Effectiveness of Physical Therapy Intervention on Neck Proprioception and Balance Parameters in Patients With Chronic Mechanical Neck Pain

Gehan M. Ahmed[1] and Azza M. Atya[2]
Department of Neuromuscular Disorder and its Surgery[1], Department of Basic Sceince[2], Faculty of Physical Therapy, Cairo University.

ABSTRACT

Back ground and aim: *Neck pain is a common condition affecting as much as two-thirds or more of the general population at one point of time during their life. Patients with chronic mechanical neck pain have somatic dysfunction in the cervical spine result in abnormal sensory input from neck proprioceptors leading to disturbed balance parameters. The purpose of this study was to investigate the effect of physical therapy intervention on neck proprioceptive regaining and balance parameters in patients with chronic mechanical neck pain.* ***Subjects, Materials and Methods:*** *Twenty patients from both gender were diagnosed as having chronic mechanical neck pain (age ranged from 32: 43 years) and compared to twenty matched subjects who did not suffer from neck pain participated in this study. Pain and cervical range of motion were measured by using visual analog scale and cervical range of motion instrument respectively. Static and dynamic balance parameters were measured by using Biodex Balance System. The treatment protocol consisted of 24 sessions as three sessions per week. The patients received hot pack on neck for ten minuet followed by exercise program.* ***Results:*** *The results revealed improvement in pain and cervical mobility after treatment program. Static and dynamic parameters showed a significant improvement in the patients after treatment compared to before treatment values. Conclusion it could be concluded that physical therapy intervention in cases of chronic mechanical neck pain increase cervical kinesthetic sensibility by improving neck pain and cervical mobility which in turn improve balance parameters.*

Key Wards: *Mechanical neck pain- Exercises – Balance parameters.*

INTRODUCTION

Mechanical neck pain MNP is common complaints with a prevalence of 60 to 70% in the general population. Neck pain is one of the most common causes of missed work and disability. Chronic neck pain has been variously defined to its duration as chronicity can develop after only one month of symptoms duration[1].

Uncomplicated mechanical neck pain is the result of a complex interaction between muscular and ligamentous factors related to posture, sleep habits, ergonomics such as computer monitor and bifocal position, stress, chronic muscle fatigue, postural adaptation to other primary pain sources (shoulder, temporo-mandibular joint), or degenerative changes of the cervical discs or facet joints[2].

Mechanical neck pain is generally experienced in the lower neck region. Although the cause of neck pain may be associated with degenerative processes identified during diagnostic imaging, the reason that is causing a patient's neck pain is most often unknown[3]. Clinicians considered that age greater than 40 is age of coexisting pain. A long history of neck pain is cycling as a loss of muscle strength, worrisome attitude, poor quality of life, and less vitality[1].

Treatment for chronic pain includes several different general categories. These categories include physical therapy and complementary medicine treatments. Physical therapy is a prescribed program of treatment that generally provided to improve or restore lost or impaired physical function resulting from illness. The physical therapist enhances rehabilitation and recovery by clarifying a patient's impairments and functional limitations and by identifying interventions, treatment goals and precautions. Regular help to restore strength of neck muscles and enhance a gradual return to everyday activities which are important for full recovery[2,4].

The system of postural regulation is considered to consist of numerous different sensorimotor loops (proprioceptive, vestibular, and visual) whose interaction maintains the

body position and restore lost balance[5]. Somatosensory input is often under-estimated as an element of normal and defective postural control. Vital information about the position of the body in space and the relative position of various body parts is constantly being transmitted by muscle and joint proprioceptors, especially those in the neck. Proprioceptors in the cervical spine are particularly important as well as information from the postural muscles[6].

Patients with chronic non- specific neck pain have somatic dysfunction in the cervical spine result in abnormal sensory input from neck proprioceptors leading to disturbed balance parameters[7]. The purpose of this study was to investigate the effect of physical therapy intervention on neck proprioceptive regaining and balance parameters in patients with chronic mechanical neck pain.

