



Comparison Of Proprioceptive Training And Craniocervical Flexion Training On Cervical Joint Position Sense In Patients With Mechanical Neck Pain.

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ABSTRACT

BACKGROUND: Neck pain is musculoskeletal condition which is the leading cause of disability with high prevalence. Previous studies have shown that alteration in cervical proprioception is associated with the neck pain. It is evaluated using Joint Position Error (JPE) test which determines the person's ability to return his head to the predefined position after cervical movements. Exercise intervention are needed for the management of patients with neck pain and altered cervical proprioception. The objective of the study is to compare the Proprioceptive Training and Craniocervical Flexion (CCF) Training in reducing pain and improving Cervical Joint Position Sense.

MATERIALS AND METHODS: 64 subjects were assessed and identified with mechanical neck pain and recruited for the study and randomly divided into two groups. In one group Proprioceptive Training and in another group Craniocervical Flexion Training had been given for 4 weeks.

RESULTS: On comparison of proprioceptive training group and Craniocervical Flexion training group for pretest and posttest values of NPRS ($P < 0.0001$), JPE for right rotation ($p < 0.0001$), left rotation ($p < 0.0001$), extension ($p < 0.0001$) and NDI ($p < 0.0001$) Extremely significant difference found. On comparison between Proprioceptive training group and Craniocervical Flexion training group, there was significant difference found for NPRS ($p = 0.0373$), JPE for Right rotation ($p = 0.0162$), Left Rotation ($p = 0.0335$), Extension ($p = 0.0372$) and NDI ($p = 0.0173$)

CONCLUSION: This study showed that Proprioceptive training is more effective than Craniocervical Flexion training in improving Cervical Joint Position Sense and reducing patients perceived pain and disability.

KEY WORDS: Joint Position Error, Proprioception, Deep neck flexors, Neck pain.

INTRODUCTION

Neck pain is one of the leading causes of disability worldwide that affects approximately 70% of people at some point in their lifetime. ^(1,2) Neck pain found to be greatest contributor to global disability with 4th rank and 21st in terms of overall burden, with peak prevalence at about 45 years of age and it was higher in women than in men ^(1,3,4)

Mechanical neck pain is described by International Association for the Study of Pain (IASP) as the nonspecific pain experienced posteriorly to the neck which originates from the superior nuchal line and extends to the first thoracic spinous process. ^(5,6)

It is defined as generalized neck and/or shoulder pain with mechanical characteristics including symptoms provoked by maintained neck postures or by palpation of cervical muscles. ^(3,7) It is insidious in onset and it is associated with various risk factors such as prolonged duration of sustained posture, sprain or strain of ligaments and muscles of neck, repetitive motions, poor workstation design, genetic predisposition, decreased strength and endurance of cervical muscles. ^(3,5,8,9) Previous research about cervical impairment suggests that Deep Neck Flexors [longus capitus, longus colli (superior portion) and rectus capitis anterior] muscle weakness might be a contributory or causative factor in the development of mechanical neck pain. ^(10,11)

In previous study done by Punjabi et al. estimated that 80% contribution to mechanical stability of cervical spine is given by neck musculature while remaining 20% given by osteoligamentous system. ^(3,10,12) Recent studies have shown that one of the main problems of patients with neck pain is that the alteration of cervical proprioception which leads to disturbances cervical sensorimotor control. ^(1,13) Balance disturbances, altered eye movement control and altered postural activity of cervical muscles have been demonstrated in people with neck pain. ⁽¹⁴⁾ Cervical sensorimotor control consists of CNS integration and processing of all the afferent information i.e., visual, vestibular, and cervical proprioceptive inputs and execution of the motor program through cervical muscles which contributes to maintenance of balance, head posture and cervical joint stability ^(1,13,15)

