Significance of Cervical Flexors Strength Training Using EMG Bio-feedback on Forward Head Posture among College Students

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Abstract

Background and Purpose: Forward Head Posture is found to be more among college students resulting in decreased Cervical flexors strength & reduction in physical performances. EMG Biofeedback is effective intervention in retraining the muscle strength & facilitates the correction of abnormal Cranio-Vertebral Angle (CVA) and purpose of this study is to find out the effectiveness of Cervical flexors strength training using EMG Biofeedback among college students, to improve Forward Head Posture. **Materials and Methods:** Totally 30 college students selected under selection criteria ages between 18-25 with Forward Head Posture and randomly allocated equally into experimental group (EMG Biofeedback cervical flexors strengthening) and control group (only cervical flexors strengthening ex's).The outcome tools used were Kinovea Software for CVA and Neck Disability Index (NDI) which was measured before and after the treatment. **Statistical analysis:** Analyzed by paired and unpaired t test. **Results:** The results shows that Group A cervical flexors strength training using EMG Biofeedback has significant improvement on FHP by improving CVA and NDI ($p < 0.0001$).**Conclusion:** This study concluded that the experimental group received cervical flexors strength Training using EMG Biofeedback is found to be effective than the control group received only cervical flexors strengthening ex's.

Keywords: *Craniovertebral angle, Electromyography, Forward Head Posture, Neck Disability Index.*

Introduction

Forward Head Posture (FHP) is the anterior positioning of cervical spine or Any alignment in which external auditory meatus is positioned anterior to plumbline through shoulder joint. It is also called as Text Neck, Turtle Neck, Scholar's Neck, Wearies Neck, I hunch, Reading Neck. Moreover it is considered to be one of the commonest postural malalignment found in today's youth[1].

The prevalence of FHP is found to be 70% amongst physiotherapists and physiotherapy student and 63.96% among university students. A study showed prevalance of FHP to be 85.5% and significant association was seen between FHP and gender. A study on heroin users showed that 36.7% had moderate FHP while 20.0% had severe FHP[2,3].

In this Condition, there is an increased external flexion torque to the vertebrae of cervical spine, that is increased extension of upper cervical spine (C1-C3) and increased flexion of lower cervical spine (C4-C7) and upper thoracic spine occurs; causing severe tension of the extensors of neck and surrounding connective tissue occurs. When the head changes its position from normal and moving center of gravity forward from spine leads to abnormal stress on cervical musculature causing muscle imbalance.

There is shortening of occipital extensor and cervical flexors with relation to lengthening of occipital flexors and cervical extensors is also noted. In EMG Studies, activities of middle trapezius, splenii, sternocleidomastoid are reduced due to changes in muscle length has been reported [3,4]. Eventually, there is increased burden on spinal tissue causing persistent spinal malformation.

Major problems associated with FHP are Tightness and weakness. Stretch weakness of Anterior vertebral neck flexors and tightness of neck extensors including the upper trapezius, splenius capitis, Sternocleidomastoid and semispinaliscapitis is noted. Muscular imbalance takes place in the body because of tight and weak muscles which adversely affects the co-ordinated movement of neck control and serves as a high risk to develop neck pain.

One of the accurate way to measure CVA is Kinovea Software. Observation associated with Kinovea Software for measurement of CVA between an imaginary line extending from C7 through the tragus and the horizontal line. The average CVA is about 48-50 degrees. Individuals with cervical pain has a CVA below 45 degrees, Smaller the CVA, greater the FHP [5,6].

Neck pain is a common disorder characterized by ache or soreness experienced in a region between the inferior margin of the occiput and T1. It is clear that improper posture (FHP) is risk factor for reduced CVA and neck pain among College Students. FHP is postural problem caused by extended use of computers, Smartphone, laptops, tablets and e-readers, sleeping with head elevated too high, lack of back muscle strength and lack of nutrients such as calcium[5]. If untreated it leads to secondary complication like abnormal posture, protracted shoulder, thoracic kyphosis and affect cervical joint position sense. The negative effect like difficulty breathing, palpitation, chest distress, sleeps disorders and numbness of arms which results in the altered functional outcome of the individuals [7,8].

