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Comparison of Upper Limb Proprioception in Chronic Mechanical Neck Pain Patients with Age-Sex Matched Healthy Normals

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Abstract: ***Purpose:Primarily to compare the Upper Limb Proprioception in Chronic Mechanical Neck Pain Patients to Age - Sex MatchedNormals.Method:30 women, 19- 30 years of age were assessed via a digital inclinometer for repositioning error for shoulder, elbow and wrist joints.Results:It was found that there was a difference in upper Limb Proprioception in Chronic Mechanical Neck Pain patients as compared to age sex matched normal individuals.Conclusion:On comparison, individuals with Chronic Mechanical Neck Pain had a statistically significant difference in the shoulder and wrist proprioception as compared to age matched Normals***.

Keywords: Mechanical Neck Pain, Chronic, Proprioception, upper limb

1. Introduction

Neck pain is a common problem with two third of the population having neck pain at some point in their lives causing substantial personal and financial costs [(1,2)]. Neck pain is more prevalent among women with its prevalence peaked in middle age[3] Chronic neck ache, where pain stays mainly in the neck may result from degenerative disc disease or arthritis of the facet joints of the cervical spine, referred to as mechanical neck pain.[4] 'Mechanical neck pain' can also be defined as pain in the anatomical region of the neck for which it is not possible to identify specific pathological causes of pain. It includes neck pain with or without pain in the upper limb which may or may not interfere with activities of daily living, with a prevalence of 60 to 70 % in general population. [(5,6)]

The term proprioception was coined in 1906 by the neurophysiologist Sir Charles Sherrington from the Latin "proprius," meaning "one's own," for sensory information derived from neural receptors embedded in joints, muscles, and tendons. Proprioception is generally divided in the sub modalities -- sense of tension (resistance), sense of movement, and joint position sense. All three modalities can be appreciated consciously and unconsciously, contributing to automatic control of movement, balance, and joint stability, and thus being essential to carry out daily living tasks, walking, and sports activities (Riemann & Lephart, 2002).

One of the identified problems in persons with neck pain is a change in proprioception. Persons with neck pain have been observed to have less accurate and precise position sense of the head and the upper limbs [(7-9)]. The majority of investigators have concentrated on proprioceptive acuity when investigating position and movement sense.[10]Jonas Sandlund, Mats Djupsjobacka et al did a study on Predictive and discriminative value of shoulder proprioceptive tests for patients with whiplash associated disorders and found that patients with whiplash associated disorders have impaired shoulder proprioception. Havik H. Murphy B et al, did the study on Subclinical neck pain (SCNP) and the effects of cervical manipulation on elbow joint position sense and found that asymptomatic people with a history of sub clinical neck pain have reduced elbow joint position sense accuracy compared to those with no history of any neck complaints. Also, Knozz JJ, Beilstein DJ, et.al found that elbow joint position error was affected by movement of the head and neck within smaller angle of neck rotation in people with whiplash associated disorder than in healthy individuals. To the author's best knowledge, there have been no studies that have taken into consideration all three joints of the upper limb proprioception in chronic mechanical neck pain patients.

Thus, the purpose of our study was to compare the upper limb proprioception in chronic mechanical neck pain patients to the normal as injuries or inflammation of structures in the neck may have an impact on proprioception of adjacent joints (e.g shoulder) as well as of the upper limb by effects mediated via spinal reflexes.

2. Aim & Objectives

The aim was to compare Upper Limb Proprioception in Chronic Mechanical Neck Patients and Age Sex matched Healthy normals. The objectives were to assess and compare Upper Limb Proprioception in Chronic Mechanical Neck Pain Patients and Healthy Normals.

3. Review of Literature

1) Jonas Sandlund, Mats Djupsjobacka et al did a study on Predictive and discriminative value of shoulder proprioceptive tests for patients with whiplash associated disorders. 37 chronic whiplash-associated patients and 41 healthy subjects matched for age and gender. All subjects underwent a shoulder proprioception test involving active ipsilateral arm position-matching. Group difference was evaluated by multiple analysis of variance and analysis of variance. Correlation and regression

analyses were done to study the associations between proprioceptive acuity and self-rated functioning and symptoms.The study concluded that patients with whiplash associated disorders have impaired shoulder proprioception.