There are three main groups of cervical muscles that form a sleeve around the vertebral column and enable control of posture and segmental movements: The Deep Cervical Flexors – longus colli, longus capitus, rectus capitis anterior and rectus capitis lateralis, Deep Cervical Extensors – semispinalis cervicis and multifidus, The Suboccipital Muscles – rectus capitus posterior major and minor, and obliquus capitus

superior and inferior. ⁽¹⁶⁾ The principal action of the deep cervical flexor muscles is Craniocervical flexion that structurally support cervical motion segments during motion. CCF muscle training is one of the techniques which is clinically used in treatment of neck pain. ⁽³⁾

Abundance of receptors are present in the cervical muscles and there are multiple cervical central and reflex connections to the visual, vestibular, and postural control systems. The highest cervical receptor density present in deep portion of suboccipital muscles and are known to have a specific role in these reflex and central connections. ^(14,17) A major component of proprioception is cervical Joint Position Sense (JPS), and it reflects the ascending input (afferent) of cervical muscle, disc, and ligament receptors. An impaired cervical JPS is due to abnormal cervical afferent input, which is measured as cervical Joint Position Error (JPE). ^(1,18)

In patients with neck pain abnormal joint position error (JPE) has been detected using either test of ability to relocate the natural head posture after an active movement or to actively relocate a position within a movement plane. ^(1,14,19) In Craniocervical flexion training exercise the deep flexors of the upper cervical region, the longus capitis, and colli which flex the neck and not the head are targeted which is a low load training of the craniocervical flexors. ^(14,20,21) It improves the contractile capacity of the deep cervical flexors muscles which has the role in improving coordination between superficial and deep layers of the neck flexors muscles. ⁽²⁰⁾ Proprioceptive training activates the mechanoreceptors in cervical muscles and thus improves the proprioception which consists of head relocation, gaze stability, eye follow and eye head coordination exercises. ^(14,20,22) The purpose of the study is to compare proprioceptive training program which trains the coordination and proprioception of the neck flexor muscles especially deep cervical flexor muscles with

craniocervical flexion training in patients with mechanical neck pain. ^(14,23)

MATERIALS AND METHODS ^(14,22)

64 subjects were recruited from the physiotherapy OPD of Dr. Vasantrao Pawar Medical college and hospital, Nashik based on inclusion criteria which was age between 18-25 years⁽²²⁾, both male and female gender, subjects having mechanical neck pain (less than 3 months), subjects with Joint Position Error Deficit in 2 out of 3 movements (left rotation, right rotation and extension), subjects willingness to participate and subjects having any neurological signs, history of neck injury, cervical spine surgeries, chronic and degenerative conditions like spondylosis, spondylolisthesis and those who participated in a neck exercise program in past 12 months were excluded. Measurements using NPRS, Joint Position Error test (for left rotation, right rotation, and extension) and NDI were taken before and after treatment session.

OUTCOME MEASURES

1. Numerical Pain Rating Scale (NPRS) ⁽¹⁴⁾
2. Joint Position Error (JPE) Test ^(1,14,49)

Patient was in sitting position which reduced any contribution of balance impairments or other postural compensations. At the patient's head height in sitting, a target was placed 90 cm away from the patient. On the patient's head a laser pointer was mounted on a lightweight headband was placed. The patient was then asked to focus on finding natural resting head position so that the laser pointer was in line with the center of the target. The patient actively moved their head in

Figure 1: Assessment of Cervical Joint Position Error

plane with eyes closed (left or right rotation or extension) and attempted to return to the starting position as accurately as possible. When he/she feels, they have returned to starting position the patient verbally indicated the same. Three trials were performed and mean score was recorded. The difference between the starting position and end position of the laser beam was measured in centimeters and then converted into degrees:

Patients with more than the following values had joint position error: ⁽⁴⁹⁾

- Left Rotation = 3.0 degrees = 4.8 cm distance
- Right Rotation = 3.6 degrees = 5.8 cm distance
- Extension = 3.2 degrees = 5.1 cm distance.



$$(\text{angle} = \tan^{-1} [\text{error distance}/90\text{cm}])^{(25)}$$

3. Neck Disability Index (NDI) ⁽¹⁴⁾

It was used to score the disability and pain in patients with mechanical neck pain. Interpretation of NDI: 4 points (0-8%) no disability, 5-14points (10 – 28%) mild disability, 15-24points (30-48%) moderate disability, 25-34points (50- 64%) severe disability, 35-50points (70- 100%) complete disability.