SUBJECTS, MATERIALS AND METHODS

Twenty patients from both gender were diagnosed as having chronic mechanical neck pain based on neurological assessment and radiological investigations participated in this study. The duration of illness was not less than three months as recurrent pain. The patients were recruited from Out- Patient Clinic of Faculty of Physical Therapy, Cairo University. Their age ranged from 32 to 43 years and compared to twenty matched subjects who did not suffer from neck pain(Continuous or recurrent) or any systemic disease.

Subjects were excluded if they had: (1) Evidence of disc prolapse, (2) Previous cervical fracture, trauma, or surgery, (3) Deformity of the spine (e.g. kyphosis, scoliosis), (4) Hypertension, hypotension, inner ear infection, or diabetes mellitus, (5) Vertebrobasilar insufficiency, (6) Known neural tissue involvement, (7) Malignancy, (8) Neurological evidence leading to balance disturbance (e.g sensory ataxia), (9) Cervical instability, and (10) Obese subjects.

Instrumentations

A- Visual analogue scale (VAS): It is a 100 mm. straight line, the left end (0) of the line representing no pain and the right end (100) of the line representing the worst pain[8]. Patients were asked to mark on the line where they think their pain is to describe the intensity of the pain.

B- Cervical range of motion instrument (CROM, basic instrument, performance Attainment Associates, Vandnais Heights) was used to measure active cervical mobility[9].

C- The biodex Balance System (Biodex Medical System, Shirky Ny 11967) consists of a movable balance platform and is interfaced with a microprocessor based actuator connected to computer system was used to measure the static and dynamic balance parameters[10].

Procedures

All the patients were asked to avoid taking medication (non-steroidal anti-inflammatory drugs) less than four hours prior to treatment appointment. All evaluating and treatment procedures were done at Out- Patient Clinic, Faculty of Physical Therapy, Cairo University. After signing a written consent form, all subjects underwent the same evaluation procedures included:

- History taking (name, age, weight, height, current behavior of symptoms, critical factors surrounding the onset of symptoms) and neurological examinations including sensory and motor examinations.
- Observation of posture (alignment of the head, neck, and shoulder girdles) while subject was in standing position and back straight.
- The patients were instructed to mark the visual analog scale VAS (0-100 mm.) to present their pain intensity (pre and post treatment program).
- Active cervical range of motion (ROM) was measured with the CROM instrument according to the manufacturer's instructions for all subjects at the beginning of the study and after treatment program for the patient group. Total ROM was assessed in flexion, extension, lateral flexion and rotation as the following:

The therapist manually stabilized the subject in sitting position with back support and the movements of the upper thoracic and

trunk were controlled. The subject practiced each movement three times before the measurement. Each motion was measured twice in successive and then averaged. The patient moved through available ROM to the point where pain began to increase and stopped movement at that point, then the average was recorded. If no increase in pain was experienced, the patient moved to the physiological end point of the active range. This test was performed twice (Pre and post treatment program). Left and right rotation were summed to provide a measure of motion in the horizontal plane, and left and right lateral flexion were also summed to provide a measure of motion in the frontal plane while flexion and extension ranges were summed in the sagital plane.

- Biodex Balance System testing: The tests were done at the balance Lab:

- The static test requires the subjects to look straight while standing as still as possible with his eyes open, focusing on the display monitor to maintain the curser within a centrally positioned in the bull's eye through the time of the test (20 seconds for each trail). A high overall balance stability index (SI) is indicative of a lot of movement during a test and less stability, on the contrary, a lower SI reflects less time spent away from the level position, interpreted as a better balance score.
- Limits of stability (LOS) is recorded for all subjects. LOS test is designed to assess an individual ability to volitional move the center of gravity COG to predetermined positions in space. The subject was instructed to begin the test while the platform advanced to unstable surface (50%). One trail was performed without recording then the test begins. The countdown clock at the lower right part of the screen provided a three seconds. When the countdown time was completed, the LOS test screen displays eight boxes arranged around the central box. The boxes on the top position of the screen represent the anterior- medial stability. The boxes at the bottom of the screen represent the posterior stability. Once the test began, the subject tried to move the cursor to the box which appeared on the screen and then back to the center box with a little deviation as possible. The mean value of three trails was calculated and recorded. High scores are good while lower scores are worse.

