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Effects of Cervical Spine Manipulation on Balance and Joint Proprioception in Asymptomatic Individuals: Plausibility and Pilot Study

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EFFECTS OF CERVICAL SPINE MANIPULATION ON BALANCE AND JOINT PROPRIOCEPTION
IN ASYMPTOMATIC INDIVIDUALS: PLAUSIBILITY AND PILOT STUDY

By

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A doctoral project submitted in partial fulfillment
of the requirements for the

Doctor of Physical Therapy

Department of Physical Therapy

School of Allied Health Sciences

The Graduate College

University of Nevada, Las Vegas

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THE GRADUATE COLLEGE

We recommend the doctoral project prepared under our supervision by

Kimberly Drayer
Michael Kauwe

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ABSTRACT

Background: Balance issues are prevalent in all ages of the population and can lead to many debilitating secondary impairments. There are various methods for treating balance problems, one of which is cervical spine manipulation (CSM). It seems to be biologically plausible that CSM would be an effective intervention, as it elicits effects in the same systems that are impaired in people with balance issues: vestibular, visual, and somatosensory.

Objective: The aim of this study is to investigate the immediate differences in balance and proprioception following a CSM in asymptomatic subjects.

Design: An experimental, cross-over study design was used

Methods: Thirty-four eligible asymptomatic volunteers (mean age 25.0 years old) with no current neck pain, neck pain within the past 6 months, balance disorders, or vertebral artery insufficiency participated. Participants came for testing 2 times; once for the sham procedure and once for the CSM procedure. The order in which the participant received their interventions was randomly assigned. Balance was assessed prior to and immediately following the CSM intervention and sham procedure using the SMART NeuroCom Balance Master™ Sensory Organization Test (SOT) and Laser Cervical Proprioceptive test (LCPT). Investigators conducting the tests were blinded to which intervention the participant had received.

Results There was a statistically significant main effect of time for the LCPT scores in the overall sample ($F(1,33)=4.780$, $p=0.036$, Power=.565). There was also a statistically significant main effect of time for the vestibular component of the SOT

($F(1,33)=5.333$, $p=0.027$, Power=.611) and the main effect of intervention for the somatosensory component of SOT ($F(1,33)=5.554$, $p=0.025$, Power=.628).

There was no significant difference between gross pre and post scores between test groups for the LCPT total error, ($F(1,33)=1.221$, $p=.277$, Power 0.189. No significant difference was found between composite SOT scores pre and post intervention ($F(1,33)=0.205$, $p=0.654$, Power 0.072 . For the individual components of balance no significant interaction was found: somatosensory, ($F(1,33)=0.370$, $p=0.547$ Power 0.091; vestibular, $F(1,33)=0.126$, $p=0.725$, Power 0.064; visual, $F(1,33)=0.054$, $p=0.818$, Power 0.056).

Limitations: The main limitations in this study were the small sample size, ceiling effect with SOT testing, and unestablished reliability and validity of the LCPT.

Conclusions: It has been shown that it is biologically plausible for CSM to evoke changes in people with balance disorders based off of proposed mechanisms and established research. Although this research was unable to capture changes in balance and proprioception following CSM, it would benefit this body of literature to repeat the design with more sensitive and valid outcome measures.

TABLE OF CONTENTS

Abstract.....	iii
List of Figures.....	vii
Introduction.....	1
Methods.....	6
Results.....	11
Discussion.....	12
Conclusion.....	16
References.....	27
Resumes.....	30

LIST OF FIGURES

Figure 1	Relationship between Balance and the Neurophysiological Effects of Cervical Spine Manipulation	18
Figure 2	Study Design	19
Figure 3	Laser Cervical Proprioception Test	20
Figure 4	Sensory Organization Test	22
Figure 5	Cervical Spine Manipulation Intervention	23
Figure 6	Laser Cervical Proprioception Test Results	24
Figure 7	Sensory Organization Test Composite Scores	25
Figure 8	Sensory Organization Test Individual Component Scores	26

INTRODUCTION

Balance problems are common conditions, affecting nearly 25% of people in their lifetime.¹ According to a study by Yardley et al¹, one in five people in the working population aged 18 to 64 had experienced symptoms of dizziness in the past month, with one half of those people reported being handicapped to a certain degree. With increasing age, the prevalence of balance issues climbs as well. At age 70, 29-36% of people report balance problems. These numbers are reported as high as 45-51% in the 88-90 year old population.² Balance problems and the devastating side effects greatly contribute to the number of falls in the elderly population and can essentially handicap people in the working population.³

It is widely accepted that balance is composed primarily from the input of three systems: vestibular, visual, and somatosensory. If one of these systems is affected, different conditions can emerge that may negatively influence balance. For example, conditions such as benign paroxysmal positional vertigo (BPPV) affect the vestibular system and thus leave a patient with poor balance and dizziness. Diabetic neuropathy can affect the somatosensory system and result in impaired balance in patients due to decreased reception of afferent signals. Patients with neck disorders may have smooth pursuit eye movement disturbances, which can certainly affect one's ability to maintain balance.^{4,5,6,7,8}

Many forms of rehab exist to treat balance disorders in patients based on pathology. For peripheral vestibular issues such as BPPV, the Dix-Hallpike test and canalith repositioning maneuvers are commonly used to diagnose and treat the

condition.⁹ For migraine-associated dizziness, which is considered a central vestibular system condition, vestibular rehabilitation programs and pharmacological therapies are commonly used. When combined with a balance exercise program, cognitive behavioral therapy has shown to be an effective form of rehabilitation for people with a variety of dizziness and balance problems.¹⁰ In addition to these interventions, many other treatment options exist to treat people with balance disorders.

