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EFFECT OF AGE ON CERVICOCEPHALIC KINESTHETIC SENSIBILITY

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

[1]Department of physiotherapy, MCOAHS, Manipal University, Manipal, Karnataka
[2]Department of Orthopedics, KMC, Manipal University, Manipal, Karnataka

E-mail of corresponding author: ravsreddy@gmail.com

ABSTRACT

Background: The ageing process is important factor related to proprioception. Age-related reduction in proprioception in weight-bearing joints, such as the knee or ankle joint, of asymptomatic adults has been documented extensively. However, no age related increases in cervical repositioning error were reported in asymptomatic adults

Objective: The aim of the study was to determine the effect of age on cervical position sense

Materials and methods: 150 asymptomatic young adults (age range, 20–60 years) were recruited in to the study. The subjects were divided in to four groups i.e. 20-29 years, 30-39 years, 40-49 years and 50-60 years. The subjects were measured for 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.

Results: The results of one way ANOVA showed there is significant difference between the groups (P<0.001) in both the Head to Neutral Head Position testing and Head to Target Repositioning tests. There showed increasing errors with increasing age.

Conclusion: As age increases cervicocephalic kinesthetic sensibility decreases.

Key words: Neck proprioception; Neck repositioning test; Aging

INTRODUCTION

Proprioception is a term commonly used to describe the ascending information by the afferent receptors towards the central nervous system contributing to the neuromuscular control of movement and encompasses the sensation of joint movement (kinesthesia) and joint position (joint position sense).[1,2] It has been demonstrated that proper function of the head–neck system relies on proprioceptive information provided from receptors in the zygapophyseal joints and small intrinsic muscles.[3] Proprioception, including joint positioning sense, protects the joint by regulating joint stiffness through the activation of mechanoreceptors and the muscle spindle system.[4,5] The cervicocephalic kinesthetic sensibility test (a frequently adapted method of determining neck proprioception) was been used to examine each subject's ability to return their head to a predetermined position without visual cues after they have moved.[6] The common methods used in literature to assess cervical proprioception include cervical range of motion (CROM) device, electromagnetic tracking system (FASTRAK), Rod and frame test, ultrasound based coordinate measuring system (CMS 70P), CA6000 spinal motion analyzer, laser pointer method.[7-12]

It is well established that as the age increases degenerative changes occurs in the cervical column and it is well established that motion of the cervical spine decreases with age, most probably because of the development of degenerative changes.[13] As a part of the degeneration process there might be an altered proprioceptive input with increasing age.[14,15] Age-related reduction in proprioception in weight-bearing joints such as the knee or ankle joint, of asymptomatic adults has been documented extensively and proprioceptive deficits have been associated with chronic pain, injury and muscle fatigue.[16,17] However, no age related altered proprioceptive inputs are reported in cervical spine in asymptomatic adults. So the purpose of the study is to determine if there is a positive correlation between altered proprioception inputs with increasing age in asymptomatic individuals.

METHODS

Subjects:

Advertisements in the University, physical therapy department, and local city were given in the form of posters and lectures for voluntary participation of the subjects. The study included 150 asymptomatic subjects (range, 20–70 years). All subjects reported that they had no neck pain at the time of the study. To be considered asymptomatic, a subject could not have had any previous treatment for neck pain, and no current neck pain. Exclusion criteria included are traumatic spinal injury, whiplash associated disorder, central nervous system impairment, demonstrated by parasthesia, vestibular impairment demonstrated by vertigo, dizziness, or motor imbalance, neck pain induced by cervical motion in the range tested for the study. Subjects were required to attend two sessions. The first was to familiarize them with the equipment and repositioning tasks. Ethical approval for this study was granted by the University Ethics Committee. All participants signed a written consent form prior to participating in the experiment.

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.[18] The Cervical Range-of-Motion Device (CROM) has been evaluated most often, with 7 studies assessing its reliability on healthy volunteers or symptomatic patients.[19] 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).[18-20]

Measurement of cervicocephalic kinesthetic sensibility

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 kinaesthetic 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.[21] 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.[22] 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.[23] 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.

Statistical Analysis

One way ANOVA was used to compare joint reposition errors within the groups. The statistical analysis was done using the SPSS 11.0 for windows software. The statistical significance value will be set at 0.05 with 95% confidence interval and a p value less than or equal to 0.05 will be considered to be significant.