2) Havik H. Murphy B et al, did the study on Subclinical neck pain (SCNP) to study effects of cervical manipulation on elbow joint position sense.25 SCNP participants and 18 control participanted. Elbow JPS was measured using an electrogoniometer. Participants reproduced angle of the elbow joint with their neck in 4 positions: neutral, flexion, rotation, and combined flexion/rotation. The experimental intervention was high-velocity, low-amplitude cervical adjustments, and the control intervention was a 5-minute rest period. It was assessed pre and post interventions with absolute, constant, and variable errors. Study concluded that asymptomatic people with a history of sub clinical neck pain have reduced elbow joint position sense accuracy compared to those with no history of any neck complaints.
3) Knozz JJ, Beilstein DJ, et.al did a study if changes in head and neck position having a greater effect on elbow joint position sense in people with whiplash associated disorders. This study included 9 people with chronic and disabling WAD and 11 healthy people participated in this experiment. The ability to reproduce a position at the elbow joint was assessed in the position of the head and neck to 30 degrees, and in midline. Pain was monitored. This study concluded that elbow joint position error was affected by movement of the head and neck within smaller angle of neck rotation in people with whiplash associated disorder than in healthy individual.

4. Materials & Methods

The study was conducted in Mumbai, India. The tools used for the study were Numerical Rating Scale, Digital Inclinometer sensors, Marker and Velcro straps.The study methodology was approved by the ethics committee at School of physiotherapy, D.Y Patil University and was carried out at D.Y.Patil Hospital and Research Centre. Subjects were explained about the procedure and consent was taken for the same. Fifteen subjects suffering from chronic mechanical neck pain with control group of fifteen healthy normals (age, gender matched) participated in this study. The duration of neck pain more than 3 months was considered as chronic. Subjects were included based on criteria given by Grieve for Mechanical Neck Pain. Subjects were briefed about the purpose and objective of the study. Patients were excluded if they had, neurological deficit, recent cervical spine trauma, upper extremity trauma, cervical spine disc pathology, radiculopathy root lesion, presence of scapula muscle weakness and absence of full ROM in upper extremity joints.

Participants were required to perform 3 distinct movements upto certain target angles, reproducing the movement actively. The test was done in supine position to avoid trick movements by the patient. They were blindfolded and instructed to perform the movement as accurately as possible till the target angle in a smooth arc of motion. 3 trials were recorded. The 3target angles were as follows (1) Shoulder adduction of 30 degrees[8] with starting position at 90 degrees of shoulder Flexionin order to prevent any provocation of pain in patients(2) 30 degrees Elbow flexion from 0 degree of elbow flexion with the entire upper extremity kept supported. (3) 30 degrees Wrist extensionfrom neutral wrist position, with hand resting on a supporting surface mimicking the functional position of the hand.Movement toward each target angle was performed at the subjects preferred speed, 3 times within 10 seconds. Participants were asked to expose the body parts for the test in an attempt to negate any direct proprioceptive input from clothing. The subjects were assured about anonymity and confidentiality of the assessment taken. On completion of data collection, the data was analyzed.

5. Results

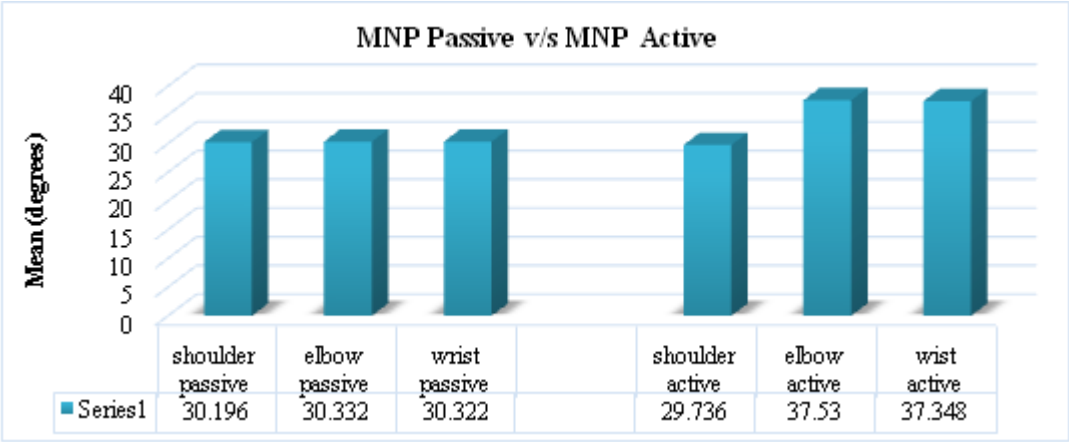

Figure 1: Graphical representation of the Mean values of passive and active repositioning of Shoulder, Elbow and Wrist of Chronic Mechanical Neck Pain patients.