Cervical spine manipulation (CSM) has been utilized in patient treatment for centuries.¹¹ CSM is commonly used by multiple health professionals to treat various disorders such as general neck pain, back pain, headaches, and neck stiffness.^{12,13} CSM has also been used effectively in the treatment of conditions where patients report dizziness and balance related conditions.^{14,15,16} Research on CSM is progressing rapidly, thus providing a greater understanding of the neurophysiological mechanisms through which CSM affects change and the functional outcomes on patients with specific conditions. Obtaining a better understanding of the mechanisms through which CSM affects patients, along with a better understanding of the functional outcomes, will help facilitate application of specific techniques to the appropriate population.

CSM has been shown to produce various effects on the body. An article by Bialosky et al¹⁷ describes the three proposed mechanisms through which CSM is effective: mechanical, neurophysiological, and placebo. While they note the importance of the other two, the authors explain that based on the current body of literature available, neurophysiological mechanisms provide the most probable explanation as to why CSM is effective.

Research has shown there are a variety of central nervous system changes which occur secondary to receiving CSM. Dishman and Burke¹⁸ observed the effects of cervical and spinal manipulations on the motor neurons of the spinal cord using the Hoffman reflex technique and found that both cervical and lumbar spinal manipulations attenuate motor neuron activity. Studies have also shown that CSM also influences the autonomic nervous system, as measured by Edge Light Pupil Cycle Time.¹⁹ Specifically regarding the somatosensory system, Haavik-Taylor and Murphy²⁰ report CSM may cause short-term changes in the somatosensory cortex. CSM has also been shown to alter the cortical integration of sensory stimuli.²¹ Evidence indicates spinal manipulations cause real changes in the body; however, it is not fully understood exactly how these different changes affect a person.

CSM is currently used as an intervention for people with balance disorders. It is thought to be effective in this population because in theory, it affects the mechanisms that influence the onset of dizziness and balance problems. According to studies by Brandt²² and Bracher et al²³, dizziness of cervical origin is due to irregular afferent activity from joint and muscle proprioceptors joining in the central nervous system with visual and vestibular systems. This creates confusing signals that are sent to the postural control system, which produces symptoms of altered orientation in space and disequilibrium. Since receptors in the cervical spine region have central and reflex connections to the CNS, visual, and vestibular systems; CSM is theorized to be an effective treatment by influencing these neurophysiological mechanisms and systems that play a role in balance disorders.^{24,25}

Neck pain can create a disturbance in the proprioceptive input to the CNS and may over time negatively affect the central processing of any afferent input received.²⁶ It was shown by Vuillerme and Pinsault²⁶ that when cervical muscle proprioceptors are stimulated by painful electrical stimuli, balance while standing was significantly impaired. This change was seen in asymptomatic subjects with no previous complaint of neck pain, neurological disease, or vestibular impairment. This supports the hypothesis suggesting a link between proprioception, CNS, and postural control.

Information received from the visual, vestibular, and proprioceptive systems converge to provide reference for orientation of the head in relation to the trunk.²⁷ This collaboration plays a big role in the maintenance of balance. Biologically it appears plausible that CSM would affect balance (see Figure 1). Therefore, for this study, we chose to observe the effects of CSM on those three systems with the use of the SMART NeuroCom Balance Master's™ Sensory Organization Test (SOT). In addition, we wanted to observe any significant changes with joint repositioning error (JPE) using a Laser Cervical Proprioception Test (LCPT). As it has been shown that CSM can be safely performed on asymptomatic individuals,^{12,28} we aimed to document the immediate effects of CSM on those three primary components of balance and cervical proprioception within an asymptomatic population.

We hypothesized that following a CSM on asymptomatic subjects; we would observe an improvement in balance throughout the vestibular, visual, and/or somatosensory systems, as it has shown to provide improvements in patients with

deficits. We also hypothesized that the JPE in our subjects would decrease, as CSM would provide increased proprioceptive awareness.

METHODS

Subjects

Thirty-four subjects participated in an experimental, cross-over study after giving informed consent as approved by University of Nevada, Las Vegas (UNLV) Institutional Review Board.^{*} This study was also registered with ClinicalTrials.gov through the US National Institute of Health.[†] The total number of subjects was selected from a population of UNLV physical therapy students based on a sample of convenience. Eligible subjects were individuals between the ages of 18 and 60 years of age who were willing to participate. Subjects were excluded if any of the following were present: 1) current neck pain/symptoms, neck pain symptoms within the last 6 months, confirmation or possibility of pregnancy, dizziness, vertigo, or nausea or 2) history of cervical spine surgery, rheumatoid arthritis, osteoporosis, osteopenia, ankylosing spondylitis, cancer, or vertebral artery insufficiency. After obtaining informed consent and prior to participation, all subjects were evaluated according to the inclusion and exclusion criteria, and a cervical spine screen was performed on each individual to minimize the risk of any injury secondary to CSM (see Figure 2).

Laser Cervical Proprioception Test (LCPT)

This test was utilized and developed to detect the changes in JPE before and after selected interventions. This research served as the pilot run of this test, which aims to measure cervicocephalic kinesthetic sensibility.²⁹ This is described as the ability

^{*} *UNLV Biomedical IRB. Protocol #1104-3780*

[†] *ClinicalTrials.gov Identifier: NCT01745705*

to actively relocate one's head to a previous reference position. According to Humphreys²⁷, this test can be performed using "simple equipment". In the fashion described, the investigators deemed it appropriate to use tools that are clinically practical. Using a laser pointer secured to a headpiece, the subject was instructed to wear the instrument and sit in a chair one meter away from a wall (see Figure 3). Each subject was told to find a neutral starting position while looking straight ahead. When this was achieved, a bull's-eye chart was placed on the wall with the center lining up with the current position of the laser beam. The subject was then instructed to close his/her eyes, bring the head back into extension, and attempt to return to the neutral starting position with eyes remaining closed. When the subject felt he/she was back to their position, the point was marked. The subject's eyes were then opened, and the subject was returned to the neutral position, if he/she was not there previously. The subject performed this test a total of 3 times pre- and post-intervention.