The available treatment to correct FHP are Cervical flexors strengthening exercises, Kendall exercises etc,.[9,10,11] In recent times EMG Biofeedback is a new mode of treatment uses computers and surface electrodes that are placed on the skin of the person to reveal their internal physiological events, in the form of visual and auditory signals. This is kind of modalities in physical therapy, assists the individual to understand & control the physiological process that are usually involuntary, through auditory and auditory stimuli. Such method of retraining muscle creates new feedback systems as conversion of myoelectrical signals in muscle into visual and auditory feedback. EMG uses surface electrode to observe changes in skeletal muscle activity and used to increase activity in weak muscle or used to facilitate a reduction in spasticity[12]. EMG biofeedback has been reported to be an effective intervention for reducing pain, improving muscle strength & re-educating posture.. Therefore the purpose of this study focuses on correcting forward head posture by Cervical flexors strength training using EMG Biofeedback along with the postural corrective exercises among college students.

Methodology

Subjects ages between 18-25 years, both male and female college students with FHP (Cranio-Vertebral Angle less than 50 deg) having moderate to severe disability using NDI were included. Disabiling neurological condition such as Cervical spondylosis, Cervical radiculopathy, Cervical fracture, Traumatic neck injury, Intervertebral disc prolapse in cervical spine and Subject with psychological or psychiatric illness were excluded.It is the experimental study at Sri venkateshwaraa college of physiotherapy. Subjects fulfilling the selection criteria were randomly allocated into two groups,15 in each group (A-experimental group, B-control group) and procedure was explained. A written consent form was taken.

Outcome Measures

Neck Disability Index: It is used to measure neck pain and functional disability, and consisted of 10 items: degree of pain, daily living, lifting, reading, headache, concentration level, work, driving, sleep and leisure activity, each of which graded from 0 to 5, to a total of 0-50. 0-4 represented no disability, 5-14 is mild disability, 15-24 is moderate disability, 25-34 is severe disability and >35 is complete disability[18,20].

PGM (Photo Grammetical Measurement) using Kinovea Software: It has a good validity and high inter-rater and intra rater reliability to assess the cranio-vertebral angle. Participants were asked to sit

comfortably on a high backed chair and instructed to visually focus on a point on the wall. The visual point was confirmed by the examiner after the subjects assumed a comfortable sitting position which minimize the flexion or extension of the neck, while maintaining a relaxed head position. A picture of the lateral view of each participant was taken in both position[6,25].

A profile photography showing the measure of CVA using kinovea software.

Procedure

Subjects who fulfilled the selection criteria were included for the study. The benefit of the study and intervention is explained to the subjects and a written informed consent is taken. The subjects will be assessed by using kinovea software for cranio vertebral angle and Neck Disability by NDI. The subjects will allocate randomly into 2 groups consists of 25 subjects each.

Group A: Experimental group.

Biofeedback Training:

Biofeedback training is performed with **NEUROSTIM-NS 2**, a two channel EMG Machine. Clear and full screen displayed the EMG signal and the curve obtained from sternocleidomastoid and anterior scalene muscle[8].

Position: The participant are asked to sit in erect posture with back supported on straight back chair with forearm and hand rested on there laps. They were asked to sit quietly with neck & shoulder relaxed. The treatment area should be silent to avoid noise pollution.

Preparation of the Patient: Before electrode placement, the patients were asked to expose the neck area and the thoroughly washed by saline water to clean and reduce skin resistance. Surface electrodes were used to record muscle activity.

Electrode placement:

A conductive transmission gel is applied to electrodes to ensure good muscle conductivity. **Active electrode:** It fixed on sternocleidomastoid muscle, at mid point of muscle belly, 4cm below the insertion on mastoid process(this distance 4cm is suggested to avoid interference in electrical signal by fibers of platysma muscle).

Inactive electrode: Inactive electrode is placed at Anterior scaleni.

Ground electrode strapped around wrist.

Exercise Manual: Once participant and electrodes are positioned, verbal command to the patient to maintain neck in neutral position and practiced to do isometric maximal voluntary cervical flexors contraction hold for 5sec and rest for 10sec. 3sets with10 repetition per day, 4 sessions per week about 4 weeks. Total Duration: 30 minutes.

EMG Biofeedback training.

Group B: Control group

Cervical extensor stretching: Placing both hands on occipital area in sitting position followed by flexed neck posture with head down to stretch cervical extensors[3,27].

Trapezius self stretching: Placing one hand on lower back and other on opposite side of the head. Then pull the head toward shoulder and looking straight ahead and repeat on other side. 3 sets with 15 sec hold on each[9,27]**.**

Chin tuck in exercise: Ask the participant to sit on chair and tuck the chin posteriorly and inferiorly hold for 5sec and repeated for 10 times[6,15,9].