PROCEDURE:

Ethical clearance had taken from Institutional Ethical Committee. Around 64



Figure 2: Head Relocation Practice

subjects with mechanical neck pain were recruited from OPD setup who met the inclusion and exclusion criteria. Each patient was asked to fill written consent form and was explained the need of the study. Patients were divided into 2 groups using simple random sampling technique by chit method. Group A received Proprioceptive Training

and Group B received Craniocervical Flexion Training. Each group had 32 subjects. 4 Patients were unable to continue the Protocol for 4 weeks, so they were dropped out, 1 was from Craniocervical flexion training and 3 from Proprioceptive training.



GROUP A: PROPRIOCEPTIVE TRAINING (14,20,22,46)

Figure 3: Gaze Stability Exercises

Exercises included: Head Relocation Practice and Oculomotor Training

1. Head Relocation Practice:

- Patient practiced relocating the head back to the natural head position and to predetermined position in range from movement direction assessed to be abnormal during JPE testing. It was first done with eyes open using the feedback from laser attached to headband then with eyes closed.

2. Oculomotor Training It involved:

1. Gaze Stability Exercises
2. Eye Follow Exercises
3. Eye-Head Co-ordination



1. Gaze Stability Exercises:

- The patient was asked to keep his/her eyes focused on the target. The target was the therapists' finger or patient's own finger. Then the patient moved his/her head in flexion, extension,

left or right rotation by keeping the gaze on target. All cervical joint motion were performed that is flexion, extension, left and right rotation. Progression was done by performing movements in diagonal pattern or tracing the shape drawn over the paper like square, triangle or circle.

2. Eye Follow Exercises:

- Here, the patient followed and fixated his/her eyes on target. Target was therapists' finger or therapist holding pen in her hands. The patient followed the movement of target.

3. Eye-Head Co-ordination:



Figure 4: Training the craniocervical action with the use of feedback from the pressure biofeedback unit



Figure 5: Eye Head Coordination

In this exercise, the patient moved his/her head and eyes in same direction to follow the movement of target in flexion, extension, left and right rotation and in diagonal direction.

The exercises mentioned above were performed for 3 sets of 5 repetitions for 4 weeks – 4 days/week. (22)

GROUP B: CRANIOCERVICAL FLEXION TRAINING. (3,20,22)

- Patient Position: Crook lying with the neck in neutral position. To achieve the neutral position, layers of the towel were placed under neck if necessary. Behind the neck that is under the

occiput an uninflated pressure sensor was placed and was inflated to stable baseline pressure of 20mmhg, which did not place the neck in lordosis. There were 5 stages which were performed and the device provided feedback and direction to the patients. Simple Head nodding action was performed slowly and gently by the patient. The patients had to hold the position for 10 seconds and then relax for 10 secs. The patient then attempted to sequentially target; 2-mm Hg progressive pressure increases from the baseline of 20 mm Hg to a maximum of 30 mm Hg. ⁽²⁰⁾ 10 repetitions of 10 seconds hold were performed at

each baseline pressure for 4 weeks – 4 days per week ⁽³⁾

RESULTS

Table no.1: Comparison of pre and post values of JPE in Group A using paired T test

<u>PARAMETERS</u>	<u>RIGHT ROTATION</u>		<u>LEFT ROTATION</u>		<u>EXTENSION</u>	
	PRE	POST	PRE	POST	PRE	POST
MEAN	7.2	4.7	6.7	4.6	5.4	3.9
STANDARD DEVIATION	1.770	1.266	1.255	1.073	1.558	1.315
P VALUE	< 0.0001		< 0.0001		< 0.0001	
T VALUE	16.941		20.090		18.897	
SIGNIFICANCE	EXTREMELY SIGNIFICANT		EXTREMELY SIGNIFICANT		EXTREMELY SIGNIFICANT	