SMART NeuroCom Balance Master™[‡]

In order to assess changes in balance due to the interventions, the SOT program was used to assess the subjects' balance when altering sensory information of the somatosensory, visual, and vestibular systems.^{30,31,32,33} The subjects were asked to step onto the forceplate with their socks on and to center their midfoot onto the midline of the forceplate with the assistance of an investigator. While wearing a harness, subjects were instructed to stand as still as possible with their hands at their sides while looking forward toward the screen to begin the testing. To perform the SOT, the subjects were

[‡] *NeuroCom® International, Inc. Equitest® P/N: A101187-00. Clakamas, Or: 2000.*

asked to maintain their balance during six sensory conditions. The order in which the stages were presented to the subject was based upon their selection of a number from one to six that represented different order of presentations of the subtests (see Table 1). During each stage, the subject attempted to maintain balance under specific conditions of visual, vestibular, and/or somatosensory conflict while receiving no input from the investigator (see Figure 4). At the conclusion of the stage, all components of the NeuroCom® returned to a neutral starting position and the next stage was set to be administered. After the entire series was completed, the series was then repeated two more times in order to obtain an average of the subjects' performance for each stage. Once all three trials of the series were completed, a printout of the subjects' performance was obtained and the subject was released from the harness and allowed to step off of the forceplate. The same investigators conducted testing on all subjects for both the pre- and post-intervention testing and were blinded to the interventions the subjects received.

Subject Assignment:

The order in which the subjects received the two interventions was determined by coin toss. Each subject participated in two separate visits. Each visit, the subjects underwent pre-intervention testing with both the LCPT and the SOT. Then, they would receive one of two interventions: the cervical spine manipulation or the sham procedure. Within two minutes of receiving the assigned intervention, all subjects were tested once again with the LCPT and the SOT to obtain immediate post intervention results.

Interventions:

Subjects received both a cervical manipulation and a sham procedure; each intervention was received on separate visits and the order was randomly assigned. The effect of the intervention was measured using the LCPT and SOT to detect whether balance and JPE in healthy individuals would be differently affected by a CSM compared to the receipt of a sham intervention alone.

CSM

The subjects were asked to lie supine on a treatment table and relax. An investigator, trained in the procedure of the cervical manipulation, provided a high-velocity, low-amplitude manipulation to the each subject's cervical spine (see Figure 5). Spinal manipulation is commonly used by many manual therapists, and various techniques are prevalent in the literature.³⁴ The manipulation utilized in this study included providing a rotary force targeting the subject's zygapophyseal joints of C2-C3 bilaterally. A CSM was performed to each side of the subject's cervical spine with the aim of achieving a joint cavitation. If cavitation was not achieved, the investigator providing the CSM was allowed one further attempt. Subjects were therefore, exposed to two, three, or four thrusts, depending on the presence or absence of cavitation. The entire procedure took approximately 45 seconds to complete.

Sham Manipulation Intervention

The sham procedure intervention for the study was one that was unlikely to produce physiological effects, but would maintain the integrity of the study by retaining any placebo effects. It was important that the procedure not include any sort of

rotation because if a cavitation were produced, it would not be considered a sham procedure. Also, absolutely no load could be applied to the cervical region because loading would stimulate the proprioceptors in the neck and might elicit an effect similar to the intervention³⁵. The subjects were asked to lie supine on a treatment table and relax. The same investigator who delivered the CSM delivered the sham. The sham procedure entailed receiving a gentle suboccipital hand-hold for 45 seconds from an investigator.

Statistical Methods:

In order to determine what effect CSM and a sham intervention had on balance (SOT Composite, Somatosensory, Visual, and Vestibular scores) and JPE (LCPT), a repeated measures ANOVA was conducted for each variable that was observed. For all repeated measure ANOVAs, sphericity was assumed. IBM SPSS[§] was used to analyze the data.

[§] IBM® SPSS® Statistics Version 20.0.0; 2011

RESULTS

The 34 subjects consisted of 20 females and 14 males. Seventy-four percent identified themselves as white, 12% as Asian, 12% as Hispanic, and 3% as Native American. The age range was 22 to 30, with a mean of 25 ± 2.0 . The height range, in inches, was 60 to 74 with a mean of 67 ± 3.5 . The weight range, in pounds, was 100 to 265, with a mean of 158 ± 43.6 .

There was a statistically significant main effect of time for the LCPT scores in the overall sample ($F(1,33)=4.780$, $p=0.036$, Power=.565). There was also a statistically significant main effect of time for the vestibular component of the SOT ($F(1,33)=5.333$, $p=0.027$, Power=.611) and the main effect of intervention for the somatosensory component of SOT ($F(1,33)=5.554$, $p=0.025$, Power=.628).

There was no significant difference between gross pre and post scores between test groups for the LCPT total error, ($F(1,33)=1.221$, $p=.277$, Power 0.189 (see Figure 6). No significant difference was found between composite SOT scores pre and post intervention ($F(1,33)=0.205$, $p=0.654$, Power 0.072 (see Figure 7). For the individual components of balance no significant interaction was found: somatosensory, ($F(1,33)=0.370$, $p=0.547$ Power 0.091; vestibular, $F(1,33)=0.126$, $p=0.725$, Power 0.064; visual, $F(1,33)=0.054$, $p=0.818$, Power 0.056) (see Figure 8).

