring motor control through maximizing sensory input from different parts of the body to improve balance and overall function level of the patient. Sensorimotor training is a special form of proprioceptive and balance exercise that was designed for management of patients with chronic musculoskeletal pain syndromes. It is based on the concept that instead of emphasizing the isolated strength of a group of muscles around a joint, we should realize the importance of the central nervous system in regulating movement in order to reach proper firing patterns for maintaining joint stability [13].

Sensorimotor training methods are a current trend in exercise therapy, and for the first time they take into account the special

function of the neck, by including connections between the perceptions of sensory organs located in the head and neck muscles. Alterations of sensorimotor control have been identified in many patients with neck pain, and are thought to play an important role in the aetiology and maintenance of associated disorders. Initial studies found that patients undergoing these training methods experienced reduced neck pain, as well as improvements in cervical range of motion, self-reported disability, and general health [14].

Current studies have indicated that one of the main problems in patients with neck pain is the cervical proprioception impairment, which leads to cervical sensorimotor control disturbances [15]. Joint position sense (JPS) or joint position error (JPE) is often used to evaluate proprioceptive ability, and the most commonly used test involves assessing an individual's ability to relocate to neutral head and neck posturing (or to a target position) after active or passive neck movement. Evidence from randomized controlled trials suggests that proprioceptive-targeted treatment improves JPS at the neck and results in pain reduction [16].

Sensorimotor training consists of set of exercises of joint position sense, occulomotor exercises and balance exercises. In this study instead of using all these three sets of exercise components, only the two sets of exercise components, the exercise set of joint position sense and occulomotor exercises and show its effect in improving joint position sense among subjects with non specific neck pain. Hence the purpose of the study is to find out the effect of Sensorimotor training on Joint position sense (proprioception) among subjects with non-specific neck pain.

Methodology

Study design

A quasi experimental study design.

Study population

Subjects with non specific neck pain.

Sampling technique

Purposive sampling method.

Study duration

3 months.

Treatment duration

All individuals will receive 12 sessions of supervised intervention, three times a week for four weeks.

The group of subjects receive

- Total duration – 4 weeks
- No. of sessions per week – 3 days
- Duration per session – 45 minutes

Sample size

A total of 15 subjects were included in the study.

Study setting

KOVAI MEDICAL CENTER AND HOSPITAL – Department of Orthopaedics.

Selection criteria

Inclusion criteria	Exclusion criteria
Localized neck pain.	History of cervical spine surgery, whiplashinjuries.
Aged between 18 – 50 years.	Patients with headache, migraine.
Individuals having altered jointposition sense about 4-5cm	Traumatic neck pain.
Both male and female.	Signs of cervical radiculopathy.
Those who are willing to participate in the study.	Rheumatic diseases.
	Neurological disorders.
	Pain in lumbar, hip, knee or ankle at thesame time.
	Cognitive impairments.
	Known or suspected vestibular pathology.
	Undergoing other concurrent treatment.

Table 1

Outcome measure

Proprioception – Joint Position Sense.

Measurement tools

Joint position sense is assessed with Head mounted laser target.

Materials used

Head mounted laser target testing.

Hypotheses

Null hypothesis

There will be no significant improvement by sensorimotor training on proprioception in subjects with nonspecific neck pain.

Alternate hypothesis

There will be significant improvement by sensorimotor training on proprioception in subjects with nonspecific neck pain.

Procedure

Subjects with nonspecific neck pain were recruited from Kovai Medical Center and Hospital. Participants were selected for the study on the basis of inclusion criteria. The baseline pre test assessment was assessed for Proprioception using laser target method. The individuals were then instructed with the intervention exercise and all individuals received 12 sessions of supervised intervention, three times a week for four weeks. The post test was taken after the treatment technique and data was analyzed.

Measurement – cervical joint position sense

A simple measure for cervical JPS is the use of a small laser pointer or torch mounted onto a lightweight headband as used by Revel., *et al*. The subject is seated 90 cm from a wall and the starting point projected by the laser is marked. The subject (blindfolded or eyes closed) performs an active neck movement (neck flexion and extension) and then returns as accurately as possible to the starting position. The final laser position is measured against the starting position in centimeters. This method provides a quantitative assessment tool as errors as little as $3–4^0$ (4-5 cm) can indicate a deficit in cervical JPS. Errors are measured following active return from cervical extension and flexion. Relocating to selected points in range and accuracy in retracing patterns can also be used to assess cervical kinesthesia. Jerky movements, searching or overshooting the initial position, reproduction of dizziness and/or a noticeable difference of cervical movement patterns in the test with eyes closed may also indicate impaired cervical kinesthetic sense [10]. Here the mean of eight trails for each direction, flexion and extension, to obtain a reliable test results will be used [17].