Table 1: Computation of statistical values of Chronic Mechanical Neck Pain patients

	Mean ±S.D		95% Confidence Interval for Mean	
	MNP		Lower Bound	Upper Bound
	Passive	Active		
Shoulder	30.19 ± 0.22	29.73 ± 3.88	0.22	0.07
Elbow	30.33 ± 0.14	37.53 ± 10.01	0.20	0.00
Wrist	30.32 ± 0.21	37.34 ± 8.21	0.18	0.14

Table 1 displays the passive and active mean values,standard deviation. The above values show that the chronic Mechanical Neck Pain group had a difference in their active repositioning of the target angle.

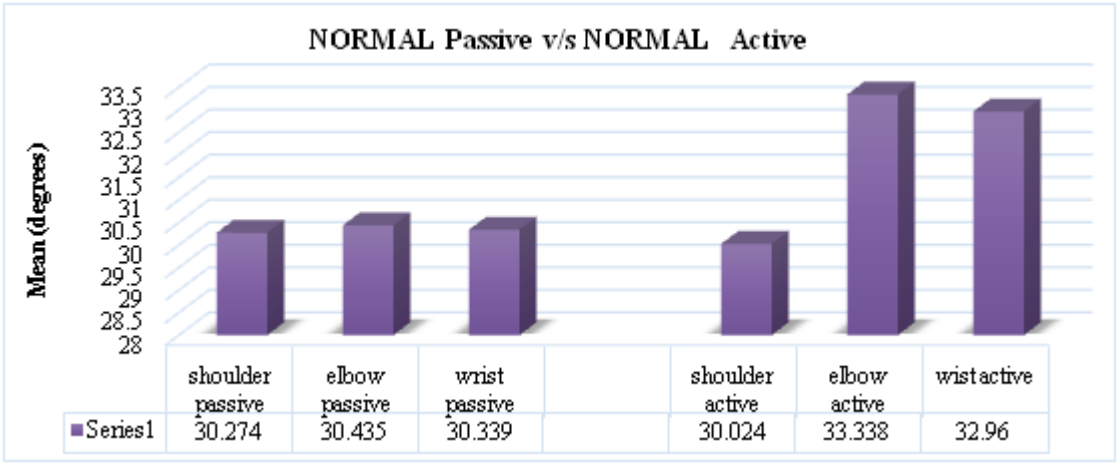

Figure 2: Graphical representation of the Mean values of passive and active repositioning of Shoulder, Elbow and Wrist of Healthy Normal Individuals

Table 2: Computation of statistical values of Normal Individuals

	Mean ±S.D		95% Confidence Interval For Mean	
	Normal		Lower Bound	Upper Bound
	Passive	Active		
Shoulder	30.27 ± 0.16	30.02 ± 2.91	2.85	2.28
Elbow	30.43 ± 0.11	33.33 ± 3.66	1.44	9.83
Wrist	30.33 ± 0.22	32.96 ± 3.79	0.39	9.17

Table 2 displays the passive and active mean values, standard deviation. The above values show that the Normal Individuals did not have a major difference in their active repositioning of the target angle.

