ORIGINAL RESEARCH

Immediate Changes in Head Repositioning Accuracy Following a Precise Upper Cervical Chiropractic Adjustment: A Randomized Clinical Trial

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ABSTRACT

Objective: The aim of this study was to assess the effect of a single Orthospinology atlas adjustment on cervical proprioception using a commonly used head relocation assessment.

Methods: The study included 72 randomly selected patients that presented to a chiropractic office seeking care for neck pain. Fifty-one patients were randomly assigned to the treatment group and 21 to the management group. All participants received two Joint Position Error (JPE) tests consisting of three consecutive tests of flexion, extension, and right and left rotation. The treatment group performed the JPE assessment prior to and immediately after their atlas adjustment. The control group performed the JPE assessment on their initial visit and again on their second visit before their adjustment was given.

Results: The results of the study showed a significant improvement in head relocation accuracy for the intervention group. Relocation accuracy improved 49.1% during flexion ($t(50) = 7.32$, $P < 0.001$, CI [-3.31, -2.06], 52.4% during extension ($t(50) = 6.48$, $P < .001$, 95% CI [-4.52, -2.38]), 42.3% during left rotation ($t(50) = 5.63$, $P < .001$, 95% CI [-3.07, -1.45] and 52.5% during left rotation ($t(50) = 6.23$, $P < .001$, 95% CI [-4/05. -2.07]). No significant improvements were noted in the control group ($P < .05$).

Conclusion: The results of this study suggest that the use of an Orthospinology high velocity low amplitude atlas adjustment can significantly improve cervical proprioception and may be considered as a management of patients presenting with deficits in sensorimotor control of the cervical spine.

Keywords: *Chiropractic, proprioception, Atlas, vertebral subluxation, chiropractic adjustment, spinal manipulation, Orthospinology*

Introduction

Cervical proprioception plays a vital role in the body's overall function and finding valid and reliable ways to improve it is essential for effectively managing disorders linked to altered movement sense, such as vertigo, dizziness, and whiplash associated disorders. The number of afferent receptors in the upper cervical spine indicates its importance in sensorimotor control, not only of the neck itself, but of the trunk and extremities as well as ocular and vestibular systems.[1,2]

The upper cervical spine is the most mobile part of the vertebral column but its mobility comes at the expense of its mechanical stability.[3] Because of this, the upper cervical spine is prone to the effects of trauma and resultant joint dysfunction.[4] In addition to altering depolarization of general mechanoreceptors, joint dysfunction creates aberrant muscle spindle Ia and II afferent signaling and group Ib afferents from surrounding joint musculature.[5-7] The resulting dysafferentation created by joint dysfunction interferes with kinesthetic sense and proprioception.[7]

Cervical proprioception is commonly assessed in clinical practice by having patients perform head repositioning assessments (HRAs) that evaluate for joint positioning errors

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(JPEs) of the cervical spine. During HRAs, patients attempt to relocate their head back to their own self-determined neutral head position after performing cardinal motions. The validity and reliability of HRAs have been established and are well documented in literature.[8-11]

Specific joint position sense training,[12,13] eye-cervical proprioceptive programs,[14] and cervical flexion training[12] have all been shown to reduce JPEs and improve cervical proprioception. Manipulation of the cervical spine has also demonstrated some efficacy, with most studies reporting reduction in JPE[15-18] and one[19] demonstrating no uniform effect of cervical spinal manipulative therapy (SMT). The results of these studies seem to indicate that therapeutic interventions directed at the cervical spine can improve head repositioning accuracy. To date, no studies have investigated the effect of adjustments to the cervicocranial junction.

The purpose of this study was to evaluate the effect of a single high velocity, low amplitude (HVLA) Orthospinology adjustment to the atlas (C1) on cervical proprioception. It was hypothesized that a single Orthospinology atlas adjustment would reduce JPE, as measured by HRAs, compared to no interventions. The proposed mechanism for the effect of the Atlas adjustment on cervical proprioception is reduction in muscle spindle gain and restoration of proper joint articulation generating more appropriate Ia afferent muscle spindle input into the somatosensory cortex resulting in better central nervous system muscle activation, as well improvement in cortical mapping for feedforward movements.[20]

Methods

This study was approved by the Sherman College of Chiropractic (Spartanburg, SC) Institutional Review Board (#ICPSOHV071625). Randomly selected, non-consecutive patients presenting to a chiropractic office seeking care for neck pain were considered for inclusion in this study. Inclusion criteria included the presence of an atlas misalignment as determined by radiographic analysis. Selected participants were screened for potential contraindications for upper cervical spine adjusting and signed informed consent for patient care and study participation.

Participants were also given an option to consent to participate in this clinical trial and receive care, or to receive care and not participate in the study. Patients meeting all study criteria were randomly assigned to either the treatment group (n=51) or the control group (n=21) prior to any evaluations being performed. Patient characteristics are in Table 1.

