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Effect of Cognitive Dual Task and Motor Dual Task on Postural Sway in Quiet Standing in Young Adults.

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Abstract: *Dual-tasking is common in daily life. One normally needs to maintain postural control while performing one or more other concurrent tasks such as walking while talking. When two tasks are being performed simultaneously, performance of one or both can be impaired; if together they require attention that exceeds an individual's capacity. Dual-task methods have been successfully applied to the measurement of postural control.The study of relation between cognitive overload and upper limb motor task, and their respective effects on postural sway in quiet standing can be used to train phases of postural stability.*
Young adults between ages 18 and 35 who were able to count; excluding the subjects with recent lower limb pathologies, neurological or vestibular conditions were taken. Arbitrarily, 100 subjects were taken, and the sampling was convenient sampling. The subject stood on the force plate of the balance system with feet on either side of the midline of the force plate. For the first 10 seconds, the subject was asked to look straight and maintain balance. For the next 10 seconds, subject was asked to hold a glass full of water in his/her hands and maintain. For the next 10 seconds, subject was asked to count back by 3s from 100 (100, 97, 94, etc.). Three trials were taken for each task. The sway velocity was measured each time by the force plate censors. One way ANOVA showed that there was statistically significant difference in postural sway while performing cognitive task as compared to quiet standing ($p<0.01$); and cognitive task as compared to motor task ($p<0.001$). However, there was no statistically significant difference in postural sway between quiet standing and motor dual task ($p>0.05$).
Hence it was concluded that increasing attentional demand by implementing a cognitive task had a greater influence on postural sway as compared to motor dual task and quiet standing.

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I. Introduction

Postural sway refers to horizontal movement around the centre of gravity. This sway is essential due to the many large and small changes in the COG due to functions such as walking and breathing. For a person to maintain balance requires coordination of input from multiple sensory systems including:vestibular, somatosensory (proprioception and kinaesthesia of joints, pressure and vibratory senses), and the visual systems.These systems together coordinate to allow us to maintain balance: the more the balance, the less the postural sway. Postural sway is typically measured by quantifying the movement of the Centre of Pressure (CoP) in the AP and ML dimensions independently on the Balance Master, and the sway velocity[1].Keeping balance of the upright stance is a highly practised daily task for healthy adults and is effectively performed without overt attentional control in most circumstances[2]. Dual-tasking is common in daily life. One normally needs to maintain postural control while performing one or more other concurrent tasks such as walking while talking. Several investigators have suggested that control of stance and control of locomotion require some level of higher cognitive processing despite their highly practiced nature[2]. An individual's attention resources and information processing capacity are presumably limited, and must be shared among all the tasks concurrently being performed. Therefore, when two tasks are being performed simultaneously, performance of one or both can be impaired; if together they require attention that exceeds an individual's capacity. If, in the dual task condition, performance on the secondary task is reduced from the baseline level, it reflects high attentional demands of the primary task and suggests insufficient reserve capacity to perform the secondary task at the baseline level[2].

II. Material And Methods

This study included 100(N=100) healthy young adults (18-35 years),
Study Design: Cross sectional study

Study Location: Research lab at K. J. Somaiya College of Physiotherapy.

Study Duration: 6 months: August 2018 to January 2019.

Sample Size: 100

Sample Size Calculation: Convenient sampling

Inclusion Criteria:
- Young adults between the ages 18 and 35.
- The subjects had to be able to count.

Exclusion Criteria:
- Neuromuscular conditions
- Cardiovascular conditions
- Vestibular conditions
- Cognitive conditions
- Musculoskeletal conditions of the lower limb

