International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Proprioceptive Reposition Errors in Subjects with Cervical Spondylosis

Ravi Shankar Reddy[1]*, Arun Maiya G[2], Sharath Kumar Rao[3]

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

*Correspondence Email: ravsreddy@gmail.com

Received: 20/12//2011 *Revised: 30/12/2011* *Accepted: 31/12/2011*

ABTRACT

OBJECTIVE: The objective of the study is to compare the proprioceptive reposition errors in cervical Spondylosis subjects compared with age and gender matched normal subjects.
MATERIALS AND METHODS: 132 subjects (66 cervical spondylosis subjects and 66 age and gender matched normal subjects) age range 30– 60 years were recruited for the study. The subjects were measured for proprioceptive reposition errors (degrees) by the cervicocephalic kinesthetic sensibility tests which include head-to-Neutral Head Position (NHP) repositioning tests and head-to-Target Repositioning tests with cervical range of motion (CROM) device. The two repositioning tests were performed in the sagital, transverse, and frontal planes. The repositioning errors 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 proprioceptive errors in cervical spondylosis subjects in all the three cardinal planes (<0.01) in both the Head-to NHP repositioning tests and head-to-Target Repositioning tests in comparison with age and gender matched normal individuals.
CONCLUSION: Cervical proprioceptive reposition errors are increased in subjects with cervical spondylosis in comparison with age and gender matched normal individuals.
KEY WORDS: Kinesthesia: Proprioception: cervical spine: spondylosis

INTRODUCTION

Cervical spondylosis is a common degenerative condition of the cervical spine in the general population with incidence rate of 83 per 100,000 populations and prevalence of 3.3 cases per 1000 people and occurs mostly in fourth and fifth decades of life.[1,2] The etiology of cervical spondylosis is associated with the ageing process, and is closely related to the intrinsic axial load imposed by the weight of the cranium lifelong.[3,4]

The Spatial orientation is a key process necessary for several normal functions such as coordinating movement and maintaining posture.[5] Head orientation in space and with respect to the trunk makes use of visual, vestibular and cervical proprioceptive cues. Purpose of proprioception is to provide awareness of position sense and kinesthesia, to produce coordinated effects on muscle tone and balance and provide peripheral feedback so that central nervous system can design and modify effective motor programs.[6] If non-specific cervical pathology is paired with an alteration in kinesthetic sensibility, it is likely that proprioception is affected primarily by a lesion or functional impairment of muscular and articular receptors, or secondarily by an alteration in afferent's integration and tuning.[6] It may impair functioning of the cervical mechanoreceptors, which interferes with precise continuous input necessary for coordinated multi segmental reflexes, which are required for normal patterns of motion, balance, coordination and equilibrium.[7] Failure and destruction of mechanoreceptor's ability to provide feedback contributes to unpredictable 'giving away" and may result in progressive degenerative changes of joint and muscle atrophy.[7] A distorted kinesthesia disrupts normal joint function (both within the joint and within neuromuscular control of the joint). It can lead to untimely and unbalanced muscle force production that places the joint at risk for trauma. [8]

The control of neck posture and movement is dependent on appropriate motor responses to mechanoreceptive input from joints and muscle spindles.[9] An impairment of kinaesthetic sense has been found to reduce the accuracy of postural repositioning following movement in patients with whiplash-related neck pain.[10] This impairment of neck function is more evident in patients with moderate to severe pain.[11] In contrast, kinaesthetic deficits have not been identified in patients with cervical spondylosis patients. One factor contributing to the development and maintenance of neck pain in spondylosis may be an impairment of kinaesthetic sensibility, such that these individuals may adopt postures which place greater load on the neck. Similarly, the ability to locate and maintain more neutral postures of the head and neck may also be reduced in patients with cervical spondylosis. The objective of the study is to compare the proprioceptive reposition errors in cervical Spondylosis subjects compared with age and gender matched normal subjects.

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. 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 1: 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 and gender 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 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 1. Finally, eligible control subjects were selected by age and gender to ensure a similar distribution to the patient group. The subjects first session were to familiarize them with the equipment and reposition tasks. All participants signed a written consent form prior to participating in the experiment. Ethics approval was obtained from the Manipal University Ethics Committee.

