Case Study

Reorganization of the Cervical Curve & Improved Quality of Life Following Network Spinal Analysis Care: A Case Study

Daniel M. Knowles III, D.C.[1]
Richelle Knowles, D.C.[1]
Boo Burnier, B.A., D.C.[2]

1. *Private Practice of Chiropractic, Boulder, CO*
2. *Denver, CO*

Abstract

Objective: The objective of this study is to report on the reorganization of the cervical curve in a patient undergoing Network Spinal Analysis chiropractic care.

Clinical Features: The patient is a 31-year-old male who presented for Network care with complaints of arthritis in his neck, stabbing pain in ribs and numbness/tingling in both hands. Radiographs were taken which demonstrated an Atlas Plane Angle measurement of 14.7° indicating loss of cervical lordosis.

Intervention and Outcomes: Chiropractic care plan consisted of Network Spinal Analysis care. Based on initial spinal assessment, low force spinal adjustment contacts were applied to enhance spinal and neural integrity and increase somatic awareness. The patient received a total of 61 adjustments over a period of 6 months. After 6 months surface electromyography, thermal scan, radiology and patient's subjective assessment demonstrated significant improvement. Lateral cervical film showed increase in Atlas Plane Angle to 30° and the restoration of the patient's lordotic cervical curve.

Conclusion: This case study reports on the increase of the cervical lordosis in a patient undergoing Network Spinal Analysis care. Improvement in the patient's objective outcomes indicates that while under Network care, the patient's body has undergone reorganization. This case study adds to subluxation-based chiropractic research focused on the restoration of the cervical curve. Further research is warranted to determine the relationship between Network Spinal Analysis adjustments and improvement in the cervical curvature.

Key Words: *Cervical curve, cervical lordosis, chiropractic, Network Spinal Analysis, vertebral subluxation, adjustment, reorganizational healing*

Introduction

The normal position of the spine is one where the vertebrae are vertically aligned in a midline neutral position.[1] A healthy spine has three natural curves: cervical lordosis, thoracic kyphosis, and lumbar lordosis.[2] These spinal curves support specific biomechanical functions, improve balance within the body, serve as attachments for spinal muscles, and protect focal area by transmitting and redistributing forces through the body.[3] Some authors indicate that out of all spinal curves, the cervical curve is a primary curve.[1] Cervical lordosis is developed in utero, and it becomes more apparent in infancy, when the child learns how to lift his/her head.[4,5] The biomechanical functions of cervical lordosis are: distribution of weight, energy efficiency, structural support, and absorbing shock. It has been suggested that cervical spine with normal cervical lordosis can better disperse external and internal forces than the spine with reduced cervical lordosis.[6]

There are a number of approaches to defining normal lordosis.[7] Measurements have been determined through observation and statistical evaluation.[8] One approach uses posterior tangent method for cervical vertebrae from C2 to C7 and estimates that average cervical lordosis ranges from 21.3° to 22.3°.[7] Harrison et al indicate that ideal cervical lordosis is 42° according to circular model.[9] In the same study, average cervical lordosis between C2 through C7 has been estimated at 34° for a given sample. McAviney et al found that a "clinically normal" range for cervical lordosis is 31° to 40°.[7]

According to Pierce, a normal cervical lordosis is +17cm, which is the measurement of the radius of an arc. A straight neck measures +500 and kyphosis measures -17cm.[10]

Theoretically, the cervical curve should have a normal lordosis. Loss of normal lordotic curve may lead to loss of proper biomechanics - the body is no longer able to accommodate, transmit and distribute all forces going through the body.[3] As a consequence of that process, a component of vertebral subluxation complex may be generated.[11] There are several symptoms that have been associated with loss of normal cervical curve. Those are: mechanical neck pain, cervical-brachial neuralgia, vascular headaches, migraine headaches, cervicogenic headache, numbness, vertigo, nausea, airway obstruction, suboccipital pain, occipital neuralgia, paresthesia, muscle spasms, and decreased cervical range of motion.[3,5,12] It has also been suggested that loss of cervical lordosis may have a detrimental effect on the brainstem.[13]