DISCUSSION

The purpose of this study was to observe for changes in balance and proprioception in asymptomatic subjects as a result of the proposed neurophysiological effects of CSM. The literature was reviewed for biological plausibility and outcomes were recorded using the SOT and LCPT to capture changes.

Plausibility

Based on the findings in the current literature regarding balance impairments and the neurophysiological effects of CSM, it is plausible that CSM can alter balance and proprioception in individuals. We found there is a good overlap between the problems encountered in balance and the neurophysiological effects purported to be offered by CSM. Biologically, it makes sense CSM could be an effective intervention for balance related conditions.

LCPT

To observe for changes in cervical proprioception, we utilized the LCPT. Independent of the intervention, subjects' scores showed statistically significant improvements in JPE. It is likely that this change was due to a learning effect. It was shown by Swait et al³⁶ that when using head repositioning accuracy (HRA) tests or joint repositioning tests, it is necessary to perform at least five trials in order to have adequate test-retest reliability. Whether or not these improvements were due to stimulation caused by the interventions or by a learning effect, it is interesting that asymptomatic subjects showed improvements.

The results from the LCPT showed no improvements specific to CSM. However, we used a clinically practical test, which should be further investigated; Test-retest reliability was not investigated during this pilot study, but it would be valuable knowledge for future studies. A study by Treleaven et al³⁷ noted that when using JPE/HRA tests, they must be used in conjunction with other tests to ensure validity for sensorimotor dysfunction. This may be related to the fact that the MCID and effect sizes for these kinds of tests are currently unknown.²⁷ We performed our LCPT along with the NeuroCom® SOT program, but this coupling has not yet been performed. Per Treleaven et al,³⁷ a standing balance test or the Smooth Pursuit Neck Torsion Test may be better options, as they have been used in past research.

In other studies, investigators have used other tools to capture changes in cervical proprioception. To most accurately determine the displacement of the head in a 3-dimensional space, it is necessary to use more advanced technology.²⁷ Electromagnetic tracking devices, such as the 3-Space Fastrak, or ultrasound measuring devices, such as the Zebris, are available. Although they may be more accurate for tracking displacement and cervicocephalic kinesthetic sensibility, these tools are not considered practical for routine use in the clinical setting.

SOT

To assess changes in balance, we looked at the composite pre- and post-intervention SOT scores of our test subjects and found no significant interactions. The main effect of time on the vestibular component of the SOT suggests subjects improved in vestibular scores regardless of intervention and suggests a possible learning effect.

The main effect of the intervention on the somatosensory component of the SOT shows those receiving the sham scored higher, but because of the crossover design of this study, this finding is not relevant. While both test groups displayed improvements in the composite SOT scores, the overall change in pre- vs. post-intervention scores was not significant. We examined the individual components of the SOT and found no significant interactions. Main effects were observed for both time and intervention for vestibular and somatosensory components, respectively.

The SOT is an excellent indicator of changes in the visual, proprioceptive, and somatosensory systems; however, it may not have been an appropriate tool to use for our study sample. A sample of convenience was used to recruit a population of subjects that was asymptomatic for balance impairments. All the validity research we were able to find for the SOT was performed on symptomatic subjects.^{30,31,32,33} It is possible that the SOT is less capable of detecting the smaller changes in balance that may occur when asymptomatic subjects receive a CSM.

There are many other functional outcomes tests used to measure balance, such as dizziness scales, gait assessments, and the Timed Up and Go. Another widely used outcome measure in this body of literature is a computerized force platform to capture changes in standing static balance.³⁷ Perhaps future research could incorporate these outcomes measures to observe for any effect of CSM on balance.

There was no noted interaction between CSM and the outcome measures used in this study. Also, there were no reports from subjects of any adverse events following either the CSM or the sham intervention. This pilot study contributes to the literature

supporting the proposition that CSM is a safe intervention when properly performed.^{12,28}

Limitations

As reported in the results section, this study was under-powered and thus the inability to detect significant interactions does not reflect an absence of changes in subject groups but rather an inability to detect any possible changes due to limitations in the study design.

This study served as the pilot run of the LCPT, and by completing this study and finding no significant difference here, it has given the investigators many things to reconsider. There should be a more efficient and precise manner in which to measure point distances. Also, only cervical extension was included in this test. If other motions were included (e.g. flexion, rotation, lateral flexion), perhaps there may have been a significant difference.

The absence of significant interactions is likely due to limitations in our study design since the biological plausibility supporting CSM in the treatment of balance disorders is valid. Our data suggests the presence of learning effects in LCPT, which was unaccounted for in our study design; a baseline should have first been established. In addition, we observed evidence of a ceiling effect in measurement of SOT in healthy individuals. These limitations and our small sample size (as indicated by power estimates) affected our ability to make conclusions about the lack of interactions between interventions and effects on balance and cervical proprioception.

CONCLUSION

There is sufficient overlap between the problems encountered in balance related conditions and neurophysiological effects of CSM to make CSM a plausible intervention for such conditions. Because we were establishing biological plausibility, we did not use symptomatic subjects. Future studies may want to perform similar research on symptomatic populations. If CSM does actually help to restore normal function, then changes in a symptomatic population may be easier to observe.

For LCPT, there was a significant interaction between pre and post test scores in an asymptomatic population; regardless of intervention, JPE improved. Further research should be done to establish the reliability and validity of the LCPT for use as a practical and affordable test and intervention for clinical use.

While our results suggest CSM did not improve balance in asymptomatic individuals, it is important to note no adverse changes in balance or JPE were observed and no adverse events were reported by subjects. We do not believe our research indicates CSM has no significant effect on balance in an asymptomatic population, but rather indicates that any balance changes that may occur were undetectable due to limitations in our study design.