Instrumentation:

Cervical Range of Motion (CROM) device:

The cervical range of motion (CROM) device is a type of goniometer designed specifically for the cervical spine and was used to measure cervical range of motion.[12] The Cervical Range-of-Motion Device (CROM) has been evaluated most often, with 7 studies assessing its reliability on healthy volunteers or symptomatic patients.[13] The CROM has 3 inclinometers, one to measure in each plane, and is strapped to the head. One gravity dial meter measures flexion and extension, another gravity dial meter measures lateral flexion and a compass meter measures rotation with its accuracy reinforced by 2 magnets placed over the subject's shoulders. CROM device is effectively used in clinical set up, Easy to apply and Cost effective. CROM device has good Criterion validity (r = 0.89 – 0.99) and Reliability (ICC= 0.92 - 0.96).[14,15]

Measurement of Cervical Proprioception

For the measurement of cervical proprioception, cervicocephalic kinesthetic sensibility tests were used. For testing the subjects were asked to sit upright in a comfortable position and look straight ahead to be determined as the neutral head position (NHP). The CROM unit was placed on top of the head and attached posteriorly using the Velcro strap. The magnetic part of the unit was then placed so that it sat squarely over the shoulders. The investigator calibrated the CROM device to a neutral head position.

For the cervicocephalic kinesthetic sensibility tests, subjects were required to keep the head in the NHP and were told to close their eyes throughout the subsequent tests. The first test was Head-to-Neutral Head Position (NHP) repositioning test.[16] The subjects were instructed to turn the head fully to the left and back to what they considered the starting point in a controlled fashion without opening their eyes. When the subjects reached the reference position the subject's relocation accuracy was measured in degrees with the CROM device. In the second repositioning test is Head-to-Target repositioning tests.[17] The investigator moved the subject's head slowly to the predetermined target position, 65% of maximum range of motion. The speed of passive neck motion was very slow as higher speeds have been associated with significant differences in vestibular function according to age.[18] The head was maintained in the target position for 3 seconds and the subject was asked to remember that position and the head was brought to neutral position and then the subject were asked to reposition actively by moving the head to the target position. When the subjects reached the reference position, the subject's relocation accuracy was measured in degrees with CROM device. The two repositioning tests were performed in the sagital, transverse, and frontal planes. Each test position was measured three times and the average of the three was taken for analysis.

RESULTS

Independent t test was used for compare the proprioceptive errors between subjects with cervical spondylosis and controls. The results of the present study show that there are increased proprioceptive errors in cervical spondylosis subjects in all the three cardinal planes (<0.01).

Table 2: Independent T-test between group analysis of Repositioning errors (degrees) during cervicocephalic kinesthetic sensibility testing in Neutral Head position and target reposition (n=66 in each group)

Variable	Cervical spondylosis	Controls	p
Neutral Head Position	6.36±1.76	4.75±1.12	<0.01
Target Reposition - Flexion	8.84±0.98	4.07±1.20	<0.01
Target Reposition - Extension	10.59±2.11	5.77±1.70	<0.01
Target Reposition - Side Bending to Left	6.00±1.60	2.48±1.70	<0.01
Target Reposition - Side Bending to Right	5.36±1.60	3.00±1.83	<0.01
Target Reposition - Rotation to Left	8.96±2.91	3.46±1.79	<0.01
Target Reposition - Rotation to right	8.83±2.76	3.72±1.74	<0.01

DISCUSSION

The results of the present study showed that there are greater proprioceptive reposition errors in subjects with cervical Spondylosis in comparison with the controlled normal subjects. The errors were statistically significant in all the three cardinal planes (flexion, extension, side bending to left, side bending to right, rotation left and rotation right) in both Neural Head Positioning and Target repositioning tests.