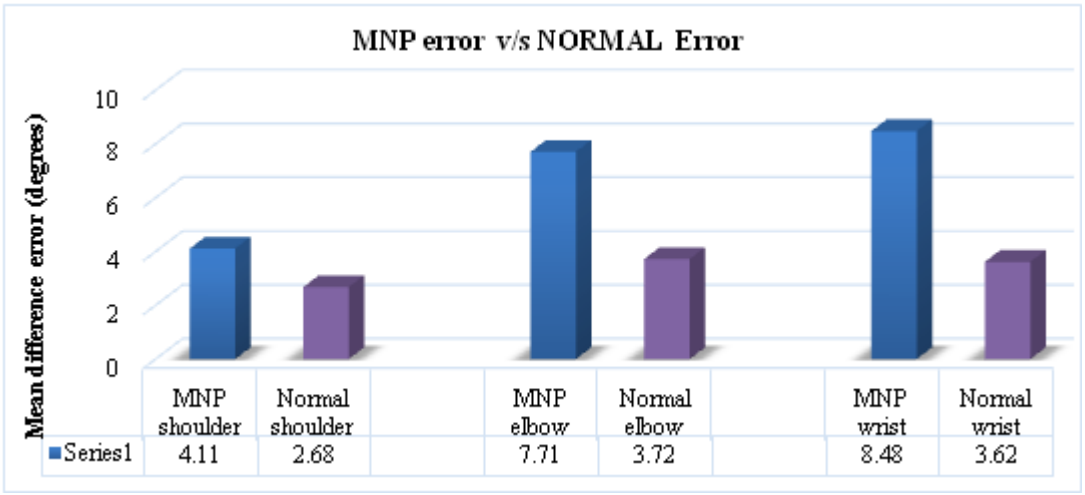

Figure 3: Graphical representation of Comparison of Mean difference value of Mechanical Neck Pain patients v/s Normal individuals

Table 3: Computation of statistical value and significance of comparison of mean difference value of mechanical neck pain patients v/s normal individuals

	MNP v/s NormaL (Mean Value)	95% Confidence Interval for Mean		P Value	Significance
		Lower Bound	Upper Bound		
Shoulder	1.69	0.40	2.98	0.012	Significant
Elbow	3.98	1.49	9.46	0.148	Not significant
Wrist	4.86	0.83	8.88	0. 020	Significant

Table 3 displays the mean difference value, calculated paired 'p'value. It was found that there was a statistical significant difference in the shoulder and wrist joint proprioception between the Chronic Mechanical Neck pain patients and Normal individuals while the difference in elbow joint proprioception was found to be statistically non-significant.

6. Discussion

A total of 30 people participated in this study with 15individuals in the experimental groupand 15individualsin the control group. On statistical analysis, on comparison, it was found that there was a difference in upper Limb Proprioception in Mechanical Neck Pain Patients as compared to age sex matched normal individuals.

Proprioception

Proprioception is "the process by which the body can vary muscle contraction in immediate response to incoming information regarding external forces," by utilizing stretch receptors in the muscles to keep track of the joint position in the body[11].Proprioception receptors, such as mechanoreceptors and free nerve endings, are found in the skin, facial, muscles, tendons, joint capsules, and ligaments. When active or passive movement occurs, receptors transmit the movement information to the central nervous system (CNS)[12]There are two distinct mechanoreceptors muscle spindles and golgi tendon organs.[13]Limb proprioception is an awareness by the central nervous system (CNS) of the location of a limb in three-dimensional space and is essential for movement and postural control. The central nervous system uses the position of the head and neck when interpreting the position of the upper limb, and altered input from neck muscles may affect the sensory inputs to the central nervous system and consequently may impair the awareness of upper limb joint position. Zabihhosseinian M[14], Holmes MW, Murphy B, et al confirmed that fatigue of the cervical extensor muscles (CEM) can reduce the accuracy of elbow joint position matching, suggesting that altered afferent input from the neck subsequent to fatigue may impair upper limb proprioception.

Neck Pain

Pain may also be a factor affecting the evaluation of muscle strength and proprioceptive acuity. [15,16]In chronic neck pain patients, overuse, repetitive trauma, serious trauma and muscle weakness cause the range of elasticity of the non-contractile tissues to enlarge, and stabilize the neutral position while the contractile tissues become weak. As a result, instability increases in the spinal segments, resulting in failure to maintain the neutral position.[17] Shoulder pain can sometimes be coming from neck. It is because the nerves and muscles that arise from neck passes through shoulder on their way down the arm. The nerves from neck (Nerve Roots) also travel down the arm (via the Brachial Plexus). Thus, neck pain may extend down your arm.[18]According to the studies, the identified problem in persons with neck pain is a change in proprioception. Persons with neck pain have been observed to have less accurate or precise positon sense of the head and limbs;[19,20] patients with whiplash associated disorders have shown to have impaired shoulder proprioception (Jonas Sandlund, Mats Djupsjobacka).