Loss of cervical lordosis has been linked to age - increase in lordosis has been noted in older individuals. There are no prevalent trends for female or male subjects indicating no correlation between sex and cervical lordosis.[7] It has been suggested in the literature that loss of cervical lordosis follows a spasm of the anterior cervical musculature, however, no evidence has been found to support that assertion.[4] Chronic stress, motor vehicle accidents, repetitive micro-traumas, macro-traumas, postural loadings, and whiplash have also been indicated as underlying causes of reduction in cervical curve.[1,13] Another hypothesis involves *buckling* or *snap through*, which causes spinal tissues to assume a different *buckled* position every time after *buckling* had occurred.[4] The reason is that *buckling* happens even 3 times faster than it takes for the spinal muscles to react. In order to go back to their original position, spinal tissues need to be remodeled, otherwise the accumulation of the effects leads to gradual loss of cervical lordosis.[4]

The literature describing conservative methods to improve cervical lordosis is scarce.[4] There are several chiropractic techniques which address the correction of the cervical curve. Those techniques are Chiropractic Biophysics (CBP), Pettibon and Pierce, which use a variety of specific procedures in order to restore cervical lordosis. Those procedures may include: chiropractic adjustments, cervical extension-traction, mirror-image adjusting, 3-point bending, headweight device, and transverse load cervical compression traction.[3,4]

Chiropractic research focusing on the application of the tonal approaches to correct spinal curves is very limited. Specifically, very few studies have been published that would directly present the outcomes of the Network Spinal Analysis care on patient's presenting with decreased cervical lordosis. The objective of this study is to fill this gap and to report on the reorganization of the cervical curve in a patient undergoing Network Spinal Analysis care.

Case Report

Patient History

The patient is a 31-year-old male chef who presented for Network care with complaints of arthritis in his neck, stabbing pain in ribs and numbness/tingling in both hands. The patient indicated that the onset of his neck condition was 8 years prior. The quality of neck arthritis was described as "sharp/shooting", and it was located at C4-C6 vertebrae. Severity of this condition was rated at 6/10 on the numerical scale. The patient stated that neck rotation and "popping" his neck helped. He said that he had never had this condition before and at the time of his visit his neck arthritis was present daily.

The onset of the stabbing pain in ribs and numbness/tingling in hands was on the day of the patient's visit and started when the patient woke up. The patient stated that he had experienced this pain before. Pain was located in mid-back and rated at 8/10 on a numerical scale. The patient said that Advil significantly helped decrease his pain - from 8/10 to 3/10. The onset of numbness/tingling in hands was also on the day of the patient's visit and started when he woke up. The patient stated that he had experienced this pain before as well. Numbness and tingling was present in both hands, however the patient's right hand was worse. The patient said that moving his hands helped with his condition.

The patient's past history revealed a motor vehicle accident, which happened when he was 16 years old. He was under chiropractic care following the accident. The patient also fell out of the tree house when he was 13 years old - he landed on his head and fractured his wrist. The patient stated that he had 20 chiropractic appointments until now. On his initial health questionnaire, the patient admitted that "grinding or cracking" noises were present when he moved his head or neck. The feeling like he needs to "twist, stretch, crack or pop" his neck was also present. The patient rated his posture at 4/10 on a numerical scale and his stress level at 6/10. He stated that his conditions were also interfering with his sleep. The patient was occasionally taking Flexeril to treat pain. He indicated that his health was preventing him from consistent aerobic exercise - he was often getting tired or hurt after his workout. He claimed that if he had optimum health, he would exercise more, sleep better and have increased focus and drive. He associated optimal health and healing with "better sleep and lower pain".

Review of systems revealed that the patient was suffering from: constitutional issues - daytime drowsiness and fatigue (both in the past and present); issues related to ears/nose/throat - ringing in the ears (in the past), snoring and sleep apnea (both in the past and present); respiratory issues - asthma or wheezing (in the present); issues related to heart and circulation - shortness of breath w/activity (in the present); issues related to stomach/intestines - frequent heartburn or indigestion (in the present); issues related to muscles/bones/joints - arthritis; issues related to nervous system - headaches (both in the past and present); and psychological issues - anxiety, depression, insomnia, mood change (in the present).

The patient's surgical history includes tubes in his ears at 6 months of age. The patient has not been hospitalized and does not have any allergies. His family history has high blood pressure and hearing loss. His father had a heart attack.

