A Pilot Study of the Effects of Instrument –Applied Chiropractic Manipulative Therapy on Postural Control

Jeffrey Becker
Greg Kleinschmidt
Andrew Biggs
William Main
Matthew Link

Faculty Advisor: Rodger Tepe, PhD

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Jeffrey Becker, Greg Kleinschmidt, Andrew Biggs,
William Main & Matthew Link
Senior Research Project
Logan College of Chiropractic, Chesterfield Missouri

ABSTRACT

Introduction: Symptoms related to equilibrium disorders occur in 5% to 10% of all patients seen by general practitioners and account for an estimated 7 million office visits per year in the United States. The ability to maintain balance is essential for mobility and overall functional independence throughout the lifespan. Equilibrium disorders are frequently due to problems with proprioception. If afferent signal input can be reduced by spinal dysfunction, then spinal manipulation may improve proprioception and equilibrium.
Objective: To determine the effects of instrument-applied chiropractic manipulative therapy (CMT) on postural control.
Method: This study was designed as a feasibility/pilot level double-blind, randomized controlled trial. Approval was obtained from the Logan College Institutional Review Board. A convenience sample of 48 consenting, asymptomatic volunteers were randomly assigned to either the experimental condition, consisting of Pro Adjuster System (PAS) analysis and treatment, or a sham condition, consisting of PAS analysis only. Postural control was measured by sway velocity (SV) scores, which were taken before and after intervention using a NeuroCom Balance Master. Participants and examiners were masked to intervention status. Interventions were provided by a Pro Adjuster certified, licensed DC.
Results: Participants receiving PAS treatment had statistically significant improvement in postural control ($p < .05$). The sham treatment participants had no improvement.
Conclusion: In this study, a single PAS treatment resulted in significant increases in postural control in a sample of asymptomatic participants. Continued study in this important topic should include longitudinal designs, different types of spinal manipulation and symptomatic participants.
Key Words: Equilibrium, postural control, spinal manipulation, proprioception, dysafferentation.

A PILOT STUDY OF THE EFFECTS OF INSTRUMENT-APPLIED CHIROPRACTIC MANIPULATIVE THERAPY ON POSTURAL CONTROL

Jeffrey Becker, Greg Kleinschmidt, Andrew Biggs,
William Main & Matthew Link
Senior Research Project
Logan College of Chiropractic, Chesterfield Missouri
Chesterfield, Missouri

INTRODUCTION:

Symptoms of vertigo, dizziness, and disequilibrium occur in 5% to 10% of all patients seen by general practitioners.[1] In the United States an estimated 7 million clinic visits per year are for symptoms related to disequilibrium.[2] Incidence increases with age and symptoms of dizziness and imbalance are reported by a majority of individuals over 70 years of age with balance related falls accounting for more than one-half of accidental deaths in the elderly.[3]

The ability to maintain balance is often taken for granted by healthy individuals, yet it is essential for mobility and overall functional independence throughout the lifespan. Equilibrium is dependent on input from the visual, vestibular, and proprioceptive sensory systems. Equilibrium disorders not specifically due to visual and vestibular systems are typically related to problems with proprioception.[4]

Proprioception is a sense of body position and movement resulting primarily from input from sensory nerve terminals in muscles, tendons and the fibrous capsules of joints with additional input from the vestibular apparatus in the middle ear. These receptors are collectively termed proprioceptors.[5] The three types of sensory structures that regulate proprioception are: 1. muscle spindles, which report muscle length; 2. Golgi tendon organs, which detect increased tension in the tendons; and 3. joint kinesthetic receptors,

which include Ruffini and Pacinian corpuscles and free nerve endings, all of which respond to joint position and movement.[6]

Chiropractic specializes in the diagnosis and treatment of neuromusculoskeletal disorders, which includes the neuromusculoskeletal, somatosensory, and proprioceptive aspects of equilibrium; however there is little published research on the effects of spinal manipulation on equilibrium. Some evidence shows that spinal manipulation stimulates mechanoreceptors in the joint capsule, resulting in increased afferent signals, which travel well-known spinal and cerebellar central nervous system pathways.[7] Seaman uses the term dysafferentation to refer to "an imbalance in afferent input such that there is an increase in nociceptor input and a reduction in mechanoreceptor input."[8] His thesis is that abnormal joint motion effects nociception, mechanoreception, and proprioception through afferent pathways and has wide ranging effects on somatosensory functioning (including equilibrium) through sub and supra spinal pathways.[9] The premise of the current investigation is that spinal manipulation will improve equilibrium by stimulating joint capsule mechanoreceptors and increasing afferent signal strength and frequency. This idea is partially supported in a study by Colloca[10] which showed that chiropractic manipulative therapy (CMT) stimulates nerve root responses and produces the resultant afferent signals. Several studies have been conducted with implications for proprioceptive change, including lower leg proprioception[11], postural sway in the elderly[12], stabilization of the spine [13], proprioceptive training [14], and improvement in proprioception with exercise.[15] The common element in these studies is that proprioception was improved through increased afferentation.