Trapezius Self Stretch

Cervical Extensor Stretching

Chin Tuck In Exercises

Postural awareness education: Sit with headrest chair and always maintain neck in neutral position and Set up workspace ergonomically by raising the computer that helps eyes to look straight ahead the screen and position the forearm parallel to floor of keyboard with elbow 90 deg. Cervical pillow or rolled towel can be used while sleeping to maintain curvature of cervical spine.

Cervical AROM exercises

AROM exercises for cervical spine: Each movements 10 repetition for about 30 times. 10 sec rest in between every 10 repetition[12]

Data Analysis

In this study, pre and post interventional differences within the two groups were analyzed using paired t test (Tab.1) and between the two groups were analyzed using unpaired t test for each of the outcome measures (Tab.2). Statistical significance was set at $p < 0.0001$.

Table 1: Pre and Post analysis of within the groups

Groups	Mean	SD	T-Value	P-Value
CVA				
GROUP A Pre Test Post Test	 38.53 42.26	2.26 1.94	20.5464	<0.0001
GROUP B Pre Test Post Test	37.13 44.07	2.88 1.39	8.0204	<0.0001
NDI				
GROUP A Pre Test Post Test	40.93 25.67	3.59 6.22	7.7978	<0.0001
GROUP B Pre Test Post Test	41.47 32.60	3.74 3.68	14.9637	<0.0001

Table 2: Pre and Post analysis of between the groups

Groups	Mean	SD	T-Value	P-Value
CVA				
Group A Group B	44.07 42.27	1.94 1.39	2.9188	<0.0001
NDI				
Group A Group B	26.67 32.60	6.77 3.68	2.9828	<0.0001

Results

The results shows that there is improvement in both the groups but between the group analysis of the post value shows that the Experimental group is significant ($p<0.0001$) than the control group.

Discussion

Strength gained by EMG biofeedback was explained by Basmajian et al., with the help of auditory and visual clues, patients could control the recruitment and frequency of discharge of motor units. In terms of the present study, one might hypothesis that the visual and auditory cues from the biofeedback unit enable group A to consciously increase either frequency of discharge of active motor neurons or number of motor units recruited by firing as possibly in faster rate and produce greater amount of tension in the muscle[18].

Waley et al., Investigated the Physiological basis underlying the increase in muscle strength associated with use of feedback and found that muscle strength increase could be attributed to an increase in the average firing rate, motor unit recruitment patterns & occurrence of synchronisation of active motor unit[31].

Furthermore, Moritani and DeVries et al.,described neural factors is a facilitation occuring as a result of neurological reorganisation. This theory also hypotheses that the persistent recruitment increases the numbers of motor units by means of biofeedback, causing a reorganisation of facilitation patterns[22]. This reorganisation may be responsible for the greater gains in strength in group A that was exposed to biofeedback.

Relaxation and facilitation of muscles are some of the main areas of treatment using biofeedback in physical therapy. A few studies reported, Biofeedback being used to facilitate and train relaxation in chronic pain. It utilizes the principle of hypostimulation (relaxation) of the central nervous system, which increases the endorphins and forms the neuro endocrine basis of biofeedback for control of pain & corrects the abnormal posture [26].

EMG Biofeedback showed good results in reducing forward head posture in accordance with altering craniovertebral and improves in managing the neck disabilty and activities of daily life. The result obtained in this study is encouraging and best strategy for muscle strengthening by use of EMG Biofeedback.

Conclusion

Therefore, this study concluded that the experimental group received cervical strengthening using EMG Biofeedback shows significant improvement in reduction of Forward Head Posture among college students than the control group who received only cervical strengthening ex's without EMG biofeedback.

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References

1. ArfaNaz,Muhamamd Salman Bashir et al., Prevalance of forward head posture among university students, Rawal Medical Journal, Vol. 43. No. 2, April.-June. 2018
2. Jinal A. Mamania et al., Prevalence of Forward Head Posture amongst Physiotherapy Students,Educ Res Health Sci2018;1(4):125-127.
3. Ruivo RM, Carita et al., The effects of training and detraining after an 8 month resistance and stretching training program on forward head and protracted shoulder postures in adolescents, Manual therapy. 2016 Feb 1;21:76-82.
4. Tanveer F et al., Effect of Forward Head Posture on Neck Disability and Level of Stress Among Undergraduate Students. Isra Med J. 2018; 10(2): 78-80.
5. Basmajian JV et al., Control and training of individual motor units. Science 1963;141: 440-1.
6. AmiraHussinDraz et al., Efficacy of deep neck flexor exercise for neck pain, Turk J Phys Med Rehab 2016;62(2):107-115.