Chiropractic Examination

The objectives of chiropractic examination were: to evaluate the patient's spine for the existence of vertebral subluxations, to evaluate the patient's neurological function, and to evaluate the alignment of the patient's spine. In addition to the health questionnaire, the following examinations were performed: heart rate variability, surface electromyography (sEMG), thermal scanning, and x-rays. The outcomes were used to monitor the patient's objective improvement under chiropractic care.

Heart Rate Variability

Heart Rate Variability is a qualitative analysis performed to measure and assess the autonomic nervous system. The autonomic nervous system reflects health status of a patient.[14] Because vertebral subluxations have an autonomic component, the analysis of heart rate variability and other factors can be used to evaluate vertebral subluxations.[15]

The study measures various factors which reflect the activity of the patient's autonomic nervous system.[16] Mean Inter-Beat Interval (IBI), Mean Beats Per Minute (BPM), and Standard Deviation of IBI are calculated during *time domain* analysis. Sympathetic Response, Parasympathetic Response, Autonomic Activity and Autonomic Balance are calculated during *frequency domain* analysis.

Heart Rate Variability scan gave the following results for the patient in the *time domain* analysis: Mean IBI = 825.97, Mean BPM = 73, STD of IBI = 77.96. Heart Rate Variability scan gave the following results for the patient in the *frequency domain* analysis: Sympathetic Response = in Normal Range, Parasympathetic Response = in Normal Range, Autonomic Activity = 73.58, Autonomic Balance = 72.22(S).

sEMG Scan

Surface electromyography is used to examine paraspinal and peripheral muscle function. Paired electrodes are used to record muscular activity and compare muscle tension along the spine. According to Kent, paraspinal sEMG scans may be helpful in determining the following: asymmetrical contraction, areas of muscle splinting, severity of the condition, aberrant recruitment patterns, dysponesis, responses to dysafferentation, and response to chiropractic adjustment.[17] An abnormal function of paraspinal muscles has been accepted as a clinical manifestation of vertebral subluxation. As sEMG records paraspinal activity and any changes indicating vertebral subluxations, it has been recognized as a valid and reliable tool to assess vertebral subluxations.[17] sEMG scan compares muscle activity (amplitude and symmetry) with reference values and so: differences between one and two standard deviations indicate mild tension or asymmetry, two to three standard deviations indicate moderate tension or asymmetry, while three or more standard deviations indicate severe tension or asymmetry.

Readings one or more standard deviations below normal means were observed at: T10(R), T12(R), which indicated reduced muscle tension. Readings one to two standard deviations above normal means were observed at: C1(L), which indicated mild elevation of muscle tension. Readings two to three standard deviations above normal means were observed at C1(R), which indicated moderate elevation of muscle tension. Areas of significant asymmetry were noted at the following sites: T2(L), L1(R), and S1(R).

Thermal Scan

Thermal scan is performed to assess skin temperature differences along the spine. The assessment of changes in skin temperature may be used to evaluate the ability of the nervous system to adapt to changes in the internal and external environments. It has been indicated that there is a positive correlation between changes in skin temperature and the function of the autonomic nervous system and that vertebral subluxations may cause thermal asymmetries.[18] The assumption underlying this claim is that in a healthy person skin temperature patterns may change when the environment changes, but will always remain symmetrical, as the body adapts to those environment changes.[18] Any difference in skin temperature exceeding 0.5°C indicates the presence of neurological interference.[19] By recording skin temperature differences and tracking underlying subluxations thermal scan improves the patient's assessment, management of the vertebral subluxations and helps monitor patient's response to care.[20] Skin temperature differences that are between one and two standard deviations indicate mild asymmetry, differences between two to three standard deviations indicate moderate asymmetry, and differences exceeding three standard deviations indicate severe asymmetry.

On the patient's thermal scan mild asymmetries were found at: C7(L), T1(L), T4(L) and T10(L). Moderate asymmetries were present at: C6(L), and T5(L). Severe asymmetry was found at T6(L).

Radiology

Radiographs were taken and lateral cervical x-ray was analyzed using Chiropractic BioPhysics protocol. It has been shown that radiographic line drawing analysis is one of the most reliable methods in clinical practice.[21] Cervical curve measurement was performed with posterior tangent method - with a line that was tangent to the posterior vertebral body margins of C2-C7. This line, called the Absolute Rotational Angle (ARA), showed significant loss of cervical lordosis (See Chart 1a in the Appendix). Atlas Plane Angle (angle between the Atlas plane and the horizontal plane line) was 14.7 degrees, which should ideally be a 28.7 degree angle.[9]

The results of all examinations listed above along with patient's history and other clinical findings were used in determining recommendations for the type, frequency, and duration of chiropractic care. Follow-up examinations were performed to evaluate the patient's response to chiropractic care.

