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Original Research Article

Postural Control in Cervical Spondylosis

Ravi Shankar Reddy[1]*@, Arun maiya G[1]**, Sharath Kumar Rao[2]**

*Associate Professor, **Professor
[1]Department of Physiotherapy, MCOAHS, Manipal University, Manipal, Karnataka, India
[2]Department of Orthopedics, Kasturba Medical College, Manipal, Karnataka, India

@Correspondence Email: ravsreddy@gmail.com

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ABSTRACT

OBJECTIVE: The objective of this study is to determine if there are significant differences in postural control between cervical Spondylosis patients and healthy controls.
MATERIALS AND METHODS: 60 subjects (30 cervical spondylosis subjects and 30 age and gender matched normal subjects) age range 30– 60 years were recruited for the study. The subjects were measured for postural control in terms of sway velocity (Mean x, Mean Y and Velocity moment) in two different conditions i.e. 1) Normal standing with eyes open and 2) Normal standing with eyes closed. The postural sway velocities of cervical spondylosis subjects were compared with the age and gender matched normal subjects using independent t test.
RESULTS: Independent t test results showed that there are increased postural sway velocity in cervical spondylosis subjects in Normal standing with eyes open and closed conditions in comparison with age and gender matched normal individuals. The difference is significant ($p<0.001$) in all the outcome variables (Mean x, Mean Y and Velocity moment).
CONCLUSION: Postural control is altered in subjects with cervical spondylosis in comparison with age and gender matched normal individuals.
KEY WORDS: Postural control: postural sway: cervical spine: spondylosis

INTRODUCTION

The maintenance of balance is a complex physiological process involving the interaction of many body subsystems and taking into account the requirements of the task and the environment. [1] Neuromuscular and musculoskeletal components are important for the control of the body's position and motor out-put. Sensory systems consisting of visual, vestibular and somatosensory components coordinate the information regarding the body's position relative to gravity and the environment and positions of body parts in relation to each other. Central nervous system processes (cognitive and non-cognitive) are also needed for adaptive and anticipatory aspects of balance control. [1, 2]

The ability to control postural balance may decline with increasing degeneration because of the deterioration in sensory systems, motor control and muscle strength and power. [3, 4] Cervical spondylosis subjects with balance impairments may not be able to meet the challenges they are faced with during daily life in situations requiring adaptability to tasks and environments. In addition, higher morbidity and increased use of medication with advancing age have been shown to influence the maintenance of balance. [3]

Ideally, the body should be able to generate quick center of pressure (COP) transitions that just exceed the current position of the center of mass (COM) and accelerate it into the opposite direction in order to maintain balance. [5, 6] Any condition affecting the afferent sensory pathways may interfere with this process. The neck is particularly prone to this due to the abundant cervical sensory receptors in joints and muscles as well as their central and reflex connections to visual, vestibular and postural control systems. [7, 8] The cause of abnormal cervical afferent input might primarily be proprioceptive or nocioceptive in nature. Deterioration of this proprioceptive information from the neck may be the determining factor in reducing the accuracy in the sensory integration process. [9]

The excitation of chemosensitive nociceptors in cervical facet joints and muscles may alter the sensitivity of the muscle spindles by reflex activation of fusimotor neurones leading to a decreased proprioceptive acuity. [10] This effect may be triggered by marked activation of mechanosensitive nociceptors as occurs in degeneration. [11] Acute "pain inhibition" may be another mechanism where discharge from high-threshold nociceptive afferents interferes with spinal motor-pathways as well as the motor cortex. Pain may also cause an increased pre-synaptic inhibition of muscle afferents as well as affect the central modulation of proprioceptive spindles of muscles causing prolonged latencies. Such alterations may lead to decreased muscle control and result in increased postural sway. [12, 13, 14]

In the case of cervical Spondylosis, facet joint components, muscles, capsules and ligaments may be at risk due to degeneration. Depending on the magnitude of degeneration, the resulting impairment of the sensory system is therefore likely to be more pronounced to impair postural control compared to normal individuals. The objective of this study is to determine if there are significant differences in postural control between cervical Spondylosis subjects and healthy controls.

METHODOLOGY

Study Design

This study took place in department of physiotherapy, Manipal University, Manipal, India. A cross –sectional 2-group design was used. Completion of questionnaires and all measurement procedures were conducted in the same room on each occasion.

Subject Selection

Cervical Spondylosis subjects in the study were selected from all patients presenting for the first time to physiotherapy outpatient and inpatient clinic over a one year period. 30 subjects with mean age of 49±5.6 were included in the study. All new patients completed a simple questionnaire as part of the inclusion-exclusion procedure. On daily review of these first stage questionnaires, the clinical records of patients who provisionally met the inclusion criteria were subjected to secondary detailed screening by an experienced member of the physiotherapy faculty who is experienced the in the field of musculoskeletal physiotherapy and manual therapy. After this screening, subjects who met inclusion-exclusion criteria (table 1) invited to participate in the study and were given further verbal and written information about the study, and were asked to read and sign a consent form.