Treatment procedures

After the baseline measurements, the treatment program involved three sessions per week for total eight weeks. The patients received superficial heat in the form of hydro-collator hot pack on the neck for ten minutes followed by exercise program.

The patients received exercise program lasted approximately 30 minutes in the form of:

- Relaxation training for the neck musculature in the form of hold-relax technique in different directions (forward, backward, and laterally) from seven to ten repetitions in each direction.
- Gradual stretching exercise for the neck extensor and lateral rotators muscles.
- Isometric technique to improve strength of neck flexors.
- Eye fixation exercises11 aiming to improve cervicocephalic kinesthesia via eye head coordination which included:

- Automatic movements of the neck to maintain the gaze on a fixed target while, the therapist passively moved the trunk.
- The patient was instructed to fix a target for few seconds and to memories the head-neck position. Then the patient performed a maximal rotation of the head (with closed eyes), tried to find the initial position and then opened the eyes. The exercise was repeated to correlate as accurately as possible the initial head position.
- All subjects received an explanatory picture about modification of activities at home and the workplace.

Statistical analysis

The date were presented as mean ± standard deviation. Comparisons of means were done using Student t-test. Mann-Whitney U test was used to compare pain mean values pre and post treatment. Statistical significant was accepted at $P<0.05$.

RESULTS

The characteristics of patients (G1) and healthy control (G2) groups were represented in table (1). Inspection of the table revealed no significant differences in mean age, body weight and height between both groups.

Table (1): The general characteristics of the study and control groups (G1 and G2).

	Age (years)		Weight (Kg.)		Height(Cm.)	
Group	Mean	S.D	Mean	S.D	Mean	S.D
G1	39	3.23	79.3	5.13	169.4	5.21
G2	40	2.32	80.8	3.12	172.6	5.62
P-value	0.70		0.41		0.60	

Significance* at P< 0.05 SD= Standard deviation.

The improvement in pain intensity in the study group after treatment program according to VAS (mm) was statistically significant at P=0.004. Cervical mobility in different plans (sagital, frontal and horizontal) tended to increase in the control group compared to the study group pre treatment program. In addition, the mobility increased post treatment in the study group compared to pre treatment values (table 2).

Table (2): Comparisons of pain intensity and cervical mobility Pre and Post treatment in the study group and between both groups (G1 and G2).

	G1 mean ± SD	G2 mean ± SD	P- Value (between G1&G2)
Pain intensity on VAS (mm.) Pre	80 ±7		
Post	30±9		
P- Value (within G1)	0.004*		
Sagital mobility Pre	35.60 ± 2.12	64.50± 3.08	0.000*
Post	61.66 ± 2.50	64.50± 3.08	0.94
P- Value (within G1)	0.001*		
Horizontal mobility Pre	39.08 ± 1.69	61.19 ± 1.69	0.00*
Post	57.44 ± 2.54	61.19 ± 1.69	0.39
P- Value (within G1)	0.01*		
Frontal mobility Pre	37.23 ± 3.41	53.10 ±1.02	0.000*
Post	50.71 ±2.15	53.10 ±1.02	0.62
P- Value (within G1)	0.001*		

Significance* at P< 0.05 SD= Standard deviation.

The results of the static and dynamic balance parameters (Overal Stability Balance index SI and Dynamic limit of stability LOS) revealed that there were a statistical significant difference of SI between pre and post treatment program values in the study group with P<0.05. Comparisons between the study G1 and control G2 groups showed a statistical significant difference when compared pre treatment while there was no significant difference between both groups post treatment program, (P >0.05) as presented in (table 3 and Fig. 1).