Chiropractic Care

The care plan consisted of Network Spinal Analysis care. Based on initial spinal assessment the practice member was to receive brief low force spinal adjustment contacts to enhance the self-regulation of passive, active and neural spinal

subsystem tension, increase somatic awareness, reduce vertebral subluxation and increase neural coherence. Recommended initial visit frequency was initially 3 times per week. After 4 months of care (42 adjustments), frequency was decreased to 2 times per week. Chiropractic management plan was dependent on the progress of the practice member and was to be adjusted according to his/her assessment. The practice member received a total of 61 adjustments over a period of 6 months.

Network Spinal Analysis

Network Spinal Analysis represents a tonal approach, which states that "tone is the normal degree of nerve tension" and views "the spine and nervous system as a functional unit".[11] The objectives of Network Spinal Analysis care are to promote practice member self-awareness, increase spinal self-organization, detect the presence of adverse mechanical cord tension and vertebral subluxation and using "hands on", low-force adjustments in order to increase spinal and neural integrity.[22] As a result of Network care the spine and nervous system become more adaptable to the environmental changes and work as one functional unit. Network Spinal Analysis, as a tonal approach, emphasizes the importance of Reorganizational functional outcomes in the assessment and management of the practice member.[11]

Assessment

During each visit the practice member was assessed according to Network Spinal Analysis care protocol. Recommended spinal assessment includes hard tissue palpation (restriction, fixation, misalignment, hypermobility, postural shifts, and bilateral weight scales), muscle palpation, and checking neural control indicators (short leg syndrome, heel tension, elevated leg, cervical syndrome, ankle eversion stress, leg adduction/abduction, z-flick, leg crossover, sacrotuberous ligament tension, sacral/thoracic correlation, and respiration changes) for presence of adverse mechanical cord tension phase indicators and vertebral subluxation.[22]

The assessment of the practice member in this study consisted of the following elements: heel tension, heel eversion stress, leg adduction/abduction, checking for the presence of (passive and active) tension in the spine and spinal musculature.

Entrainment

During each visit, assessment of the practice member would determine the adjustment (called "Spinal Entrainment") at the specific access point to the nervous system (called "Spinal Gateway").[5] It has been suggested that certain shift in the brain/body is associated with Network Spinal Analysis low-force contact. This shift occurs from stress physiology to that expressing "safety" which supports growth and reorganization.[5] The objective of the Spinal Entrainment is to synchronize internal processes throughout the body, "to result in a state that promotes healing and growth."[23]

Results

After 7 weeks of Network care the patient stated that, "subjective experience is improved". He noted that he had become more aware of his spine. This awareness was especially noticeable while the patient was sitting and was not a result of greater discomfort or pain. The patient became aware that sitting and lying down bring about this awareness.

The patient stated that overall pain decreased and there was more ease in the spinal movement. The patient noted that the way he carried his body changed: he was holding his head higher, slouching less and he found it easier to keep straight up. He also realized that he had become more aware of his breathing, which was easier and deeper. He claimed that his body had become more effective at releasing its tension. During that period, the patient experienced the following changes in his life: ended several years long incompatible relationship and his "bad boss" was gone.

Eight weeks later initial care reevaluation was performed. The patient stated that he had experienced breath move through his body and his body moved on the table in response to adjustments. He felt "more in touch with feelings/emotions" and could "experience them more intensely." He also noticed more balance and flexibility, ease in his back and better sleep. After 6 months of Network care, follow-up examinations were performed: heart rate variability, sEMG, thermal scan and radiology (see Charts 1 through 3 in the Appendix). Surface EMG demonstrated an improvement in all areas of tension exhibited at the initial exam - muscle tension was normal at T10(R), T12(R), C1(L) and C1(R) and there was no asymmetry at T2(L), L1(R), S1(R). Thermal Scan demonstrated increased symmetrical temperature patterns for areas of asymmetries exhibited at the initial exam - there were no asymmetries shown at C7(L), T1(L), T4(L), T10(L), C6(L), T5(L) and T6(L). Lateral cervical film showed a significant improvement in Atlas Plane Angle (which was now 30.0 degrees) and the restoration of the patient's lordotic cervical curve.