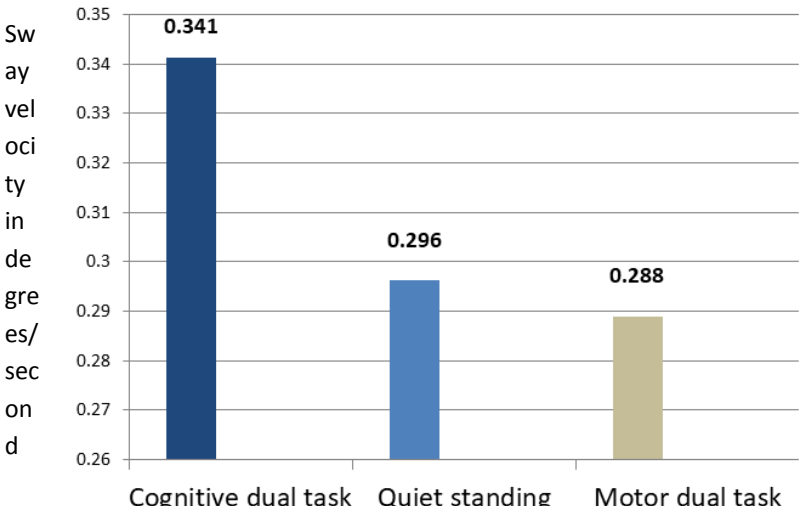
Procedure methodology: A consent form was filled by the subjects and duly signed. The order of the various tasks for each subject was decided by picking chits. The subject stood on the forceplate of the balance system with feet on either side of the midline of the forceplate. For the first 30 seconds, the subject was asked to look straight and maintain balance. For the next 30 seconds, the subject was asked to hold a glass full of water in his/her hands and maintain quiet standing. For the next 30 seconds, subject was asked to count back by 3s from 100 (100, 97, 94, etc.). The sway velocity was measured each time by the force plate censors.

Statistical Analysis: The data, thus collected (N=100), was analysed using Graph Pad Instat version 3. M ANOVA was used to analyse the sway velocities in quiet standing, cognitive dual task and motor dual task. All tests were done at 5% significance.

III. Results

The p value is 0.0002 which is extremely significant.There was significant difference between values of postural sway in quiet standing, i.e., no task (mean 0.296±0.083) and cognitive dual task (mean 0.341±0.116); p value<0.01, and between cognitive dual task (mean 0.341±0.116) and motor dual task (mean 0.288±0.083); p value<0.001.There is no significant difference between values of postural sway in quiet standing (mean 0.296±0.083) and that in motor dual task (mean 0.288±0.083); p value>0.05.

Graph I: Shows the mean sway velocity in the three experimental conditions.



IV. Discussion

The purpose of this study was to examine the influence of concurrent cognitive tasks and motor tasks respectively, on postural sway in young healthy participants. The cognitive dual task was focussed on conscious thinking and calculating, along with static balance maintenance. The motor task aimed at engaging the upper limbs in a static position which involved contraction of the muscles isometrically to hold on to the glass of water.

Of the total subjects taken (N=100), 18% were males and 82% were females. In the study, the sway velocity increased for the cognitive dual task ($p<0.01$), whereas it showed no statistically significant increase in the motor dual task ($p>0.05$), as compared to sway velocity in quiet standing. Increased postural sway under cognitive dual task in this study can be explained by divided attention. Divided attention is the highest level of attention in the clinical model proposed by Sohlberg and Mateer, in which different levels of attention are organised in a hierarchical fashion; hence divided attention is followed by alternating, selective, sustained, and focused attention. Divided attention allows us to attend to multiple tasks simultaneously, i.e., multitasking. In this study, while the primary task of standing is being performed, the cognitive overload (counting) is being added as another task, and both these tasks being performed together make it a dual tasking effort. The authors indicate the term as 'divided attention may reflect either rapid and continuous alternating attention or dependence on more unconscious automatic processing for at least one of the tasks', in this case, standing upright and maintaining balance. It is known that when one needs to maintain the balance of upright stance while performing a concurrent cognitive task, attention is divided between postural and cognitive tasks. During a dual task, postural and cognitive tasks can also be in competition for central processing or attentional resources, causing a reduction in performance of either task[2].

In the motor dual task, the difference in postural sway is statistically insignificant probably because the motor challenge along with quiet standing causes increased arousal in the subjects, leading to a better performance at maintaining postural stability. Increased arousal enhances an individual's tendency to perform the dominant response, i.e., reaction elicited most quickly and easily given by stimulus[16].

V. Conclusion

Increasing attentional demand by implementing a cognitive task had a greater influence on postural sway as compared to motor dual task and quiet standing.

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