Graph no. 1: Comparison of mean values of pre and post of JPE of Group A

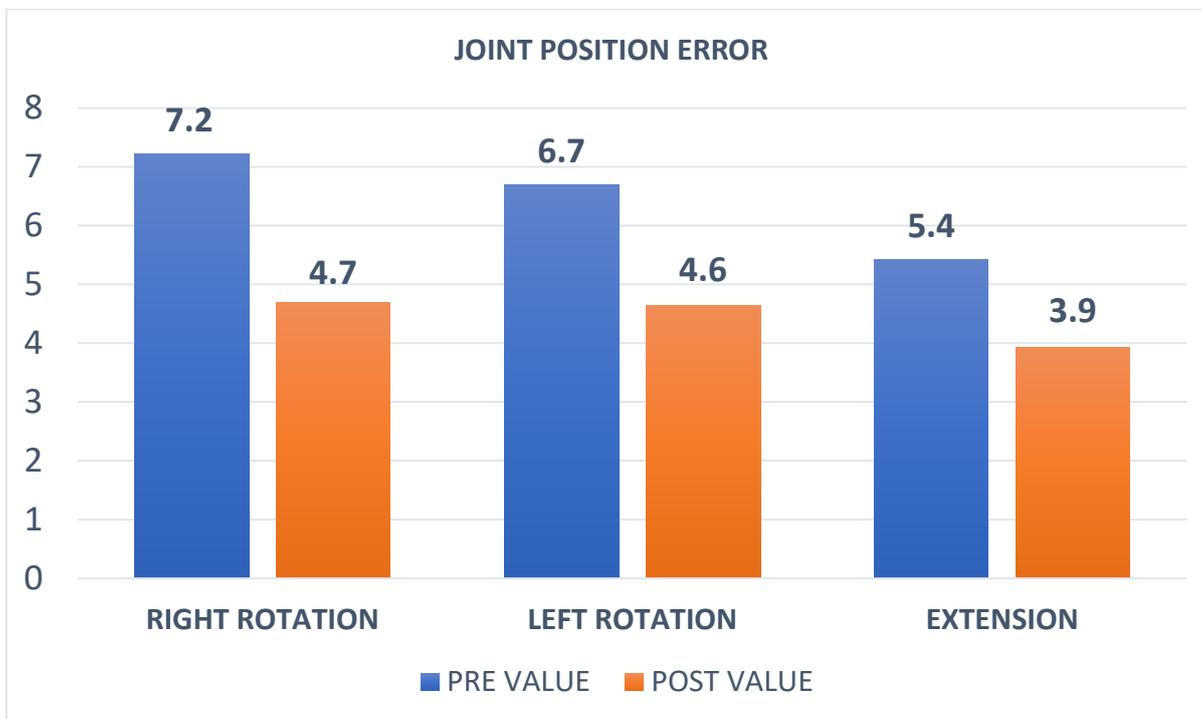


Table no.2: Comparison of pre and post values of NDI in Group A using paired T test

<u>PARAMETER</u>	<u>PRE-VALUES</u>	<u>POST VALUES</u>
MEAN	21.8	11.6
STANDARD DEVIATION	6.746	4.441
P VALUE	< 0.0001	
T VALUE	19.353	
SIGNIFICANCE	EXTREMELY SIGNIFICANT	

