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EFFECT OF DORSAL NECK MUSCLE FATIGUE ON POSTURAL CONTROL

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ABSTRACT

Background: There appears to be a relationship between muscle fatigue in the cervical spine and deficits in postural control, however, no previous studies have been examined the effects of specific dorsal neck muscle fatigue on designated movers of cervical spine. By systematically fatiguing dorsal neck muscles and measuring subsequent postural control, it may be possible to determine to what extent deficits in postural control exist after fatigue.

Methods: 30 subjects were included in the study**.** Initial dorsal muscle neck strength (Kg) was measured with digital dynamometer and postural sway velocity analysis (mm^2 / sec) with eyes closed was measured with posturography. Then the subjects were made to follow the dorsal neck muscle fatigue protocol, where the patient is positioned in prone lying with legs straight and arms positioned at the sides in the bed. Load of 2 kg for women and 4 kg for men is applied around the head above the ears. The load is sustained till the subject's tolerance and then post analysis of postural sway velocity and dorsal muscle neck strength were measured.

Results: There was a significant increase in postural sway velocity (<0.01) with eyes closed and the strength of dorsal neck muscles (<0.01) decreased following dorsal neck muscle fatigue protocol.

Conclusion: Postural control alters with dorsal neck muscle fatigue.

Keywords: Dorsal Neck Muscle, Muscle Fatigue, Posturography, Postural control.

INTRODUCTION

Muscle fatigue is related to a decline in tension capacity or force output after repeated muscle contraction. [1] The onset of fatigue may be attributed to metabolic or neurologic factors controlled peripherally and centrally by the neuromuscular system. [1-11] Fatigue has been demonstrated to have an adverse effect on neuromuscular control. [8, 11-14] One way of quantifying an aspect of neuromuscular control is through measures of postural control. Maintenance of posture is reliant on input from the visual, vestibular, and somatosensory systems. The somatosensory system receives input from articular, cutaneous, and musculotendinous receptors, including muscle spindles and Golgi tendon organs, that send afferent signals regarding changes in length and tension. [12-14] It is theorized that muscle fatigue may impair the proprioceptive and kinesthetic properties of joints by increasing the threshold of muscle spindle discharge, disrupting afferent feedback, and subsequently altering conscious joint awareness. [12-14] Therefore, altered somatosensory input due to fatigue could result in deficits in neuromuscular control as represented through deficits in postural control.

The location of the dorsal neck muscles suggest that they potentially play an important role in stabilizing the cervical spine.[15-16] In upper quadrant postural dysfunction the dorsal neck muscles are always overused due to forward head position adapted by the subject resulting in loss of strength and endurance.[17-19] It is apparent that the afferent input originating from the dorsal neck muscles does exert an influence in the activation of the muscles that control the cervical motion and, thus, may contribute to dynamic stability of the cervical spine.[17-19] Little is known, however, about how dorsal neck muscle fatigue affects postural equilibrium and orientation. The purpose of the study is to know the effect of deorsal neck muscle fatigue on postural control.

METHODS

An advertisement in the physical therapy department was given in the form of posters for the voluntary participation of the subjects in the study. Screening was done and the subjects were selected according to the inclusion criteria, where the sample size is 30 subject. (n=30) irrespective of their gender. The study purpose was explained to the subjects and written consent and demographic profile was taken from the subject. At the beginning of the first session pre dorsal neck muscle strength (Kg) were measured using digital dynamometer with the subject lying in prone with leg straight and arm positioned at the sides. Followed by pre postural control analysis in the form of postural sway velocity (mm^2 / sec) of the subjects were measured using posturography by asking the subject to stand with equal distance between both the leg on the fixed instrument platform (force plate) connected to sensitive detector (force and movement transducers) with both the hands flexed across the chest and eyes closed for 30 second [figure 1]. Then the subjects were made to follow the standardized neck muscle fatigue protocol, where the subject is positioned in prone lying with legs straight and arms positioned at the sides in the bed. Load of 2 kg for women and 4 kg for men is applied around the head above the ears [20]. The load is sustained on the subject until the subject's tolerance [figure 2]. Immediately following the fatigue protocol, dorsal neck muscle strength (Kg) and postural control (mm^2 / sec) were measured using the same protocol.

RESULTS

Paired t test was used for comparison of pre and post dorsal neck muscle strength and postural sway velocity with eyes closed. The results of the present study show that there is a significant decrease in dorsal neck muscles strength (<0.01) and increase in postural sway velocity with eyes closed (<0.01) following fatigue protocol.

DISCUSSION

The results of the present study showed that postural sway velocity with eyes closed increased following fatiguing the dorsal neck muscles. The possible reason for increased postural sway might be that dorsal neck muscles are more responsible for stabilization of cervical spine and fatiguing these muscles might modify the discharge of sensory receptors such as muscle spindles or Golgi tendon organs.[21-22]

The dorsal neck muscle strength decreased significantly following fatigue protocol, which implies that the fatigue protocol used in the study was able to fatigue the dorsal neck muscles resulting in altered postural sway. Muscle fatigue has been shown to increase body sway significantly after strenuous physical exercise possibly owing to alteration in proprioception. [23-24]

As in this study, our present results lead us to suggest that localized muscle fatigue of the dorsal neck muscles may modify sensory inputs, affecting central mechanisms of postural control. This may have occurred because of an increased inflow from free nerve endings because of ionic or metabolic changes, such as elevated interstitial potassium concentration, or insufficient oxygen input due to reduced blood flow. [25-27]

Because fatigue slows neural transmission, perhaps the ability to efficiently create compensatory contractions about a joint is reduced, resulting in a lack of neuromuscular control and greater changes in joint position [27]. This larger variability in joint motion in the absence of corrective muscle actions may result in diminished postural control, as indicated by greater excursion[26-27].

In a study , it is found that there is decrease in balance performance after fatigue protocol, although our fatigue protocol did not include the same type of muscles, our results immediately after the end of our fatigue protocol concur with those of previous researchers with respect to postural[28]. Another study suggests that localized muscle fatigue of the dorsal neck muscles may modify sensory inputs, affecting central mechanisms of postural control[29].

These results would suggest that patients with cervical disorders may be more susceptible to altered postural sway velocity by neck muscle fatigue than normal subjects. It is possible that the chronic pain state experiencing by patients could lead to disturbed postural control and its ability to compensate for abnormal neck input. Indeed, it is known that cervical pain-related input is able to provoke deficits in postural control induces changes in the perception of the vertical. Further studies are needed to obtain the results in different cervical pathologies.

CONCLUSION

The results of the present study proved that dorsal neck muscle fatigue will alter the postural control. Therefore it is understood that endurance of this muscle plays vital role in maintaining cervical postural control, which is necessary for maintaining position sense.

Table 1: Pre and post fatigue change in muscle strength and sway velocity (n=30)

Measure		Pre Fatigue Exercise	Post Fatigue Exercise	p
	n	Mean ± SD	Mean ± SD	
Strength (Kg)	30	6.95±1.44	4.99± 1.29	<0.01*
Sway Velocity (mm^2/s)	30	7.49±2.40	12.03±2.91	<0.01*

Figure 1: Postural sway velocity measurement using Posturography.

Figure 2: Subject positioned during fatigue protocol "Extended neck lift technique"

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