Intervention

Sensorimotor exercises

Cervical joint position sense

The participants practice moving their head to points in different directions initially with eyes open, using a laser pointer mounted onto a lightweight headband. This practice will involve relocating the head back to a neutral posture or to predetermined points in range. The exercise is progressed by closing the eyes and by changing directions and ranges of movement.

Exercise description

With laser on headband for feedback, relocate back to neutral head position from all head movements with eyes open.

- Subject will be instructed to sit in front of a wall with a laser pointer fixed to a headband (like the assessment)
- Subject will be instructed to bring the head back to neutral from any direction for e.g. flexion or extension
- Train the most difficult/symptomatic direction by rotating towards or from the impaired side
- Eyes open and then progress to eyes closed and then open to check position.

Progression

1.	**Relocating with laser feedback**	
	Sitting	
	- Head relocating to neutral position with eyesopened (vertical/horizontal)	5 reps × 3 sets
	- Head relocating to predetermined position inrange with eyes opened (vertical/horizontal)	5 reps × 3 sets
2.	Sitting	
	- Head relocating to neutral position with eyesopened (diagonal)	5 reps × 3 sets
	- Head relocating to predetermined position inrange with eyes opened (diagonal)	5 reps × 3 sets
	- Head relocating to specific targets with eyesopened (all directions)	5 reps × 3 sets
3.	- Head relocating to neutral position with eyesclosed (all directions)	5 reps × 3 sets
	- Head relocating to predetermined position in range with eyes closed (all directions)	5 reps × 3 sets

Table 2

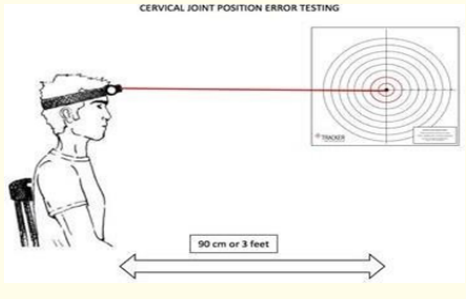

Figure 1

Oculomotor control exercises

Exercise description

- Train the eye follow. The participants will be instructed to follow a target moving from side to side and up and down while keeping their head still.
- Train gaze stability exercises. The participants will perform active movements, while fixing their gaze on the target. Progressions include increasing the target's speed, changing the participant's position and changing visual background and focus point.
- Train eye head co-ordination exercises. The participants will move their eyes and head in the same direction to focus on a target. Progressions include moving the eyes first then the head and moving eyes and head in opposite directions.

Progression

1.	**Eye follow, gaze stability and eye-head coordination**	
	Sitting	
	- Eyes following a target with slow speed whilekeeping the head still (vertical/horizontal)	5 reps × 3 sets
	- Head moving while fixing eyes on a single spot(vertical/horizontal)	5 reps × 3 sets
	- Eyes and head moving together to the samedirection (vertical/horizontal)	5 reps × 3 sets
2.	Sitting	
	- Eyes following a target with fast speed while keeping the head still (vertical/horizontal)	5 reps × 3 sets
	- Head moving while fixing eyes on complex targets (vertical/horizontal)	5 reps × 3 sets
	- Moving the eyes first then the head to the same direction	5 reps × 3 sets
3.	Sitting	
	- Eyes following a target with neck in 45° torsion (vertical/horizontal)	5 reps × 3 sets
	- Head moving while fixing eyes on a word target with complex backgrounds (vertical/horizontal)	5 reps × 3 sets
	- Eyes and head moving to the opposite direction (vertical/horizontal)	5reps × 3 sets

Table 3

Statistical analysis

Statistical analysis was made using paired't test at a 5% level of significance.

Paired 't test: (within group)

$$t = \frac{\bar{d}\sqrt{n}}{s} \text{ Where } S = \sqrt{\frac{\sum d^2 - (\bar{d})^2 n}{n-1}}$$

n= number of samples

d=difference between pre and post test

S= standard deviation.