This is the first time a JPE test has been coupled with the SOT. Further research should be performed to discover the effects of CSM on populations who have balance impairments using other outcome measures. Also, alternative tests with established reliability and validity specific to the population should be used. This was a pilot study

and thus has given direction for future research on observing the neurophysiological effects of CSM on balance as measured by functional outcome measures.

Table 1. Different Conditions for the Sensory Organization Test.

Stage Description of Stage

1	Eyes open, floor plate stationary, walls stationary
2	Eyes closed, floor plate stationary, walls stationary
3	Eyes open, floor plate stationary, walls moving
4	Eyes open, floor plate moving, walls stationary
5	Eyes closed, floor plate moving, walls stationary
6	Eyes open, floor plate moving, walls moving

Figure 1. Relationship between Balance and the Neurophysiological Effects of Cervical Spine Manipulation.

Source for balance

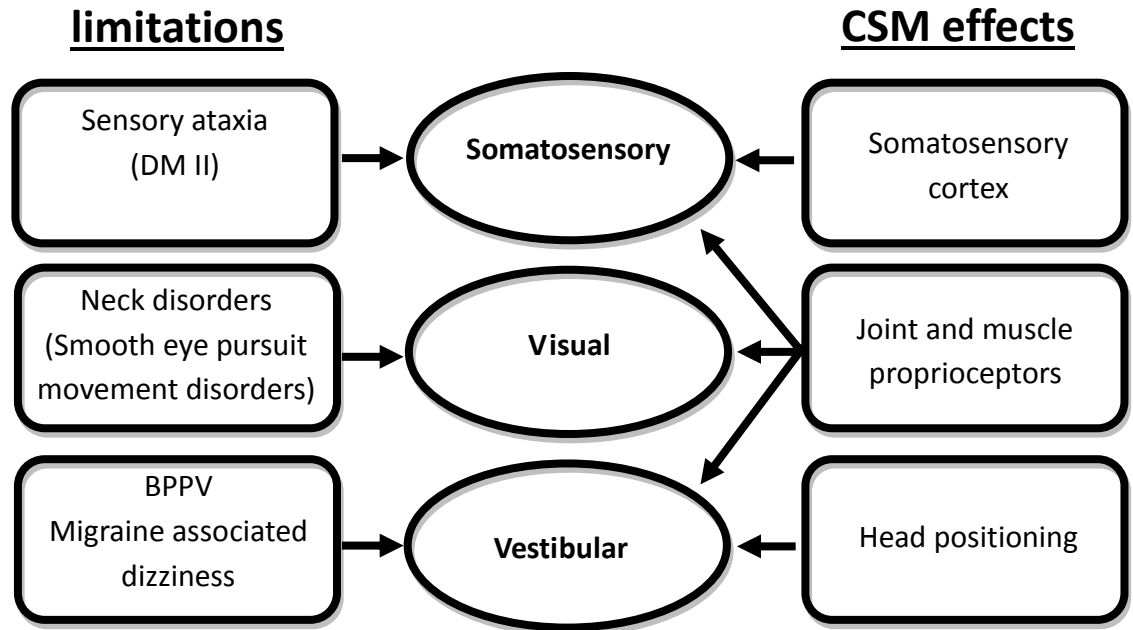


Figure 2. Study Design.