RESULTS

The mean values of repositioning errors during cervicocephalic kinesthetic sensibility testing in Neutral Head position (table 1) and target reposition (table 2) shows greater increase in repositioning errors as the age increases. The results of one way ANOVA showed there is significant difference between the groups ($P<0.001$) in both the Head to Neutral Head Position testing and Head to Target Repositioning tests (table 3).

DISCUSSION

The results of the present study demonstrate with increasing age there is decreased cervicocephalic kinaesthetic sensibility. Head-to-NHP repositions in the sagittal, frontal and transverse plane were less accurate for all subjects. The active motion components involved in the repositioning testing require the activation of bilateral dorsal and ventral neck muscle at various layers. Given that muscle spindles significantly contribute to the sense of body position the present results probably indicate the decreases of muscle spindle function as age increases in subjects.[24] Because both the activated agonists and the lengthened antagonists contribute to the proprioceptive information, this reduced cervicocephalic kinaesthetic sensibility in various directions indicates decreases of sensory function of multiple neck muscles.[25]

One of the main functions of the cervical spine is to bear the weight of the head, the findings of this study are consistent with those of other studies in which proprioception in weight-bearing joints decreased with increasing age.[16,17,27] Similar findings have been reported for the area of the lumbar spine, where the movement threshold was found to be changed with age.[28-30]

In older subjects there may be age-related changes in the cervical spine because of biologic factors in the intervertebral disc and neck muscles or physical fitness factors, such as less physical activity and prolonged sedentary lifestyle may be associated with various age-related decreases in the musculoskeletal system, including disc degeneration and muscle atrophy.[31] Age-related disc degeneration might 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 kinaesthetic 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. 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.[25] During the Head-to-NHP reposition in the sagittal plane, the capsules on both sides are presumably loose and posterior neck muscles in both sides are highly activated.

In the present study there was a tendency for the older subjects (more than 50 years old) to overshoot the target position, as evidenced 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.[27,28] Thus, the overshooting phenomenon in the present study indicates decreases in proprioceptive afferent inputs, presumably from the activating neck muscles.

CONCLUSION

As the age increases cervicocephalic kinaesthetic sensibility decreases with increasing errors while performing cervicocephalic kinaesthetic sensibility tests.

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Table 1: Repositioning errors (degrees) during cervicocephalic kinesthetic sensibility testing in Neutral Head position (n=150)

Measure	Mean ± SD
Neutral Head Position	
• 20-29 years	1.33±1.09
• 30-39 years	2.73±1.46
• 40-49 years	5.00±1.66
• 50-59 years	6.00±1.66
• 60-70 years	7.66±1.84

Table 2: Repositioning errors (degrees) during cervicocephalic kinesthetic sensibility testing in target reposition in different planes (n=150)

Measure	Mean ± SD
Flexion	
• 20-29 years	1.80±1.32
• 30-39 years	2.20±1.68
• 40-49 years	4.53±0.93
• 50-59 years	5.53±0.93
• 60-70 years	9.00±0.78
Extension	
• 20-29 years	2.80±1.54
• 30-39 years	3.26±1.85
• 40-49 years	5.96±1.06
• 50-59 years	7.96±1.06
• 60-70 years	11.26±1.41
Side Bending Left	
• 20-29 years	1.20±0.99
• 30-39 years	1.26±1.22
• 40-49 years	2.60±1.83
• 50-59 years	2.60±1.83
• 60-70 years	5.93±1.61

Side Bending Right • 20-29 years • 30-39 years • 40-49 years • 50-59 years • 60-70 years	1.26±1.12 1.33±1.32 3.76±1.81 3.76±1.81 4.53±1.13
Rotation Left • 20-29 years • 30-39 years • 40-49 years • 50-59 years • 60-70 years	1.46±1.38 2.00±1.66 2.40±1.81 6.40±1.81 10.53±2.50
Rotation Right • 20-29 years • 30-39 years • 40-49 years • 50-59 years • 60-70 years	1.53±1.25 2.20±1.42 2.93±1.94 6.80±1.71 9.53±2.53

Table 3: ANOVA between group analysis of Repositioning errors (degrees) during cervicocephalic kinesthetic sensibility testing in Neutral Head position and target reposition (n=150)

	Mean Square	F	p
NHP	200.693	81.927	<0.001
Flexion	245.960	176.091	<0.001
Extension	340.077	168.604	<0.001
SB.Left	110.827	46.860	<0.001
SB.Right	69.650	32.088	<0.001
Ro.Left	388.400	110.920	<0.001
Ro.Right	410.367	119.157	<0.001