Improvement in the patient's objective outcomes indicates that while under Network care, the patient's body has undergone a reorganization.[24] Restoration of the lordotic cervical curve is a sign that the patient's spinal and neural integrity improved, which allowed for healing and correction.

Discussion

Different approaches have been described in chiropractic literature that attempt to correct cervical curve and posture-related imbalances.[3] Those include: Pierce Results System, CBP protocol, Pettibon Corrective and Rehabilitative Procedures, Activator Methods Chiropractic Technique, Diversified Technique, Gonstead Technique, Knee Chest Technique, and Network Spinal Analysis. [2-5,10,12,13,23,25-33] All those chiropractic techniques differ in approach to patient, assessment, management protocol and outcome measures. The studies available in the literature provide various results in terms of management period, frequency of visits, angle of correction, etc. It makes it therefore challenging to indicate which of the available chiropractic approaches may be suggested as more efficacious for patients with decreased cervical lordosis.

Harrison et al used spinal manipulation combined with extension-compression cervical traction to manage patients

with decreased cervical lordosis.[4] The management period was 14.6 weeks and the patients were seen 38 times. During that time average increase in Cobb angles was 13° to 14° and the angle of intersection of the posterior tangents on C2 and C7 improved on average by 17.9°. In another study, Harrison et al reported that an average of 60 visits over a 3-month period is needed to note significant improvements of cervical lordosis.[31] The results demonstrated that the average increase in cervical lordosis was 13.2° when a combined approach of cervical extension compression traction and spinal adjustment was used. The same study found no improvement when only CBP spinal adjustment was administered.[31] Plaugher et al also reported no improvement in patients with decreased cervical curve who underwent 6.5 adjustment sessions over 3 weeks under Gonstead chiropractic care.[30] There are studies, however, which demonstrate improvement in cervical lordosis following chiropractic management alone.[4,5,23,25,29,32] Only two of those studies utilize Network Spinal Analysis technique.[5,23]

Improvement in cervical lordosis or restoration of the cervical curve has been associated with various outcomes in the literature. It has been suggested that restoration of normal spinal curves leads to improved health outcomes, pain reduction, increased function, and improved quality of life.[12,13] Chiropractic literature provides limited evidence that the following conditions may resolve following increase in cervical curvature and reduction of vertebral subluxations: headaches, migraines, chronic otitis media, neck pain, sinus infection, muscle aches, fatigue, joint dysfunction, asthma, allergies and digestive problems.[2,4,12,26,27,33] In the study by Soriano and Apatiga, improvement in fibromyalgia symptomatology has been reported following reduction of vertebral subluxations and increase in cervical curvature.[29] Morningstar suggested that loss of the cervical curve may have negative musculoskeletal effects beyond the cervical spine. His study demonstrated that restoration of the cervical curve might help eliminate mechanical lower thoracic pain.[3]

The evidence available in the scientific literature suggests that in case of decreased cervical lordosis, cervical vertebrae may be in a position where they directly touch the spinal cord.[13] Loss of normal cervical curvature may therefore exert pressure, cause compression or traction on the spinal cord leading to loss of spinal and neural integrity. It has also been hypothesized that the abnormal posture may result in excessive loading to the spine and spinal structures, and negatively affect physiological function.[1,12]

Alterations in the biomechanics of the cervical spine - loss of cervical lordosis in particular - may alter normal afferent input into the cerebellum.[28] Tension in the medulla, brain stem and cranial nerves is generated by flexion and extension motions of the cervical spine. And so, when normal biomechanics of the cervical spine is compromised, the brain stem may touch the anterior wall of the foramen magnum during flexion of the cervical spine. When that occurs, the anterior subarachnoid space may narrow even to an extent where it vanishes completely.[34] Increased stretching and traction of the spinal cord may lead to increased intramedullary pressure, increased pressure of the cerebrospinal fluid, increased pressure within the nerve cells, and consequently cause neurologic deficit.[1,23] According to Harrison et al, exerting pressure on nerve tissues through mechanical traction caused by loss of normal cervical lordosis increases levels of sympathetic nerve activity.[1]

Chiropractic literature seems to emphasize the biomechanical components resulting from loss of normal cervical lordosis. However, there is evidence that low force contact approach, such as Network Spinal Analysis protocol, may lead to increase in cervical lordosis. The evidence is still limited, and the exact mechanism explaining how Network Spinal Analysis adjustments transmit through the body and result in the reorganization of the cervical curve, remains unknown.[5] Low-force adjustments used during Network care result in reduction of vertebral subluxation and consequently an increase spinal and neural integrity. Reorganization of the lordotic cervical curve is a sign that the patient's spinal and neural integrity improved, which allowed for healing and improved function of the nervous system.