Table (3): Comparisons between pre and post treatment program mean values of balance parameters (stability index and limits of stability) in the study and control groups (G1 and G2).

	G1 mean ± SD	G2 mean ± SD	P- Value (between G1&G2)
Pre Stability index(SI)	4.33 ± 1.15	2.09 ±0.66	0.0001*
Post	2.01 ± 0.75	2.19 ±0.66	0.40
P- Value (within G1)	0.001*		
Pre Dynamic limit of stability (LOS)	14.56 ±3.09	22.34 ± 3.53	0.004*
Post	21.56 ±2.09	22.34 ± 3.53	0.39
P- Value (within G1)	0.001*		

Significance* at P< 0.05 SD= Standard deviation SI= stability index LOS= limits of stability

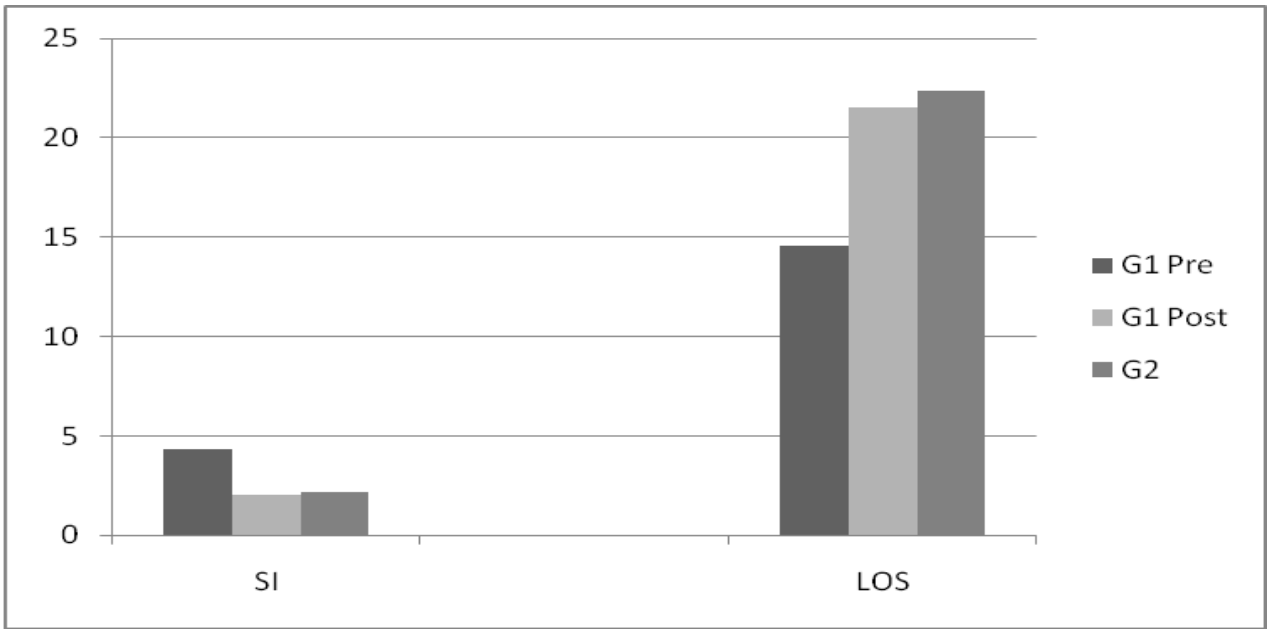

Fig. (1): Pre and post treatment program mean values of balance parameters (SI and LOS) in the study and control groups (G1 and G2).

DISCUSSION

This study was done to examine the effect of physical therapy intervention(hot pack and exercises) on balance parameters in patients with chronic mechanical neck pain. The primary findings were; cervical mobility (CROM) and neck pain (VAS) were improved following the physical therapy program.