The current study was designed to investigate the effects of an instrument-applied CMT (Pro Adjuster System ™ (PAS)) on equilibrium. The Pro-Adjuster System™ is an FDA approved chiropractic-specific instrument used for spinal analysis and treatment.

The PAS consists of a computer, software and a piezoelectric instrument, with protocols for analysis and treatment of disorders related to vertebral motion anomalies. The instrument head engages when a specific preload force (6 lbs) has been applied. In analysis mode, the instrument functions as a durometer that, when placed against the transverse processes of a vertebra, measures the vertebra's resistance to movement. When a 6 lb. Preload is reached, a single impact event determines whether manipulation is needed based on a computerized analysis of a vertebra's absolute and relative motion. In manipulation mode, the instrument head delivers a calibrated series of percussive impulses (10 to 35 pounds), stopping when ten consecutive impulses are within a 95% oscillatory confidence interval for the vertebra being treated. A post-manipulation scan then re-evaluates vertebral movement and resistance and characteristics. It was thought by the authors that, because the PAS delivers a series of percussive impulses, the total afferent signal increase would be greater than that resulting from a single high velocity-low amplitude (HVLA) CMT. This seems to be a reasonable assumption, but further study will be needed to investigate whether PAS and HVLA CMTs result in similar or different effects on afferentation and/or proprioception. The current study is the first investigation of the effects of PAS on equilibrium.

METHOD

This study was approved by the Logan College of Chiropractic Institutional Review Board. Design: This feasibility/pilot study was designed as a one-shot, double-blind (examiners and participants were masked, the treating physician could not be masked), randomized controlled trial to investigate the hypotheses that: 1. The PAS experimental group would have significant ($p < .05$) improvement in postural control post treatment; and 2. The PAS sham group would not improve ($p > .05$) post treatment. Participants: A convenience sample of 48 asymptomatic consenting volunteers (26 males, mean age = 28.4; 22 females mean age = 25.2) were recruited from the student body at Logan College of Chiropractic. Exclusion criteria were based on no prior exposure to or experience with the PAS or any current or prior condition that would effect equilibrium: No previous lower extremity injury, surgery, systemic illness, visual or vestibular condition that would affect equilibrium; local infection, injury, malignancy, or unstable joint affecting the lower extremity; prescription or other substance that could affect equilibrium; any spinal manipulation within 48 hours; and pregnancy. Participants were naïve to PAS and masked with respect to experimental vs. sham treatment. Interventions: 1. The experimental condition was analysis and treatment with PAS. Analysis was a single pass of the PAS instrument consisting of a durometer reading of each spinal segment from C1 through S5. Treatment was percussion of spinal segments with restricted motion according to the PAS protocol. 2. The sham condition was the PAS analysis without treatment. Since the participants were naïve with respect to PAS, and the analysis consisted of a 6 lb. impulse at each spinal segment, this was considered a reasonable sham. Measures: Postural control (equilibrium) was measured with a

NeuroCom Balance Master. Sway Velocity (SV) was measured under four conditions (given in order of increasing difficulty): 1. Eyes open on a firm surface (EO firm); 2. Eyes closed on a firm surface (EC firm); 3. Eyes open on a compliant surface (EO foam); and 4. Eyes closed on a compliant surface (EC foam). Three 10 second trials were recorded for each condition, which were averaged for analysis. "Spotters" were present for all measures as a safety precaution. Examiners: Two senior interns, trained in the use of the Balance Master, recorded all measures. Examiners were masked to participant status. Treating Physician: All experimental and sham PAS analysis and treatment was provided by a licensed DC who was certified in PAS protocol. Procedure: 1. Inclusion/exclusion screening; 2. Consent; 3. Scheduling for participation; 4. Random assignment to treatment or sham condition; 5. A brief demonstration of the Balance Master; 6. Pre treatment SV measures; 7. Experimental or sham PAS administered; 8. Post treatment SV measures; 9. Participants were excused from the trial. Data Analysis: Pre and post SV measures for the experimental and sham groups were analyzed by repeated measures ANOVA. Although no intention to treat concerns were anticipated or encountered, we would have carried the last observation forward on drop-outs. We knew of no reasonable basis to calculate a power analysis without effect size estimates, which this study will provide for future investigations.