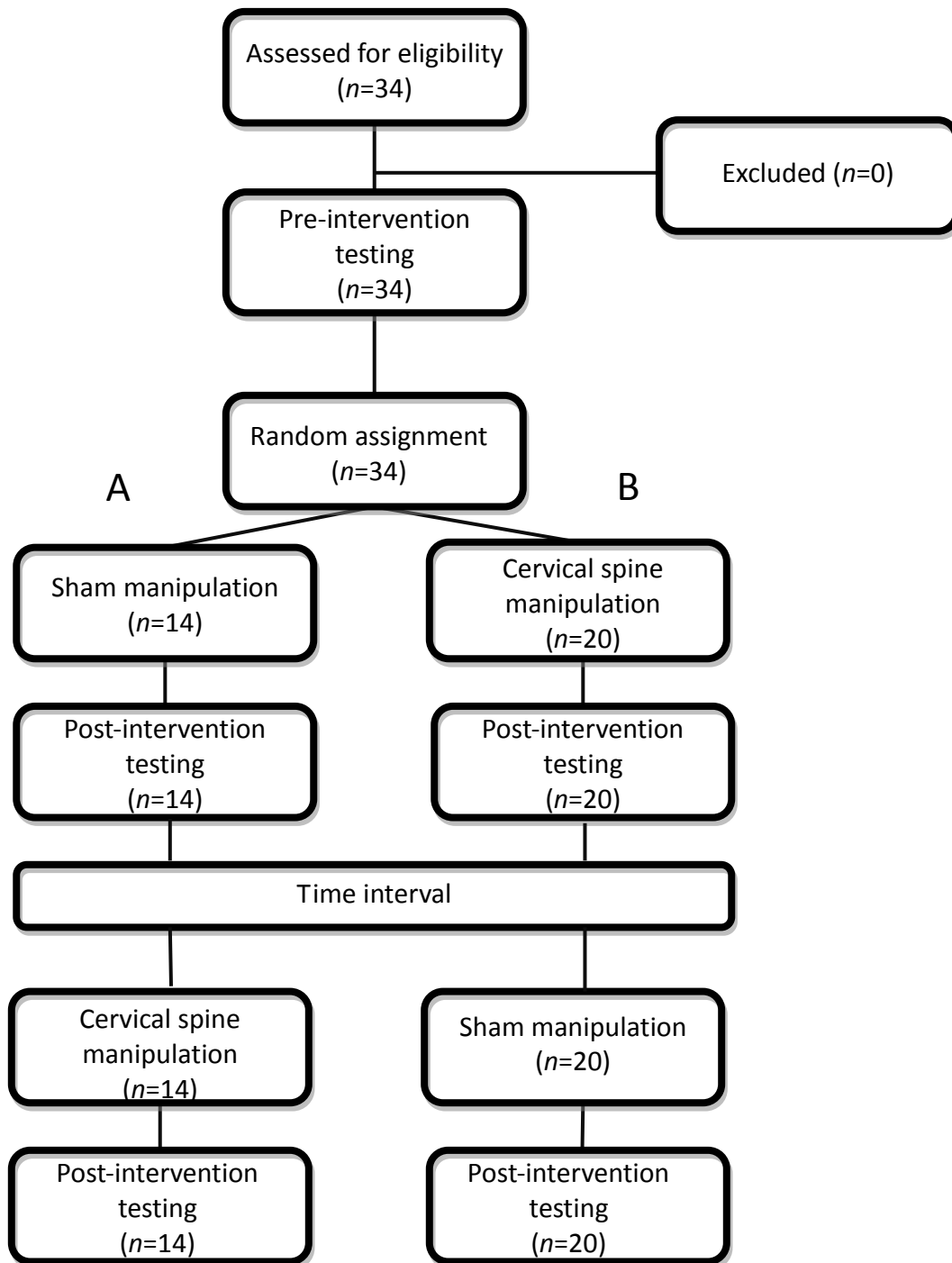


Figure 3. Laser Cervical Proprioception Test.



Figure 4. Sensory Organization Test.



Figure 5. Cervical Spine Manipulation Intervention.

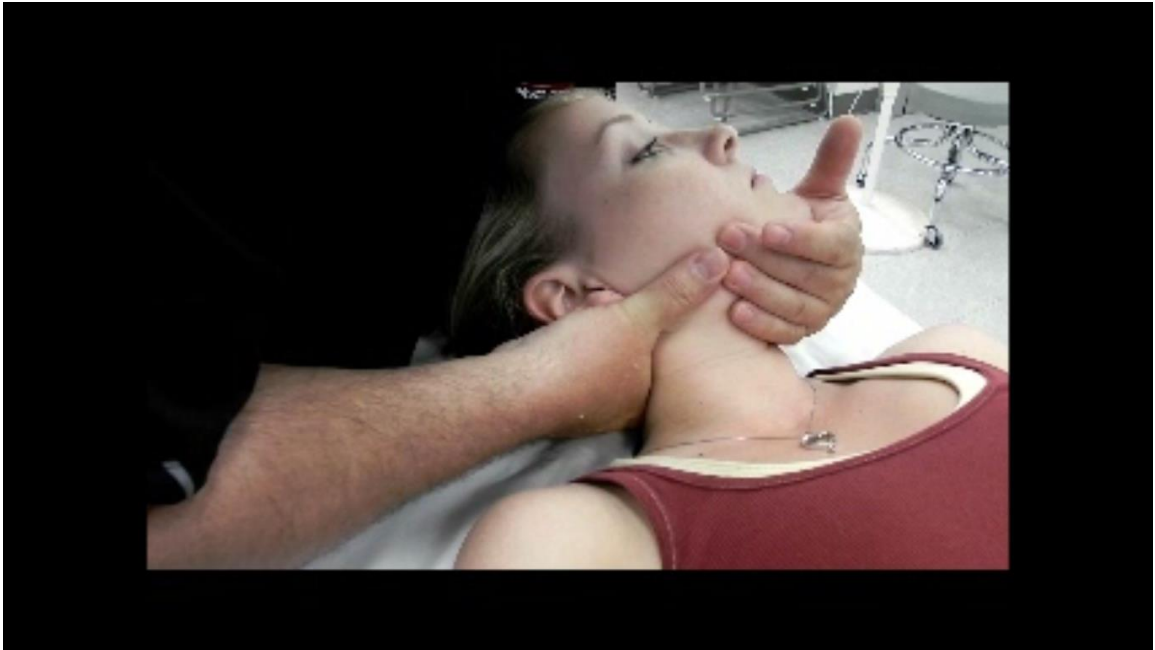


Figure 6. Laser Cervical Proprioception Test Results.