The reason for the more altered proprioceptive inputs in the cervical Spondylosis subjects might be the involvement of muscles, capsules and the intervertebral disk in the degeneration. [19] Sensory information from mechanoreceptors in the skin, muscles, tendons, and joint structures plays an important role in joint stability.[20] The active motion components involved in the repositioning testing require the activation of bilateral dorsal and ventral neck muscle at various layers.[21,22] Given that muscle spindles significantly contribute to the sense of body position,[23] the present results probably indicate the decreases of muscle spindle function in cervical spodylosis subjects. Because both the activated agonists and the lengthened antagonists contribute to the proprioceptive information, this reduced cervicocephalic kinesthetic sensibility in various directions indicates decreases of sensory function of multiple neck muscles.[24] It also might be due to disc degeneration in cervical Spondylosis which may have resulted in muscle active insufficiency because of changes in the length–tension relationship of the muscles that cross the inter-vertebral disc or indirectly affected the sensitivity of the muscle spindles in the deep spindle-rich muscles. The contribution of joint receptor in capsule to the cervicocephalic kinesthetic sensibility could not be neglected, based on the facts that it's close relationship among the inter-vertebral disc, facet joints, and the muscular control of the neck.[25] Any degenerative change in the inter-vertebral disc or segmental muscles might affect the function of receptors in the capsule of facet joints and vice versa. Furthermore, the different findings of Head-to NHP and Head to- Target repositioning tests might relate to the different contribution of muscle or joint afferents.

The pain in cervical Spondylosis subjects might also be the reason for altered proprioception as pain is capable of inducing changes in muscle spindle discharge and the proprioceptive properties of brainstem neurons.[26] Disturbance of the proprioceptive system has been shown to interfere with motor control, and it has been suggested that aberrant motor control may expose the spinal components to abnormal and repetitive strain.[27,28]

There was a tendency for the cervical Spondylosis subjects to overshoot the target position, as evidenced by greater errors during repositioning from both the flexed and extended positions to the neutral position. Several other investigators have reported a similar overshooting phenomenon occurring in patients with low back pain, patients with fewer large afferent fibers, such as patients with large-fibre sensory neuropathy or patients with deafferentation.[29,30] Thus, the overshooting phenomenon in the present study indicates decreases in proprioceptive afferent inputs, presumably from the activating neck muscles. Furthermore, additional studies are needed to determine whether a compensatory strategy is used by cervical spondylosis patients who have neck pain of different severity and a progressive decrease in cervicocephalic kinesthetic sensibility

Clinical application

Comprehensive Head-to-NHP and Head-to-Target repositioning tests in three cardinal planes could be used to reveal the afferent function of the neck structure. The clinical application of the cervicocephalic kinesthetic sensibility, thus, resides in examining the functional performance of spindle-rich neck muscles and joints under the influence of multiple clinical factors including age, pain, and trauma. Furthermore, an exercise program to enhance the cervicocephalic kinesthetic sensibility should be considered for cervical Spondylosis patients regardless of previous neck pain experiences.

CONCLUSION

On the basis of the data in this study, we conclude that cervicocephalic kinesthetic sensibility in all the three planes is significantly reduced in cervical Spondylosis subjects. This reduction was demonstrated by increased errors during repositioning tests that required greater contribution of muscular activity, such as repositioning of the head to the neutral position (Head-to-NHP) in the sagittal plane and (Head-to-Target) to a target position in all the three cardinal planes. Thus, these results may imply that the number of proprioceptive afferents from multiple neck muscles and/or joints decrease in cervical Spondylosis subjects.

REFERENCES

1. Bovin G, Schrader H, Sand T. Neck pain in general population. Spine 1994; 19: 1307-9.
2. Cote P, Cassidy DJ, Carrol L. The Saskatchewan health and back pain survey. The prevalence of neck pain and related disability in Saskatchewan adults. Spine 1998; 23: 1689-98.
3. Lestini WF, Wiesel SW. The pathogenesis of cervical spondylosis. Clin Orthop 1989;12:69-93.
4. Fenlin JM. Pathology of degenerative disease of cervical spine. Orthop Clin North Am 1971;2:371-387.
5. Jarolaw P, Grod DC, Peter R, effect of neck pain on verticality perception. Arch Phys Med Rehab 2002;83:236-40
6. Revel M, Deshays A, Minguet M, Cervicocephalic kinesthesia sensibility in patients with cervical pain. Arch Physical Med Rehab 1991;72:288-91.
7. Seaman DR, James F, Winterstein DC, Dysafferentiation: A Novel Term. JOSPT 1994;19:2-11
8. Strimpakosa N, Sakellarib V, Gioftsosb G, Cervical joint position sense: an intra- and inter-examiner reliability study. Gait & Posture 2006;23:22–31
9. Kristjansson E. The cervical spine and proprioception. In: Boyling J, Jull G, editors. Grieve's modern manual therapy: the vertebral column. 3rd ed. Edinburgh: Churchill Livingstone; 2005. p. 243–56 [Chapter 18]
10. Heikkila H, Astrom P. Cervicocephalic kinesthetic sensibility in patients with whiplash injury. Scandinavian Journal of Rehabilitation Medicine 1996;28:133–8.
11. Sterling M, Jull G, Vicenzino B, Kenardy J. Characterization of acute whiplash-associated disorders. Spine 2004;29:182–8.
12. Kelvin J. Assessment of published reliability studies for cervical spine Range of motion measurement tools.