Graph no. 2: Comparison of mean values of pre and post of NDI of Group A

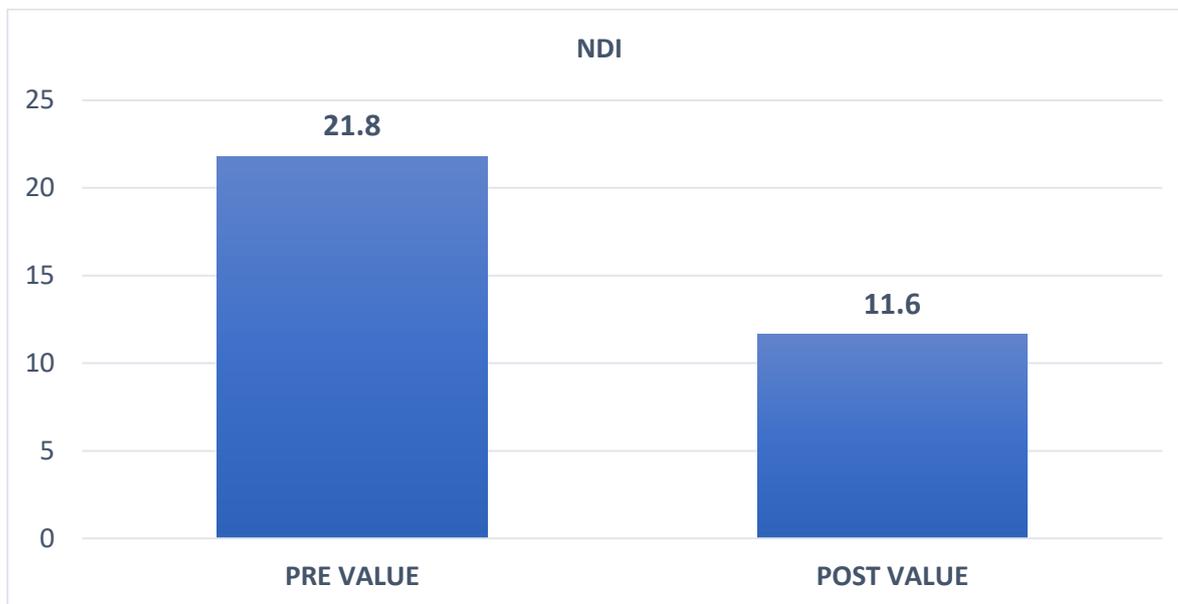
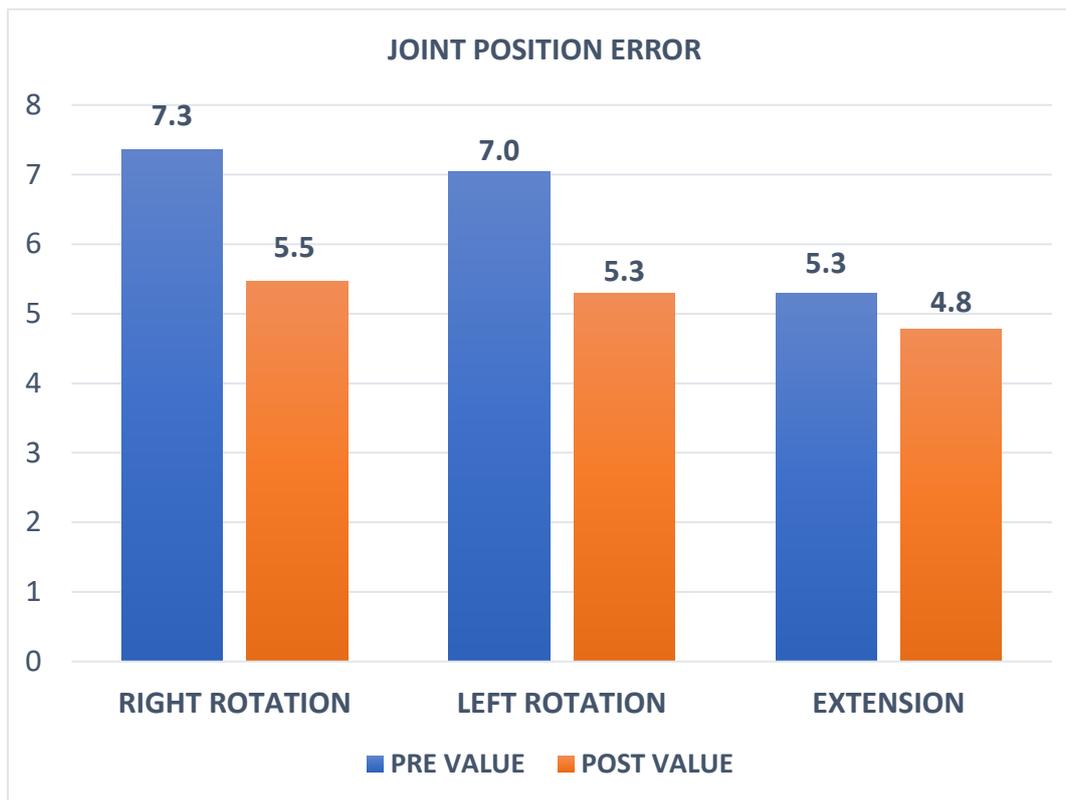