Table I: Inclusion and exclusion criteria

Inclusion	Exclusion
1. Age 30–60yr 2. Men and women 3. Referred from physician 4. Neck pain as main presenting complaint 5. Radiologically conformed for Cervical Spondylosis 6. Spurling's test positive 7. Limitation of Cervical spine range of motion.	1. Onset of presenting neck pain episode after trauma (eg, whiplash) 2. History of cervical injury of trauma since the onset of presenting neck pain episode 3. History of cervical injury or trauma 4. Cervical myelopathy 5. Inflammatory arthritis involving Cervical spine 6. Tumor or infection involving C-spine 7. Vertebrobasilar artery insufficiency 8. Neurologic disease (eg, multiple sclerosis, Parkinson's disease, syringomyelia) 9. Congenital anomalies involving the C-spine 10. Systemic disease (eg, diabetes mellitus)

For controlled age matched normal subjects an advertisement was given in physiotherapy department and Manipal University for their voluntary participation in the study. To be considered for inclusion, the subjects must have been aged between 30 to 60 years, have had no history of whiplash or other cervical spine injury or pain, have had no history of dizziness or vertigo, have been under no treatment for any other musculoskeletal complaint, and have had no systemic disease or any of the conditions listed under the exclusion criteria in table I. Finally, eligible control subjects were selected by age to ensure a similar distribution to the patient group. The subjects first session were to familiarize them with the equipment and postural sway testing tasks. All participants signed a written consent form prior to participating in the experiment. Ethics approval was obtained from the Manipal University Ethics Committee.

Experimental Procedure and Data Acquisition

Good Balance Platform System: To check the postural control we used Good Balance Platform System (GBPS) from Finland. The *GBPS* converts shifts in weight to digital data to obtain a quantitative assessment of maintenance of balance. The components of the system include a force platform and a handrail that wraps around the front and sides for safety. The *GBPS* records several functions of the amount and speed of the subject's mediolateral (ML) and anterior-posterior (AP) sway over a specified duration of time. Table II describes the balance platform variables associated with the displacements. During the experiments, each subject was asked to quietly stand on GBPS with his or her eyes open or closed. The subject was asked to stand for duration of 120 seconds in each test condition. Note that this sample duration was chosen based on the findings by Carpenter et al. [15] who recommended a trial length of 120 seconds to increase the reliability and low-frequency sensitivity of the identified COP measures. The participants stood in the center of the triangular platform with their bare feet about a foot apart, with arms folded across the waist, holding the elbows with the hand. The order of the two trials (i.e. Eyes open or eyes closed) was randomized. In between the two trials, the subject was able to rest for as much time as he/she needed. The subjects were analysed for mean X velocity in mm/sec, mean Y velocity in mm/sec, and velocity moment in mm^2/sec in both eyes open and eyes closed conditions.

Table II: Balance platform main variables

Mean X speed	Average speed of lateral movement of center of forces
Mean Y speed	Average speed of antero-posterior movement of center of forces
Velocity moment	Average horizontal area covered by movement of center of forces per second

RESULTS

Data was analysed using SPSS Student Version14.0. Independent t test was used for compare the postural sway variables between subjects with cervical spondylosis and controls. The results of the present study show that there are increased postural sway velocity in cervical spondylosis subjects when compared with controls. There was a statistically significant difference in all the variables between cervical spondylosis subjects and age matched normal controls ($p<0.001$) i.e. mean X velocity, mean Y velocity and velocity moment in both with eyes open and closed conditions. The table III summarizes the results.

Table III: Independent t-test statistics for between group analysis of postural sway variables (n=60).

Variable	Cervical spondylosis (Mean ± SD)	95% Confidence Interval		Age matched normal subjects (Mean ± SD)	95% Confidence Interval		Mean Difference	p
		Lower	Upper		Lower	Upper		
Mean X velocity – eyes open (mm^2)	6.12±1.40	2.27	3.96	2.92±1.51	2.45	3.96	3.20	<.001
Mean Y velocity – eyes open (mm^2)	7.67±2.18	1.52	3.95	4.29±1.54	.48	2.40	3.38	<.001
Velocity moment – eyes open	12.27±3.96	0.24	10.07	6.50±4.68	3.53	8.01	5.77	<.001
Mean X velocity – eyes closed (mm^2)	6.31±1.83	1.08	3.93	3.50±1.88	1.85	3.77	2.81	<.001
Mean Y velocity – eyes closed (mm^2)	8.76±2.70	1.14	4.07	6.02±2.93	1.28	4.20	2.74	<.001
Velocity moment – eyes closed	17.05±6.23	3.89	10.54	8.32±3.35	6.14542	11.32	8.73	<.001

DISCUSSION

For cervical spondylosis group 56 subjects were screened out of which 30 met the inclusion criteria and were included in the study. The results of the present study showed that postural control is altered in cervical spondylosis subjects when compared with the normal subjects. The postural sway velocity in increased in medial to lateral direction (Mean X velocity), anterior to posterior direction (Mean Y velocity) and velocity moment. The reason for this change in cervical spondylosis subjects might be that the continuous process of postural control is disturbed in subjects with cervical spondylosis i.e. sensing the position of body relative to gravity involves combinations of visual, vestibular, and somatosensory inputs. [3, 4] The body movements used to maintain postural balance can vary from simple contractions to complex series of movements depending on the demands of the task and the environment.Central adaptive processes are needed to modify the sensory and motor components so that stability can be maintained under changing conditions might be affected in cervical spondylosis subjects. [16, 17, 18] Regulation of postural balance is also dependent on information from the proprioceptive and mechano receptive organs. Several aspects of proprioception such as position sense and movement detection threshold have been found to deteriorate due to degeneration. [19, 20, 21] This impaired proprioception has been linked with balance problems which in turn have been associated with the increased sway velocity in subjects with cervical spondylosis. [22, 23, 24, 25] The deterioration in function of proprioceptive receptors located in muscles, tendons and joints affect postural control through diminished information about the position of the limbs and body to each other and the distension of muscles. [26] These losses increase the threshold for movement detection and decrease precision in reproducing joint angles, leading to poorer balance control. [26, 27, 28] Receptors in cutaneous and subcutaneous tissue, particularly pressoreceptors in the in the neck derive exteroceptive information, and hence less accurate input with cervical spine degeneration may cause difficulties in maintaining balance. [29, 30, 31]

CONCLUSION

Postural control is altered in subjects with cervical spondylosis in comparison with age and gender matched normal individuals.

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