For the elbow joint it has been found that there was mean difference in both the groups, but it was statistically non significant. Studies have shown that the asymptomatic people with a history of sub clinical neck pain have reduced elbow joint position sense accuracy compared to those with no history of any neck complaints (Havik H. Murphy B). Knox &Hodges [21]and Knox et al. [22,23] have shown that the perceived position of the head and neck influences the perception of elbow positioning. Knowledge of head position thus appears to be a vital component in the organization of intrinsic sensory information for upper limb position and possibly for other joints. The proprioceptive deficits found in persons with neck pain could be a consequence of re-weighting of sensory signals. Re-weighting of sensory signals (gain control process) has been reported in patients with spasmodic torticollis and in patients with low back pain [24,25] This could possibly explain the difference in elbow proprioception between both groups.

According to the studies, unilateral musculoskeletal pain appears to delay grip initiation and relaxation, perhaps due to centrally mediated mechanism.[26] Michael et al investigated that patients with cervical spondylosis had significantly lower grip strength and grip endurance than the controls in both dominant and non-dominant hands. They clarified that increased tissue pressure arising from degenerative changes compromises myoneural conduction velocity and tissue blood flow and oxygenation which interfere with ability of the nervous system to activate hand muscles.[27] Also it has been revealed that there is a significant positive correlation between neck pain and hand grip strength.[28] Huysmans MA et al investigated that abnormality of sensory motor integration found in neck pain lead to deficit in the quality of sensory information that generate output or may be due to sensory hyper excitability.[29]This would explain the deviation seen at the wrist.

Neck Muscles

Studies have shown that co-ordination of movements, including balance, is dependent on information from the visual, vestibular and proprioceptive systems. The high concentration of muscle spindles in the neck and cephalic muscles[30] and disturbances in motor control after anaesthesia of neck muscles[31] supports the importance of neck muscle receptors for motor control. The importance of muscle receptors in proprioception has been demonstrated through the finding of impaired reproduction of joint angle after fatiguing contractions of the associated muscles. Whiplash trauma has been hypothesized to cause lesioning of receptor-bearing structures or functional impairment of muscular and articular receptors. This would have an impact on proprioception and motor control and thus provide an explanation for the disturbances in sensory-motor control of the neck found in patients with WAD [32-34]which might possibly be present in mechanical neck pain too.

Muscle fatigue also has its impact on proprioception. Muscle fatigue could be seen as any reduction in the maximal capacity to generate force or power output (Völlestad 1997).

Thus, it is associated with an impairment of motor performance that includes a perception of increased effort to sustain the task and the eventual failure to do so due to the reduced force capacity. For the shoulder joint, the proprioceptive acuity following fatigue has been shown to be reduced. Myers et al, did the study on effects of fatigue on the shoulder position sense and found that the amount of error made by the subjects was significantly different before and after fatigue, compared to the control group. Voigt et al did a similar study on both active and passive repositioning tests to determine the acuity of proprioception; found position sense error to be significantly increased after fatigue. Also, it was found that the threshold of movement detection significantly increased after fatigue (Carpenter). Studies have shown that the fatigue has its effects on proprioception in a multi-joint upper extremity task. (Tripp, Boswell et al. 2004; Tripp, Yochem et al. 2007) It was investigated that for both positions in the movement trajectory, the acuity was significantly decreased after fatigue, also the effect was seen in all of the upper extremity joints including scapulothoracic, glenohumeral, elbow and wrist. Thus, this explains that proximal muscles including the neck and scapula muscles that help in stabilizing the neck have an influence on the proprioception of the entire upper limb.

Age

Decrease in proprioception has also been foundwith increasing age and may be part of the normal aging process. There is evidence which suggests that proprioceptive function declines during the aging process (Bullock-Saxton, Wong, & Hogan, 2001; Kaplan, Nixon, Reitz, Rindfleish, & Tucker,1985; Pai, Rymer, Chang, & Sharma, 1997)

7. Conclusion

Patients with Chronic Mechanical Neck Pain showed a statistically significant difference in the shoulder and wrist proprioception.

8. Acknowledgment

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9. Conflict of Interest

None

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