Table no.3: Comparison of pre and post values of JPE in Group B using paired T test

<u>PARAMETERS</u>	<u>RIGHT ROTATION</u>		<u>LEFT ROTATION</u>		<u>EXTENSION</u>	
	PRE	POST	PRE	POST	PRE	POST
MEAN	7.3	5.5	7.0	5.3	5.3	4.8
STANDARD DEVIATION	1.787	1.242	1.708	1.338	1.940	1.836
P VALUE	< 0.0001		< 0.0001		< 0.0001	
T VALUE	11.816		17.946		17.640	
SIGNIFICANCE	EXTREMELY SIGNIFICANT		EXTREMELY SIGNIFICANT		EXTREMELY SIGNIFICANT	

Graph no. 3: Comparison of mean values of pre and post of JPE of Group B**Table no.4: Comparison of mean values of pre or post of NDI in Group B using paired T test**

<u>PARAMETER</u>	<u>PRE-VALUES</u>	<u>POST VALUES</u>
MEAN	23.3	14.3
STANDARD DEVIATION	5.803	4.556
P VALUE	< 0.0001	
T VALUE	17.880	
SIGNIFICANCE	EXTREMELY SIGNIFICANT	

Graph no. 4: Comparison of mean values of pre and post of NDI of Group B

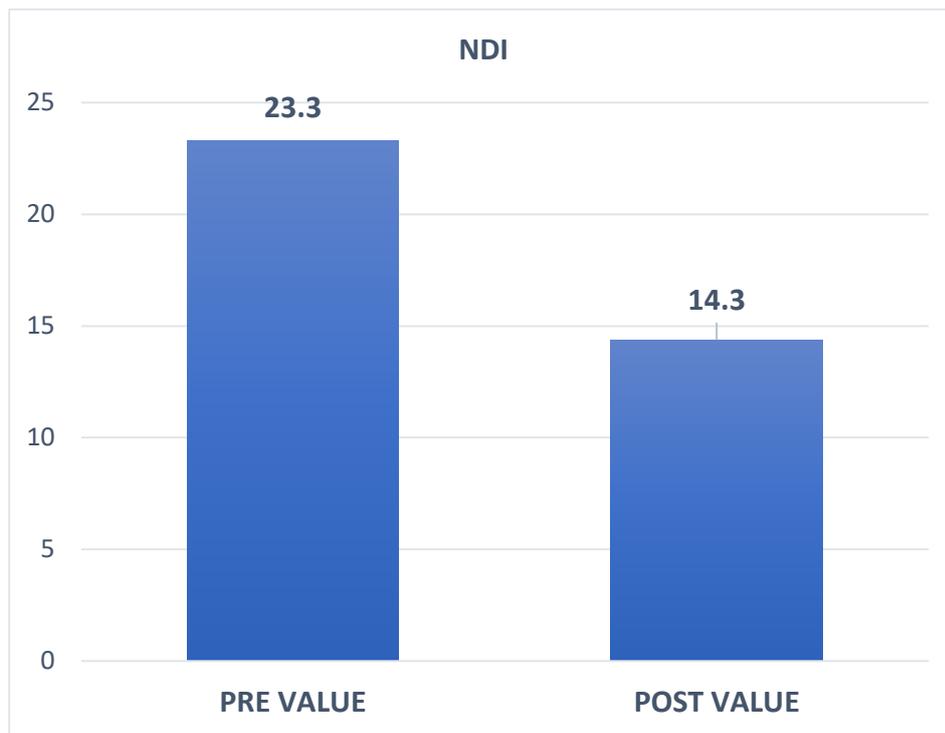


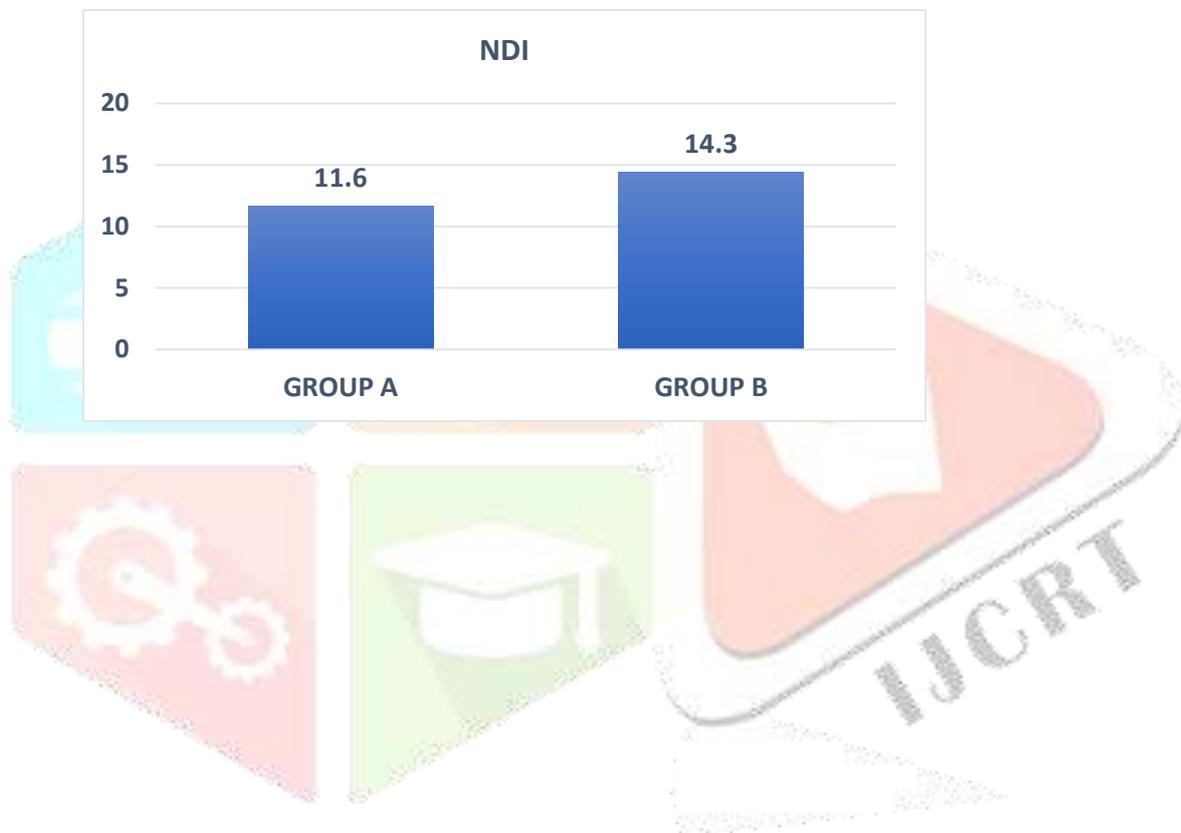
Table no. 5: Comparison of Group A and Group B mean values of NPRS, JPE, NDI using Unpaired T test

<u>PARAMETE</u> <u>RS</u>	<u>NPRS</u>		<u>JOINT POSITION ERROR (JPE)</u>						<u>NDI</u>	
	<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>	<u>RIGHT ROTATION</u>		<u>LEFT ROTATION</u>		<u>EXTENSION</u>		<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>
			<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>	<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>	<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>	<u>GROUP</u> <u>A</u>	<u>GROUP</u> <u>B</u>
MEAN	2.4	2.8	4.7	5.5	4.6	5.3	3.9	4.8	11.6	14.3
STANDARD DEVIATION	0.7121	0.9197	1.266	1.242	1.073	1.338	1.315	1.836	4.441	4.556
P VALUE	0.0373		0.0162		0.0335		0.0372		0.0173	
T VALUE	2.128		2.471		2.175		2.129		2.445	
SIGNIFICA NCE	SIGNIFICANT		SIGNIFICANT		SIGNIFICANT		SIGNIFICANT		SIGNIFICANT	

Graph no.5: Comparison of mean value of JPE of Group A and Group B



Graph no.6: Comparison of mean value of NDI Of Group A and Group B



DISCUSSION

The primary purpose of the study was to compare the effect of Proprioceptive Training and Craniocervical Flexion (CCF) Training on cervical Joint Position Sense (JPS) in patients with mechanical neck pain between the age group 18-25 years.