Limitations

This case study has several limitations. As it is a case study, the sample size is small and the evidence provided - low. The patient presented with several conditions accompanied by loss of cervical lordosis. Hence the outcomes obtained in this study may not be generalized to all patients with decreased cervical lordosis. Another limitation could also be the patient's lifestyle - the patient's file indicates that at the beginning of Network care, he "ended several year-long incompatible relationship and his bad boss was gone". It remains unknown if any other changes had been made during the course of chiropractic management, and how they affected the patient's progress and response to Network care. While two questionnaires - Initial Care Reevaluation and Basic Care Somatic Observations Survey - were filled out by the patient during the period of care, additional subjective outcome measures would have provided further useful information in this study.

Conclusion

This case study reports on the increase of the cervical lordosis in a patient undergoing Network Spinal Analysis care. Improvement in the patient's objective outcomes indicates that while under Network care, the patient's body has undergone reorganization. This case study adds to subluxation-based chiropractic research focused on the restoration of the cervical curve. In particular, this study provides limited evidence that Network Spinal Analysis care may be safe and effective in addressing loss of normal cervical lordosis.

Further research is warranted to determine the relationship between Network Spinal Analysis adjustments and improvement in the cervical curvature, to elucidate the mechanism of improvement following Network care, and to clarify how Network care may facilitate the reorganization of the cervical curve. Current evidence available in the literature is limited, and requires further investigation. The majority of chiropractic research consists of case studies using various research methods, management protocols and outcome measures. Conducting larger population studies and using unified research methodology are therefore important recommendations for future research.