RESULTS:

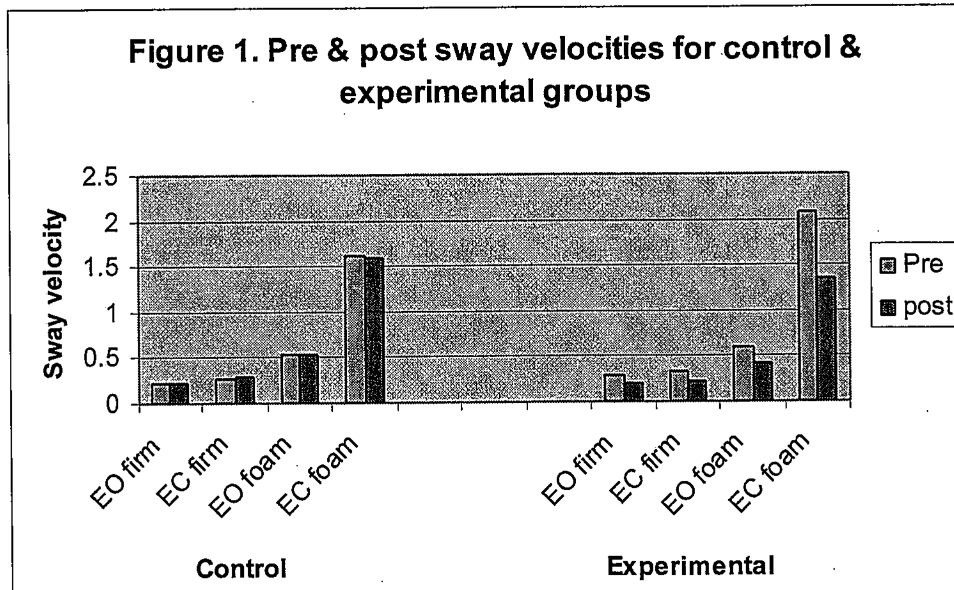
All data sets were complete with no drop-outs and no adverse events reported. Both hypotheses were supported as shown in Table 1 and Figure 1. The experimental group had significant decreases is sway velocity in all four postural control measurement

conditions, while the sham group post intervention sway velocity scores were no different than pre.

Table 1. Repeated measures ANOVA of pre/post experimental and control group sway velocity measures.

Variable type by group	Mean (SD) Pre	Mean (SD) Post	Df	F	Significance level
Eyes open, firm surface					
Experimental	0.29 (0.14)	0.20 (0.12)	22	5.06	0.029*
Control	0.23 (0.11)	0.22 (0.12)	23		
Eyes closed, firm surface					
Experimental	0.33 (0.19)	0.22 (0.11)	22	8.78	0.005*
Control	0.27 (0.10)	0.28 (0.17)	23		
Eyes open, foam surface					
Experimental	0.59 (0.17)	0.43 (0.13)	22	9.94	0.003*
Control	0.54 (0.14)	0.53 (0.18)	23		
Eyes closed, foam surface					
Experimental	2.08 (0.57)	1.36 (0.51)	22	48.74	0.000*
Control	1.62 (0.42)	1.59 (0.44)	23		

* $p < .05$



DISCUSSION:

It is tempting to consider this study as a preliminary test of the proprioception aspect of Seaman's [8, 9] dysafferentation hypothesis. Although our evidence is both preliminary and somewhat indirect, it is consistent with Seaman's premise and evidence from other studies which have found exercise based afferentation-increasing interventions to have positive effects on equilibrium. An important difference between the results of the current study and exercise based interventions is that the PAS intervention showed significant improvement in postural control in a single intervention, while exercise based interventions required as long as 6 weeks to produce effects.[14, 15] No helpful information is published on the duration of effects of any conservative treatment for equilibrium disorders for any population. For such an important topic, surprisingly little is known. Future study will need to determine dose responses and effect sizes of different interventions, and combinations of interventions on symptomatic populations. In retrospect, this seems to have been a well-designed pilot study with a reasonable sample size. Treatment conditions, as well as the outcome measures were straight forward, masking was well maintained, and there were no irregularities during the trial. Robust, statistically significant effects were found in the expected direction; i.e., the size of the differences in the experimental group increased with increasing difficulty in the postural control measures. It is likely that this trend will hold up with even larger effect sizes found in symptomatic populations.

CONCLUSION:

In this study, a single PAS treatment resulted in significant increases in postural control in a sample of asymptomatic participants. Effective treatment for equilibrium disorders and fall-prevention programs provided by chiropractic physicians is a prospect worthy of serious attention. Patients need good, evidence-based care and chiropractic needs to expand its scope of practice into new areas. Chiropractic care for disorders of proprioception and equilibrium meet these needs. Future studies should mix and match different types of CMT with exercise and rehabilitation/training methods of improving equilibrium. We believe that CMT will increase the efficiency of other interventions and we plan to test these hypotheses in various populations. It remains to be seen which types of CMT will produce the most benefit for disequilibrium. Future studies should also combine electrophysiological measures and advanced measures of postural control to more precisely determine the relationship between segmental dysfunction and postural control.

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