All study participants were given a JPE test using NeckCare software. The NeckCare system employs a Bluetooth-enabled head strap to sense and record head positions and documented angular difference between the patient's initial head position, and the head position after each motion was performed. Errors were recorded in degrees. When performing the JPE test, each patient was asked to sit up straight in what they considered good, normal posture.

Once the patient alerted the evaluator that they were ready, patients were asked to close their eyes and move their head into their maximum position for each movement and then to return to their original starting position. The patients were told to state "here" when they believed they had returned to their original starting position. NeckCare reported the results as degrees of error, which was the angle between the neutral head position and the position after each relocation. Each patient was assessed in order of flexion, extension, left rotation and finally in right rotation. Each position was performed three times before and after the upper cervical atlas adjustment was administered.

Patients in the control group were given a JPE test on their initial visit and then again when they returned to the office for their report of findings prior to their initial adjustment. The average time between initial visit and the patient's report of findings was three days. In the treatment group, participants were given their JPE test on the second visit, immediately before and after their atlas adjustment. The adjustment consisted of a force directed at the atlas transverse process using an Orthospinology Table Mount Torque Instrument and Orthodyn adjusting table. A regular adjusting tip set to a ⅜" depth with the use of a quick pull single adjustment was used.

Statistical analysis of JPE included calculating mean percent difference in error between the tests and retests in both groups. T-scores and P-values were also calculated for both groups to determine if the differences in means between the first and second HRA for each group were statistically significant ($P < .05$).

Results

The results of the study showed a significant reduction in JPE between pre and post assessment in the Orthospinology HVLA atlas adjustment test group for all four planes of movement. (Table 2, Figure 1) There was no significant improvement observed in the control group, but right rotation was significantly worse on post testing. (Table 3) (Figure 1) The greatest change in the intervention group was seen in cervical extension followed by cervical flexion, left cervical rotation and then right cervical rotation respectively.

Discussion

The results of this study demonstrate that a single HVLA adjustment to the atlas vertebrae can significantly improve cervical proprioception. This study supports the findings or other studies which have demonstrated reductions in JPE in the cervical spine after spinal manipulative therapy (SMT)[15-18] and does not support the findings of one study that demonstrated no uniform reduction in JPE after SMT.[19]

These prior studies utilized lower cervical spine manipulation as their intervention making this study inherently different. The lower cervical spine contains more joint mechanoreceptors, due to large numbers in facet capsules, and fewer muscle spindles than the upper cervical spine.[21] Facet dysfunction is associated with WAD and dizziness, which have been connected to decreases in cervical proprioception.[22]

In contrast, the upper cervical spine, especially the inferior oblique muscle, has a higher density of muscle spindles.[23] The results of this study suggest that changes in muscle spindle activity as a result of HVLA forces delivered to the C1

vertebrae, can also lead to significant improvements in cervical proprioception.

Depicting the exact mechanism of how an Orthospinology atlas adjustment would influence cervical proprioception can only be hypothesized. In Orthospinology, patients are set up in a position that enhances the potential for a successful reduction of all misalignment components. This positioning not only considers the relationship between C1 and occiput for both laterality and rotation, but also the relationship between C1 and C2 and C2 and the lower cervical spine.[24] The set-up itself aids in contributing to the thixotropic behavior of cervical muscle spindles.[25]

Patient positioning in Orthospinology is determined by analysis of pre-adjustment radiographs. During radiographic evaluation, the clinician assesses for the presence of head tilt, lateral displacement of the atlas, and deviations of the cervical spine (C2–C7) from orthogonal neutral alignment. Particular attention is directed toward rotational malposition of C2, as well as rotational or translational abnormalities throughout the remaining cervical vertebrae. Based on radiographic findings, the patient is positioned on the adjusting table in a manner designed to biomechanically facilitate realignment of the skull, atlas, C2 vertebral body, and the lower cervical segments toward a neutral orthogonal position.

Consequently, the craniocervical junction and its associated anatomical structures are biomechanically preconditioned to optimize physiological range of motion while minimizing the external corrective force required to re-establish proper alignment. This preparatory state reduces the likelihood of excessive loading, ensuring that the cervical articular facets, ligamentous complexes, and periarticular musculotendinous structures are not subjected to undue tension or strain prior to adjustment.

In orthospinology, patient positions, stylus vectors, and head piece tilt are all modifiable to help achieve neutral positioning to maximize the effectiveness of the thrust.

Once the patient and stylus are appropriately set up, the stylus is preloaded. The table mounted Orthospinology percussion instrument produces a preload of approximately 0 lbs.[26] Smaller pre-load magnitudes increase muscle spindle response during the manipulative thrust.[25]

After preload is set, a HVLA thrust is delivered by percussion through the use of an excursion stylus directed at either the right or left transverse process of C1. The adjustment creates a stretch of the deep paraspinal muscles. The rectus capitus posterior (RCP) major and minor, the myodural bridge of the RCP major and minor, as well as the obliquuis capitus superior and inferior are of great importance when considering the effects of adjusting the C1 vertebrae.[27-32]

Stretching of the cervical paraspinal muscles with an adjustment stimulates Type Ia, Ib, and Type II afferents,[33] as well as Type Ib afferents from muscles in the SCM, trapezius and splenius muscles. The mechanical stimulation of these afferents is converted into an electrochemical signal which will cause the opening of Piezo2 channels. Piezo2 channels are mechanosensitive ion channels that play a crucial role in detecting mechanical stimuli, such as touch, pressure, stretch, and proprioception.[34] These channels are found in sensory neurons, Merkel cells (skin), muscle spindles, and Golgi tendon organs, making them essential for movement and sensory feedback.[34] Piezo2 is critical for proprioception, allowing the nervous system to sense joint position, muscle stretch, and body movement.