64 subjects were taken based on inclusion criteria which was age between 18-25 years, both male and female gender, subjects having mechanical neck pain (less than 3 months), subjects with Joint Position Error Deficit in 2 out of 3 movements (left rotation, right rotation and extension), subjects willingness to participate and subjects having any neurological signs, history of neck injury, cervical spine surgeries, chronic and degenerative conditions like spondylosis, spondylolisthesis and those who participated in a neck exercise program in past 12 months were excluded. Measurements using NPRS, Joint Position Error test (for left rotation, right rotation, and extension) and NDI were taken before and after treatment session.

The result of the present study demonstrated that both Proprioceptive Training and Craniocervical Flexion Training are effective in improving Joint Position Error (JPE) and reducing pain and disability. The results for CCF training exercise protocol emphasizes one plane of motion (sagittal plane) but it shown to improve cervical proprioception in measures of movement in both transverse and sagittal plane.⁽¹⁴⁾

The mechanism behind this is that it decreases the stresses placed on the joints and other structures of the cervical region as it uses biofeedback provided by pressure sensor under the neck in which subject practices precise holding of progressive inner range positions which enhances the activity of deep cervical musculature.⁽¹⁴⁾ It has been suggested that abnormal joint stress may alter firing of cervical afferents with resultant changes in proprioceptive functions and deep muscle activity is increased following CCF Training and this may alter intersegmental kinematics leading to improved acuity for cervical movement.⁽³⁾

Thus, CCF training directly activates the deep cervical flexor musculature which has high density of muscle spindles so repeated contractions involved in CCF training improves muscle spindle function translating to improved cervical proprioception.⁽¹⁴⁾

Proprioceptive training has shown greater benefits in improving JPE and reducing pain and disability. Previous studies suggested that Proprioceptive training not only improves patient perceived pain and disability, but also has other aspects of neuromuscular function, specifically the coordination between the deep and superficial cervical flexors.⁽²⁰⁾ Cervical muscles are the direct performers of the sensorimotor control system and coordination between cervical muscles ensures the dynamic stability of cervical spine during neck movements.⁽⁵⁰⁾

Proprioceptors are responsible for providing afferent information regarding change of position and angular velocity of spine to central nervous system (CNS) which controls tension of the neck muscle and react to those changes according to this information.⁽³⁶⁾ Neck pain is associated with disturbance in cervical sensorimotor control. The evidence indicated that the activation of nociceptors (type 3 and type 4 afferents) could inhibit the activity of gamma motor neurons, which leads to proprioceptive disturbance.⁽⁵⁰⁾

Proprioceptive training involves practice of relocating the head back to the natural head posture and to predetermined positions in range, oculomotor exercises such as gaze stability exercises, eye follow exercises and eye head coordination exercises which reduces pain and muscle tension via changes in suboccipital muscle spindle activity, consequently improves Cervical Joint Position Sense. In addition, there are many receptors in the deep suboccipital muscles that create reflex and central communication with vestibular, visual, and postural control systems. Thus, Proprioceptive Training shows greater results.^(14,22)

CONCLUSION

This study concludes that both the techniques are effective in improving cervical joint position error in the age group 18 – 25 and can be used in rehabilitation of patients with Mechanical neck pain.

Proprioceptive Training is more effective than Craniocervical Flexion Training in improving Joint Position Sense in patients with Mechanical Neck Pain in individuals between 18-25 years.

It improves not only Proprioception but also reduces the patient's pain and disability.

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