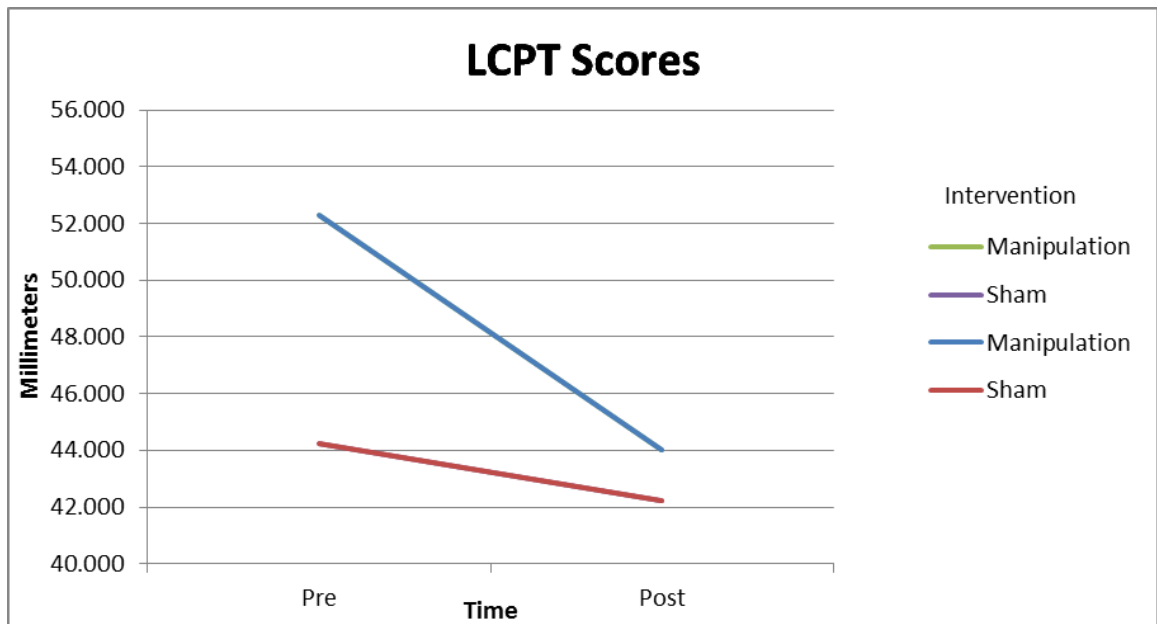


Figure 7. Sensory Organization Test Composite Scores.

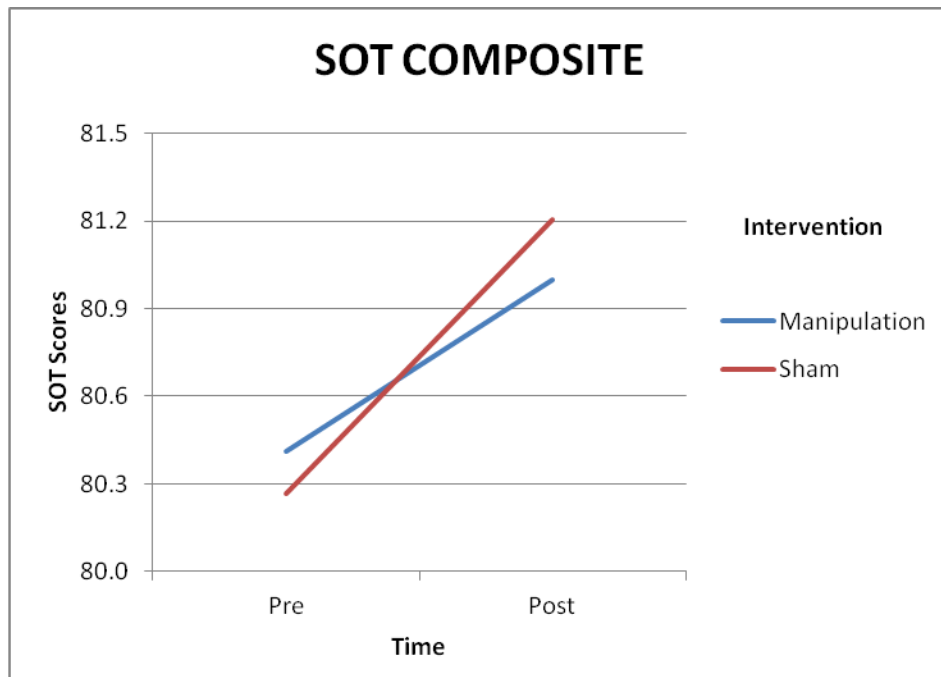
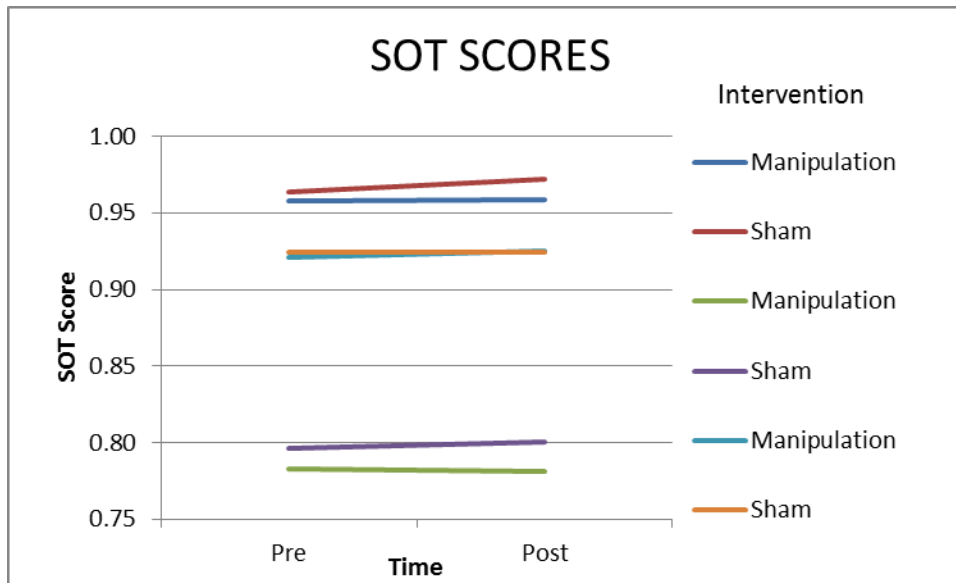


Figure 8. Sensory Organization Test Individual Component Scores.