Despite the observed effectiveness of a single HVLA Orthospinology adjustment to the atlas vertebra in improving cervical proprioception, the present study does not address the duration of these proprioceptive changes. Future research is therefore warranted to determine whether such an intervention produces sustained neuroplastic adaptations in proprioceptive function, and or if continued adjustments yield better or potential worse outcomes. Additionally, this study was limited to assessments performed in a seated posture and did not evaluate whether similar outcomes would be observed when standing.

Given that daily activities typically involve both seated and standing tasks, it is important for future investigations to include standing posture joint position error (JPE) testing to assess the generalizability of these findings. Lastly, control and intervention groups had different time frames between test administration. It cannot be discounted that this affected the results. However, prior studies on test/retest reliability have not demonstrated test-retest learning within a single session, as ICC values have ranged from 0.20[35]-0.86[36] on test-retest reliability studies in a single session.

Conclusion

The results of this study demonstrate that a single Orthospinology high velocity low amplitude atlas adjustment can improve cervical JPEs in both the vertical and horizontal planes. This suggests that an Orthospinology high velocity low amplitude atlas adjustment can have both segmental effects and regional influence on cervical spine functioning. The results add additional support to a small but growing body of literature that suggests that cervical spine adjusting, whether done by hand or instrument, can influence the function of the cervical spine and should be considered in the treatment profile of a patient with cervical proprioceptive deficits.

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Appendix

Table 1. Control and Test Group Summary Information

	Control (*N*=21)	Test (*N*=51)
Average Age	55	50
Age Range	22-79	21-77
Average Levels of DDD	2	2
Average Levels of Facet Hypertrophy/Degeneration	3	3
QVAS Score Average	52.6%	53.6%

Table 2. Results of the Pre and Post Orthospinology High Velocity Low Amplitude Atlas Adjustment Group

Movement	Pre-test Error (°)	Post-test Error (°)	% Change	t-Score, p-value, CI
Flexion	Mean 5.6 (2.8) 95% CI [4.8, 6.4]	Mean 2.7 (1.2) 95% CI [2.36, 3.04]	-51.8%	*t*(50) = 7.32 *P* < 0.001 95% CI [-3.31, -2.06] T crit= 2.01
Extension	Mean 6.3 (3.9) 95% CI [5.15, 7.41]	Mean 2.9 (1.5) 95% CI [2.47, 3.33]	-54.0%	*t*(50) = 6.48 *P* < 0.001 95% CI [-4.52, -2.38] T crit= 2.01
Left Rotation	Mean 5.2 (3.3) 95% CI [4.26, 6.14]	Mean 3.0 (1.4) 95% CI [2.60, 3.40]	-42.3%	*t*(50) = 5.63 *P* < .001 95% CI [-3.07, -1.45] T crit= 2.01
Right Rotation	Mean 5.9 (3.6) 95% CI [4.88, 6.92]	Mean 2.8 (1.5) 95% CI [2.37, 3.23]	-52.5%	*t*(50) = 6.23 *P* < 0.001 95% CI [-4.05, -2.07] T crit= 2.01

Table 3. Results of the Pre and Post JPE for the Control Group

Movement	Pre-test Error (°)	Post-test Error (°)	% Change	t-Score (p-value, CI)
Flexion	Mean 4.9 (1.9) 95% CI [4.04, 5.76]	Mean 6.5 (2.8) 95% CI [5.23, 7.77]	+32.7%	*t*(20) = 2.57 *P* = .03 95% CI [0.35, 2.99] T crit= 2.09
Extension	Mean 6.9 (4.9) 95% CI [4.67, 9.13]	Mean 7.7 (4.5) 95% CI [5.65, 9.75]	+11.6%	t(20) = 0.51 *P* = .61 95% CI [-1.40, 3.03] T crit 2.09
Left Rotation	Mean 5.3 (2.7) 95% CI [4.07, 6.53]	Mean 5.2 (2.4) 95% CI [4.11, 6.29]	–1.9%	*t*(20) = -0.24 *P* = .82 95% CI [-1.13, 0.92] T crit = 2.09
Right Rotation	Mean 6.0 (4.1) 95% CI [4.13, 7.87]	Mean 6.6 (2.7) 95% CI [5.37, 7.83]	+10.0%	*t*(20) = 0.16 *P* = .88 95% CI [-0.81, 1.99] T crit = 2.09

Figure 1. Joint Position Error in Degrees For Each Motion