Journal of Manipulative Physiological Therapeutics 2000; 23:180-195.
13. Michel T, Cecile S, Anne-Marie B. Criterion validity of Cervical Range of Motion (CROM) device for Rotational range of motion on healthy adults: Journal of Orthopedic and Sports Physical Therapy 2006:36:242-248.
14. Tousignant M, de Bellefeuille L, O'Donoughue S, Grahovac S. Criterion validity of the cervical range of motion (CROM) goniometer for cervical flexion and extension. Spine. 2000;25:324-330.
15. Tousignant M, Duclos E, Lafleche S, et al. Validity study for the cervical range of motion device used for lateral flexion in patients with neck pain. Spine. 2002;27:812-817.
16. Lee H-Y, Teng C-C, Chai H-M, Wang S-F. 2006. Test-retest reliability of cervicocephalic kinesthetic sensibility in three cardinal planes. Manual Therapy. 11:61–8.
17. Loudon JK, Ruhl M, Field E. 1997. Ability to reproduce head position after whiplash injury. Spine. 22:865–8.
18. Goebel JA, Hanson JM, Fishel DG. 1994. Age-related modulation of the vestibulo-ocular reflex using real and imaginary targets. Journal of Vestibular Research. 4:269–75.
19. Richmond FJR, Bakker DA. Anatomical organization and sensory receptor content of soft tissues surrounding upper cervical vertebrae in the cat. Journal of neuro Physiology 1982; 1:49-61.
20. Gregory GP, common vertebral joint problems. 2nd edition, Churchill Livingstone, Edinburg, London, Melbourne and New York 1998.
21. Vitti M, Fujiwara M, Basmanjian JM, Iida M. The integrated roles of longus colli and sternocleidomastoid muscles: an electromyographic study. Anatomic Record 1973;177:471–84.
22. Costa D, Vitti M, de Oliveira T. Electromyographic study of the sternocleidomastoid muscle in head movements. Electromyography and Clinical Neurophysiology 1990;30:429–34.
23. Gandevia SC, McCloskey DI, Burke D. Kinaesthetic signals and muscle contraction. Trends in Neurosciences 1992;15:62–5.
24. Ribot-Ciscar E, Roll JP. Ago-antagonist muscle spindle inputs contribute together to joint movement coding in man. Brain Research 1998;791:167–76.
25. Anderson JS, Hsu AW, Vasavada AN. Morphology, architecture and Biomechanics of human cervical multifidus. Spine 2005;30:E86–91.
26. Johansson H, Djupsjobacka M, Sjolander P. Influences on the gamma muscle spindle system from muscle afferents stimulated by KCl and lactic acid. Neuroscience Research 1993;16:49–57.
27. Goodwin GM, McCloskey DI, Matthews PB. Proprioceptive illusions induced by muscle vibration: contribution by muscle spindles to perception? Science 1972;175:1382-4.
28. Goodwin GM, McCloskey DI, Matthews PB. The contribution of muscle afferents to kinesthesia shown by vibration induced illusions of movement and by the effects of paralysing joint afferents. Brain 1972;95:705-48.
29. Lam SS,JullG, Treleaven J. Lumbarspine kinesthesia in

patientswith longus colli and sternocleidomastoid muscles: an electromyo-low back pain. Journal of Orthopaedics and Sports Physical graphic study. Anatomic Record 1973;177:471–84. Therapy 1999;29:294–9

30. Gordon J, Ghilardi MF, Ghez C. Impairments of reaching movements position awareness as a function of age and footwear. Age Ageing in patients without proprioception. I. Spatial errors. Journal of 1995;24:67–72. Neurophysiology 1995;73:347–60

****