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KIMBERLY DRAYER, SPT

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EDUCATION:**University of Nevada, Las Vegas – Las Vegas, NV**

- Doctor of Physical Therapy – July 2010 - May 2013

Northern Arizona University – Flagstaff, AZ

- Bachelor of Science: Exercise Science, Biology minor – August 2006 - May 2010

PROFESSIONAL EXPERIENCE:**Tri-City Medical Center: Oceanside, CA****January 2013 – April 2013**

- Clinical Internship
 - Provided skilled physical therapy interventions in the acute setting
 - Handled 100% of full caseload independently by end of affiliation
 - Assisted with leading weekly exercise class for people with Parkinson's Disease
 - Gained experience in NICU, ICU, orthopaedic unit, and behavioral health unit

RehabCare/PeopleFirst: Cherry Hills: Englewood, CO**Oct 2012 – December 2012**

- Clinical Internship
 - Gained valuable experience in skilled nursing facility setting
 - Provided inservice regarding pain management in the elderly population with an emphasis on dementia and non-verbal pain-rating scales
 - Scored above entry level in all areas of CPI by end of affiliation

Physiotherapy Associates: Englewood, CO**July 2012 – September 2012**

- Clinical Internship
 - Constructed physical therapy diagnoses based on evaluations
 - Designed appropriate physical therapy intervention protocols using evidence-based knowledge to suit the goals of patients
 - Participated in marketing outings
 - Handled 70% of full caseload independently by end of affiliation

Olsson Physical Therapy: Grand Junction, CO**June 2011 – July 2011**

- Clinical Internship
 - Examined and evaluated patients with musculoskeletal and neurological pathologies
 - Able to provide interventions with assistance required 25% of time by end of affiliation
 - Observed surgeries: SLAP repair, SLAP repair with biceps tenodesis, and carpal tunnel
 - Provided inservice of patellofemoral dysfunction and effective intervention plans

PRO Therapy**May 2008 – August 2008, May 2009 – August 2009**

- Physical Therapy Technician
 - Gained experience and knowledge about the physical therapy profession
 - Assisted physical therapists with interventions for patients

- Experience with outpatient orthopaedic, geriatric, and aquatic therapy

RESEARCH EXPERIENCE:

Mentored Group Research Project, University of Nevada Las Vegas In Progress

- Student Investigator: "Effects of Cervical Spine Manipulation on Balance and Joint Proprioception in Asymptomatic Individuals: Plausibility and Pilot Study."

Mentored Group Research Project, Northern Arizona University 2008

- Loveday DE, Drayer KA, Pierotti DJ, Coast JR. "Variations in Muscle Activation Timing With Changes in Pedal Technique." *International Journal of Performance Analysis in Sport*. 2008;8(3):119-29.

PROFESSIONAL MEMBERSHIP / CERTIFICATIONS:

American Physical Therapy Association (APTA) member since 2010

- Nevada chapter
- Joined research section 2012

Healthcare Provider CPR Certified since 2011

- American Heart Association - Expires May 15, 2015

CONTINUING / SUPPLEMENTAL EDUCATION:

APTA Combined Sections Meeting (CSM)

- San Diego – February 2013
- New Orleans – February 2011

APTA – Nevada Chapter Meetings

VOLUNTEER EXPERIENCE:

- Served on organization board of UNLVPT's 12th annual fundraising golf tournament – 2012
- Participation in research projects – 2012
 - Effects of Foot Strike on Low Back Posture, Shock Attenuation, and Comfort

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EDUCATION

Doctorate of Physical Therapy

University of Nevada, Las Vegas **2013**

Bachelor of Science in Exercise Science

Brigham Young University **2010**

PROFESSIONAL EXPERIENCE

Sunrise Hospital and Medical Center - Las Vegas, Nevada January 2013-April 2013

- Acute care – Clinical Internship
 - Utilized physical therapy in collaboration with a multi-disciplinary team to optimize functional mobility and minimize disability of patients.

St. Rose Dominican Hospital, Rose de Lima- Henderson, Nevada July 2012-August 2012

- Acute Rehabilitation – Clinical Internship
 - Individualized physical therapy techniques to evaluate and treat patients to maximize independence in functional mobility

Rapid Rehab - Las Vegas, Nevada July 2012-September 2012

- Orthopedic Outpatient Clinic – Clinical Internship
 - Evaluated and treated patients using pilates-based rehabilitation, manual therapies and modalities

Humboldt Physical Therapy - Winnemucca, Nevada June 2011-August 2011

- Orthopedic Outpatient Clinic – Clinical Internship
 - Examined, evaluated, diagnosed, created intervention plans and treated patients

Utah State Hospital - Provo, Utah August 2009-December 2009

- Extended Care Facility – Physical Therapist Aide
 - Instructed and supervised patients in therapeutic exercises

RESEARCH EXPERIENCE

Mentored Group Research Project, University of Nevada, Las Vegas

In Progress

- Effects of Cervical Spine Manipulation on Balance and Joint Proprioception in Asymptomatic Individuals: Plausibility and Pilot Study – Student Investigator

BioMed RAP, Washington University in St. Louis June 2009-August 2009

- Does Mammalian Bombesin Receptor-Mediated Grooming Reflect an Independent Sensation from Pain and Itch? – Student Investigator

Environmental Impact Studies, Brigham Young University February 2005-April 2006

- Impact of coal mining on Carbon County, Utah invertebrate populations – Project Manager

PROFESSIONAL MEMBERSHIPS / CERTIFICATIONS

APTA and Nevada Chapter memberships

2010-current

Licensed Massage Therapist; Utah (6665022-4701) and Hawaii (MAT-9859) 2007-current

CPR certified 2006-current

CONTINUED EDUCATION

Understand and Explain Pain for Physical Therapy .8 CEU	July 17, 2010
Introduction to Graston	April 2, 2011
Mobilization of the Nervous System Course	April 10, 2011
Advances in Diagnosis and Treatment of Upper Limb Spasticity .1 CEU	April 12, 2011
Introduction to Electrodiagnosis	September 13, 2011
American Academy of Cerebral Palsy and Developmental Medicine	October 15, 2011
Rotator Cuff Injuries, Diagnosis, Treatment and Rehab .1 CEU	November 8, 2011

OTHER

Bilingual: English and Portuguese