Data presentation

Tabular presentation

Paired 't' test analysis for pre-test and post-test values of cervical joint position sense - flexion

Measurement tool	Mean value ± S.D		Calculated' value	Table 't' value	P value and level of significance
CERVICAL JOINT POSITION SENSE – Head mounted laser target testing	Pre test	Post test	13.3442	2.145	P < 0.05 Significant
	7.020 ± 1.099	4.807 ± 0.899			

Table 4

Paired 't' test analysis for pre-test and post-test values of cervical joint position sense – extension

Measurement tool	Mean value ± S.D		Calculated' value	Table 't' value	P value and level of significance
CERVICAL JOINT POSITION SENSE – Head mounted laser target testing	Pre test	Post test	21.5873	2.145	P < 0.05 Significant
	6.980 ± 1.006	5.040 ± 1.001			

Table 5

Graphical presentation

Pre test and post test mean values of cervical joint position sense for flexion

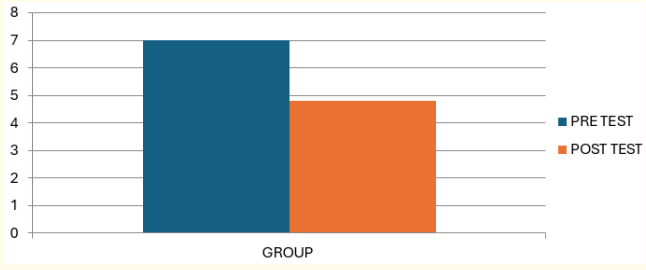

Figure 2

Pre test and post test mean values of cervical joint position sense for extension

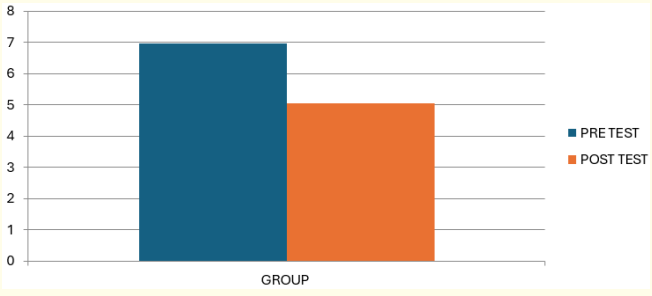

Figure 3

Data analysis

The difference between the pre test and post test of the group was analyzed by means of Paired' t test. Statistical analysis was made using paired't test at a 5% level of significance.

Cervical joint position sense for flexion

The pre test and post test value of the Cervical joint position sense for flexion was analysed using a paired t-test. For 14 degrees of freedom and at a 5% significance level, the table t' value was 2.145 and the calculated t' value was 13.3442. Since the calculated t' value was greater than the table t' value, the null hypothesis was rejected. Hence there was a significant improvement on cervical joint position sense for flexion.

Cervical joint position sense for extension

The pre test and post test value of the Cervical joint position sense for extension was analysed using a paired t-test. For 14 degrees of freedom and at a 5% significance level, the table t' value was 2.145 and the calculated t' value was 21.5873. Since the calculated t' value was greater than the table t' value, the null hypothesis was rejected. Hence there was a significant improvement on cervical joint position sense for extension.

Results

A total of 15 subjects who were selected based on inclusion and exclusion criteria with age group between 18 to 50 years.

For them, Sensorimotor training components – the cervical joint position sense and oculomotor control exercises were instructed. The calculated t' value for cervical joint position sense flexion and extension were greater than the table t' value, Sensorimotor training exercises have significant effect on the Joint position sense (proprioception),

Discussion

The purpose of the study was to find out the effect of sensorimotor training exercises that included the cervical joint position sense exercises and oculomotor control exercises on cervical joint position sense (proprioception) among subjects with non-specific neck pain. 15 subjects with non specific neck pain were taken. They were selected in accordance with the inclusion criteria.

The result of this study shows a significant improvement in cervical joint position sense for neck flexion and extension which was analysed using paired't test. To our knowledge this is the first article to conduct the sensorimotor training exercise components of only the cervical joint position sense training and oculomotor control exercises in subjects with nonspecific neck pain.

This positive effect of the sensorimotor training could be explained by the influence of oculomotor exercises on sub occipital muscles [18]. These muscles have a large number of muscle spindles for controlling the head orientation in space [11].

Therefore, activating these muscles through sensorimotor training could be beneficial for the improvement of muscle spindle function and neck position sense. In addition, it is possible that improvement in joint position sense follows from the principle of task specificity.

After 4 weeks of training, the subjects have shown significant improvement in joint position sense which was reflected in the statistical analysis. Thus, this study has proved that sensorimotor training for subjects with low back pain and improves their joint position sense.

Conclusion

This study concluded that Sensorimotor training with set of cervical joint position sense training and oculomotor control exercises improves cervical joint position sense (proprioception) among subjects with Non-specific neck pain.

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