These findings are parallel to the previous study[12] which concluded that thermal treatment is typically used to decrease muscle spasm, pain and increase circulation and tissue extensibility. Leman and Delateur[13] studied the temperature effects on muscle spasm and demonstrated that the rate of firing of the group Ia afferents was increased by warming. The secondary afferents responded via a similar manner whereas those with a low initial discharge rate showed a cessation of firing. Increasing firing from golgi tendon organs occurs which in turn leading to increase the inhibitory impulses.

Somatosensory inputs from the neck activated by changes in head orientation which influence the distribution of postural tone in the trunk and limbs[7]. Vestibular inputs, activated by a change in head orientation, alter the distribution of postural tone in neck leading to abnormal vestibulocollic and vestibulospinal reflexes[5,13].

The results of the present study supported the findings of the previous study[14] which proved that multimodal emphasizing exercises are beneficial for chronic non-specific neck problems as the ability to work are different among these patients. The results

of this study were also supported by Ylinen et al.,[15] who, examined 125 women diagnosed with chronic neck pain and found that (muscle strength, R.O.M and pain) were significantly improved post exercise program. The authors concluded that the exercise program intended to improve postural control, strength, muscle length as well as kinesthetic accuracy.

The findings of the current study agreed with the previous studies[16,17,18] which concluded that therapeutic exercises that included proprioceptive reeducation demonstrated higher significant improvement of pain, functional status and balance scores. Considering the goal of rehabilitation program, it is noted worthy that in addition to retinal information, extracranial signals, coming from extraoccular and neck muscles, proprioceptive receptors could also participate in eye-head coupling during gaze orientation. The functional organization of the neck and mainly of its proprioceptive apparatus supported the inclusion of exercises based on eye-neck coordination in exercise program for cervicalgic patients[19,20,21].

Conclusion

It could be concluded that physical therapy intervention in cases of chronic mechanical neck pain increase cervical kinesthetic sensibility by improving neck pain and cervical mobility as well as neck proprioceptive regaining which in turn improve balance parameters.

RERERENCES

1- Delitto, A., George, M., Ferland A, Fearon H., MacDermid J., Matheson JW, McClure P., Shekelle P., Russell S., Leslie T. Neck Pain: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health J Orthop Sports Phys Ther., 38(9): A1-A34, 2008.

2- Airaksinen, O., Brox, J.I., Cedraschi, C., Hildebrandt, J., Moffett, J. and Kovacs, F.: Management of chronic nonspecific neck pain, Eur Spine J.; 15 Suppl 2: S192-206, 2006.

3- Bogduk, N. and Mercer, S.: Biomechanics of the cervical spine, I: normal kinematics. Clin Biomech, American Physical Therapy Association (APTA). Criteria for Standards of Practice for Physical Therapy. BOD S03-06-16-38 (Program 32). 2006. Accessed June 12, 2008.

4- Hoving, J.L., Koes, B.W., De Vet, H.C., Assendelft, W.J., Windt, D.A. and Mameren, H.: Manual therapy, physical therapy or continued care by the general practitioner for patients with neck pain: short-term results from a pragmatic randomized trial. Ann Intern Med; 136: 713-722, 2002.

5- Graham, B.P. and Dutia, M.B.: Cellular basis of vestibular compensation: analysis and modelling of the role of the commissural inhibitory system. *Experimental Brain Research*; 137*:* 387-396, 2001.

6- Newton, R. and Neal, R.: Dimensional qualification of human standing posture, Gait and Posture; 4: 306-312, 2000.

7- Koskimies, K., Sutinen, P. and Aalto, H.: Postural stability, neck proprioception and tension neck. J. Acta Otolarayngal Suppl; 596: 59-65, 2000.

8- Princo, D.D., Me Grath, L.A., Raffi, A. and Buckingham, B.: The validationof Visual Analoug Scale as a measure for chronic and experimental pain, Pain; 37: 55-63, 1993.

9- Youdas, J.W., Garett, T.R., Suman, V.J., Bogard, C.L., Hallman, H.O. and Cary, L.A.: Normal range of motion of the cervical spine: Initial goniometric study. Phys Ther; 72: 770-780, 1992.