7. Gohari M, et al., Assessment of forward head posture in females: observational and photogrammetry methods. J Back MusculoskeletRehabil 2014;27(2):131–139.
8. Hodges PW et al., Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine (Phila Pa 1976) 2004; 29:2108-14.
9. Katherine Harman et al., Effectiveness of an Exercise Program to Improve Forward Head Posture in Normal Adults.The Journal of Manual & Manipulative TherapyVol. 13 No. 3 (2005), 163 - 176.
10. Vijay Kage et al., To compare effects of deep flexor strengthening exercises and McKenzie neck exercises in subjects with forward neck posture. International Journal of Physiotherapy and Research, Int J Physiother Res 2016, Vol 4(2):1451-58. ISSN 2321-1822. www.ijmhr.org/ijpr.html.
11. Juchul Cho et al., Upper thoracic spine mobilization and mobility exercise versus upper cervical spine mobilization and stabilization exercise in individuals with forward head posture.BMC Musculoskeletal Disorders (2017) 18:525.
12. Howell ER et al., The association between neck pain, the Neck Disability Index and cervical ranges of motion. J Can ChiroprAssoc 2011;55:211-21.
13. Merletti R et al., An electromyographic analysis of the deep cervical flexor muscles in performance of craniocervical flexion. Physical Therapy 2003;83:899-906.
14. Ekholm J et al., Principles of prevention of neck-and-shoulder pain. Scand J Rehabil Med Suppl 1995;32: 87-96.
15. Hodges PW et Al., The effect of therapeutic exercise on activation of the deep cervical flexor muscles in people with chronic neck pain(2009);14:696-701.
16. Jiamjarasrangsi W et al., Risk factors for the onset and persistence of neck pain in undergraduate students. BMC public health, 2011 Jul 15;11(1):1.
17. Park HR et al., Comparison of the Effects of Deep Neck Flexor Strengthening Exercises and Mckenzie Neck Exercises on Head forward Postures Due to the Use of Smartphones. Indian Journal of Science and Technology. 2015 Apr 1;8(S7):569-75.
18. Gong W, Kim C, Lee Y et al., Correlations between cervical lordosis, forward head posture, cervical ROM and the strength and endurance of the deep neck flexor muscles in college students. J of PhysTherap Sci. 2012; 24(3): 275-77.
19. Jiamjarasrangsi W et al., Risk factors for the onset and persistence of neck pain in undergraduate student. BMC Public Health. 2011; 11(1): 1-3.
20. Vernon H, Mior S et al., The neck disability index: a study of reliability and validity. J ManipPhysiolTher1991;14(7):409–415. Epub 1991/09/01.
21. Etruw E, McAlpine C, et al., Measurement properties of the neck disability index: a systematic review. J Orthop Sports PhysTher. 2009;39(5):400–417. Epub 2009/06/13.
22. Moritani T, Se Cries HA. Neural factors in hypertrophy in the time course on muscle strength gain. Am J Physical Medicine 1979; 58: 115-30.
23. Chris Ho Ting Yipa et al., The relationship between head posture and severity and disability of patients with neck pain.Manual Therapy 13 (2008) 148–154.
24. Albert Puig-Divi et al., Validity and Reliability of the Kinovea Program in Obtaining Angular and Distance Dimension.(2017). http://www.kinovea.org.
25. Youssef R et al., Photogrammetric quantification of forward head posture is side dependant in healthy participants and patients with mechanical neck pain. Int J Physiother2016, 3 (33), 326–331.
26. Mamania JA, Anap DB et Al., Prevalence of Forward Head Posture amongst Physiotherapy Students. Int J Educ Res Health Sci 2018; 1(4):125-127.
27. Pezarat-Correia P et al., The effects of training and detraining after an 8 month resistance and stretching training program on forward head and protracted shoulder postures in adolescents. Manual therapy. 2016 Feb 1;21:76-82.
28. MeysamGoosheh et al., Comparing the immediate effect of chin tuck and turtle exercises on forward head posture.Pol Ann Med. 2019;26(1):8–13.

29. Butler H et al., Effectiveness of an exercise program to improve forward head posture in normal adults. J Man ManipTher. 2005;13(3):163–176.

30. Josep Maria Padulle et al.,Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. PLoS ONE 14(6):e0216448. https://doi.org/10.1371/journal.(2019).

31. Waley SM., The role of feedback information in isometric muscle training; 1986.p.35.