

Effect of Instrument Applied Spinal Manipulative Therapy Upon Dual-Task Performance Involving Complex Postural and Cognitive Tasks

Kristan Giggey, DC, Rodger Tepe, PhD

Division of Research, Logan College, St. Louis, MO 63017

Abstract

Introduction:

Postural regulation and motor control were once thought to be exclusively automatic processes carried out at a sub-cortical level. A consensus of recent evidence indicates that the neural mechanisms of postural control are intimately joined to cognition (Woollacott & Shumway-Cook). The relationship between postural control and cognition is studied using a dual-task paradigm employing balance as a measure of postural control. With a dual-task methodology, a primary (postural) task will demonstrate degradation with the addition of a secondary, concurrent (cognitive) task. Using a dual-task paradigm, it is possible to show a relationship between the higher cognitive functions and those that were previously thought to be reflexive. The extent to which the two tasks interfere with each other indicates the degree of shared cognitive processing (Woollacott & Shumway-Cook). It is important to understand the cognitive implications of postural control because the activities of daily living often involve some degree of cognitive operation during motor tasks such as level walking, stair ascent, or stair descent, or reaching for an object. It has been hypothesized that there may be an attentional component associated with motor accidents such as falls (Shumway-Cook & Woollacott).

Previous studies have demonstrated that sensory and cognitive systems share common neural substrates (Woollacott & Shumway-Cook). The afferent neural impulses of mechanoreception (also known as somatosensation) as produced by joint mechanoreceptors and adjacent muscle spindle cells are necessary for the proper function of supraspinal centers (Seaman & Winterstein). Few studies have been done to determine if spinal manipulative therapy (SMT) can impact the processing that occurs at supra-spinal centers. Recently, Lersa, Stinear, and Lersa, using reaction time tasks as a measure of cognitive processing, determined that the presence of two or more sites of cervical spine dysfunction is predictive of longer reaction times, higher error rates, and a more variable performance.

The purpose of this investigation was to determine if instrument applied spinal manipulative therapy improves postural control during the performance of a complex postural task coupled with an attentionally demanding cognitive task. Three hypotheses were tested: 1. Sway velocity will increase during the dual-task condition; 2. Sway velocity will decrease post-treatment for the simple task; 3. Sway

velocity will decrease post-treatment for the complex task. A one-week post-treatment measure will be taken to examine for any lasting effects.

Methods:

We tested 12 asymptomatic individuals (9 males, 3 females; average age 23 years) with no history of visual or vestibular problems. Following a short demonstration and explanation of the procedure, the participant was asked to stand on a forceplate (NeuroCom Balance Master) to assess and record balance data. The forceplate was covered with a compliant surface to increase sensory integration demands. Balance measures were taken at three intervals and consisted of two conditions at each interval: eyes closed, and eyes closed plus a cognitive task (serial 7's counting task). Pre-treatment measures of balance were obtained and then the participant began a two week period of instrument-applied SMT (ProAdjuster System). Participants received 6 treatments over the two week period followed by a post-treatment assessment, and then a follow-up assessment one week later.

Results:

Data were analyzed with a one-way ANOVA to examine effects between the simple and complex conditions for each balance assessment. A main effect was found for the type of balance task. The addition of the cognitive component to the simple postural task significantly altered balance at each assessment. For assessments 1 through 3 respectively: $F(1, 22) = 5.8, p < .05$; $F(1, 22) = 7.6, p < .05$; and $F(1, 22) = 4.11, p < .05$. The direction of the main effect was not as predicted. The mean sway velocities decreased with the addition of the cognitive task, on average by 0.62 degrees per second.

Repeated measures ANOVA were used to examine for differences across each balance assessment within the two task conditions. Significant mean differences were found for the pre, post, and follow-up assessments during the simple and complex postural task conditions. Respective values are: $F(1, 11) = 6.84, p < .05$ and $F(1, 11) = 10.4, p < .05$. Instrument-applied SMT improved postural control post-therapy with lasting effects one week later at follow-up under both simple and complex postural control conditions.

Conclusion:

It was hypothesized that use of a mental task would increase the cognitive load associated with the postural task. The use of the serial 7's counting task did significantly change the mean values between the two conditions (quiet standing versus counting) but instead of increasing sway-velocity as hypothesized, sway velocity decreased. Several authors have noted that the use of a cognitive task can demonstrate degradation of a postural task (Shumway-Cook & Woollacott;

Woollacott & Shumway-Cook). Adkin et al., found that the use of a cognitive task improved balance and suggested that the improvement was due to a change in arousal levels.

The use of instrument applied spinal manipulative therapy was found to significantly improve postural control under both simple and complex conditions. There was a lasting effect upon postural control after one week post-treatment. The improvement in postural control found for the dual-task condition may indicate an improvement in cognition as it is related to postural control. The results of this preliminary study warrant continued investigation with symptomatic and asymptomatic participants i.e., performance athletes and geriatric populations

Key Indexing Terms: Sway, SMT, balance, dual-task

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