10- Pincivero, D., Lephart, S. and Henery, T.: Learning effects and reliability of the Biodex Balance System. J. Atheletic Training; 30: 35-39, 2000.

11- Re'vel, M., Minguet, M., Gergory, P., Vaillant, S. and Lue, J.: Changes in cervicocephalic kinesthesia after a proprioceptive rehabilitation program in patients with neck pain; A randomized controlled study. Arch Phys Med Rehabil; 75: 895-899, 1998.

12- Lewis, J.S., Hewitt, J.S., Billington, L., Cole, S., Byng, J. and Karayiannis, S.: A randomized clinical trial comparing two physiotherapy interventions for chronic low pain; Spine30(7): 711-721, 2005.

13- Babalian, A.L. and Vidal, P.P.: Floccular modulation of vestibuloocular pathways and cerebellum-related plasticity: An *in vitro* whole brain study. *Journal of Neurophysiology;* 84*:*2514–2528, 2000.

14- Leman, J.F. and Delateur, A.: A therapeutic heat In: Leman Jed, therapeutic heat and cold, 5th ed., Baltimore M, Williams and Willins, 1994.

15- Tiamela, S., Takala, E., Askolf, T., Seppala, K. and Parvianen, S.: Active treatment of chronic neck pain; A prospective randomized intervention. 25(8): 1021-1027, 2000.
16- Ylinen, J., Takala, E.P., Nykänen, M., Häkkinen, A., Mälkiä, E. and Pohjolainen, T.: Active neck muscle training in the treatment of chronic neck pain in women: a randomized controlled trial. JAMA; 289: 2509–2516, 2003.
17- Brossoeau, L., Tugwell, P., Wells, G., Robinson, V., Graham, I., Mcgowan, J. and Peterson, J.: Guidelines selected rehabilitation interventions for neck pain, phys Ther; 81(10): 1701-1712, 2001.
18- Richard, L.A.: Management of neck pain. Phys Sports Med; 42: 279-289, 1999.
19- Gross, A.R., Aker, P.D., Goldsmith, C.H. and Peloso, P.: Conservative management of mechanical neck disorder.J Curr Clin; 200: 21-31, 2000.
20- Goodmann, R. and Frew, L.J.: Effectiveness of progressive strength resistance training for whiplash. Physiother Canda; 67: 211-219, 2000.
21- Grantyn, A., Berthoz, A. and Hardy, G.A.: Contribution of reticulospinal neurons to the dynamic control of head movement on; Berthoz, A., Vidal, P., Graf, W, editors, The head- neck sensory motor system. New York, Oxford Uni. Versity Press, 617-628, 2000.

الملخص العربي

تأثير تدخل العلاج الطبيعي على المستقبلات الحسية للرقبة وقياسات الاتزان فى مرضى ألم الرقبة الميكانيكي المزمن

أجريت التجربة بهدف دراسة تدخل العلاج الطبيعى وتأثيره على قياسات الاتزان فى مرضى ألم الرقبة الميكانيكى المزمن.تم علاج عشرون مريضا ممن يعانون من ألم الرقبة المزمن لأسباب ميكانيكية وتم مقارنتهم بعشرين أخرين من الأصحاء . تم علاج المرضى بالبرنامج التالى : كمادة ساخنة لمنطقة الرقبة لمدة 10 دقائق يتبعها برنامج من التمرينات العلاجية بمعدل 3 جلسات فى الاسبوع لمدة 8 أسابيع . وأسفرت النتائج عن تحسن فى درجة الألم والمدى الحركى للرقبة بالاضافة الى تحسن قياسات الاتزان الثابت والمتحرك فى المرضى بعد تلقيهم برنامج العلاج الطبيعى. وقد أوضحت الدراسة ضرورة أهمية تدخل العلاج الطبيعى لتحسين الاتزان لدى هؤلاء المرضى .