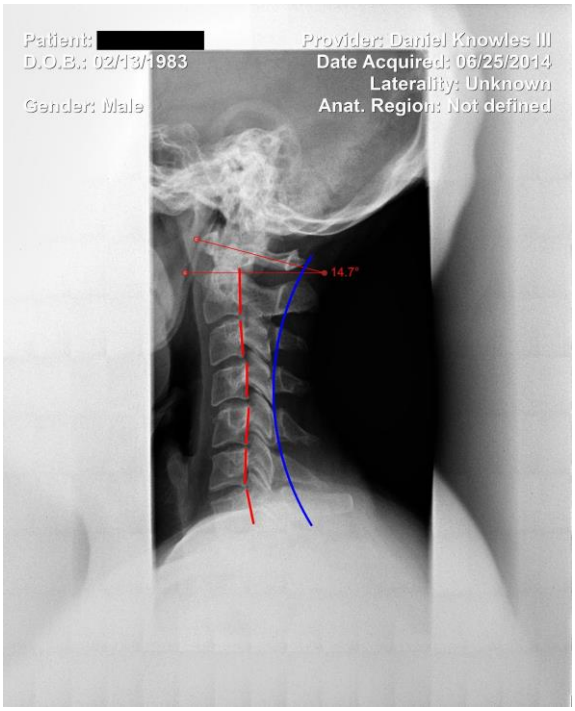
References

1. Harrison DE, Harrison DD, Troyanovich SJ, Harmon S. A normal spinal position: It's time to accept the evidence. J Manipulative Physiol Ther. 2000 Nov/Dec;23(9):623-644.
2. Cardwell A, Barone B. Improved Health Outcomes Following Reduction of Vertebral Subluxation and Improved Cervical and Lumbar Curves Utilizing Chiropractic Biophysics Protocol. Ann Vert Sublux Res. 2014;:113-128.
3. Morningstar M. Cervical curve restoration and forward head posture reduction for the treatment of mechanical thoracic pain using the Pettibon Corrective and Rehabilitative procedures. J Chiropr Med. 2002 Summer;3(1):113-115.
4. Harrison DE, Harrison DD, Betz JJ, Janik TJ, Holland B, Colloca CJ, Haas JW. Increasing the cervical lordosis with chiropractic biophysics seated combined extension-compression and transverse load cervical traction with cervical manipulation: nonrandomized clinical control trial. J Manipulative Physiol Ther. 2003 Mar-Apr;26(3):139-51.
5. Rohrbach T, Knowles D, Knowles R. Restoration of the Cervical Curve and Improvement in Neurological Function in a Patient Following Network Spinal Analysis. Ann Vert Sublux Res. 2011;:99-103.
6. Gay RE. The curve of the cervical spine: variations and significance. J Manipulative Physiol Ther. 1993 Nov-Dec;16(9):591-4.
7. McAviney J, Schulz D, Bock R, Harrison DE, Holland B. Determining the relationship between cervical lordosis and neck complaints. J Manipulative Physiol Ther. 2005 Mar-Apr;28(3):187-93.
8. Yochum T, Rowe L. Essentials of skeletal radiology. 2nd ed. Baltimore: Williams & Wilkins; 1996.
9. Harrison DD, Janik TJ, Troyanovich SJ, Holland B. Comparisons of lordotic cervical spine curvatures to a theoretical ideal model of the static sagittal cervical spine. Spine. 1996;21:667-75.
10. Berner N, DeMaria C. Improvement of Migraines in a Child Following Cervical Curve Correction Using the Pierce Results System™. J Pediatr Matern & Fam Health - Chiropr. 2013;2013(2):47-53.
11. Kent C. Models of vertebral subluxation: a review. J Vert Sublux Res. 1996;1(1):11-17.
12. Fedorchuk C, Wheeler G. Resolution of Headaches in a 13 Year-Old Following Restoration of Cervical Curvature Utilizing Chiropractic Biophysics: A Case Report. J Pediatr Matern & Fam Health - Chiropr. 2009;2009(4):1-7.
13. Pero J, Jockers D. Improvement in Cervical Curvature and Health Outcomes in a Patient with Rheumatoid Arthritis Undergoing Chiropractic Care to Reduce Vertebral Subluxation. Ann Vert Sublux Res. 2012;:77-81.
14. Eingorn AM, Muhs GJ. Rationale for assessing the effects of manipulative therapy on autonomic tone by analysis of heart rate variability. J Manipulative Physiol Ther. 1999;22(3):161-164.
15. Hart J. Association between heart rate variability and novel pulse rate variability methods. Ann Vert Sublux Res. 2012;:65-71.
16. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Heart Rate Variability - Standards of Measurement, Physiological Interpretation and Clinical Use. European Heart Journal. 1996;17:354-381.
17. Kent, C. Surface Electromyography in the assessment of changes in paraspinal muscle activity associated with vertebral subluxation: A Review. J Vert Sublux Res. 1997;1:1-7.
18. McCoy M. Paraspinal thermography in the analysis and management of vertebral subluxation: a review of the literature. A Vert Sublux Res. 2011;2011(3):57-66.
19. Uematsu S, Edwin D, et al. Quantification of thermal asymmetry. Part 2: application in low-back pain and sciatica. J Neurosurg. 1988;69:556-561.
20. Uematsu S, Edwin DH, Jankel ER et al. Quantification of thermal asymmetry. J Neurosurg. 1988;69:552-55.
21. Oakley PA, Harrison DD, Harrison DE, Haas JW. Evidence-based protocol for structural rehabilitation of the spine and posture: review of clinical biomechanics of posture (CBP) publications. JCCA. 2005 Dec;49(4):270-96.
22. Epstein D. Network Spinal Analysis Care: Basic Care Intensive Seminar Notes. 2014. Wise World Seminars, Longmont, CO.
23. Ray K, Knowles D, Knowles R. Reduction of a lumbar scoliosis & improved cervical curve in a geriatric patient following network spinal analysis care: a case study. Ann Vert Sublux Res. 2013;2:18-28.
24. Epstein D, Senzon SA, Lemberger D. Reorganizational Healing: A paradigm for the advancement of wellness, behavior change, holistic practice, and healing. J Altern Complement Med. 2009;15:475-487.
25. Coleman RR, Hagen JO, Troyanovich SJ, Plaugher G. Lateral cervical curve changes in patients receiving chiropractic care after a motor vehicle collision: a retrospective case series. J Manipulative Physiol Ther. 2003 Jul-Aug;26(6):352-5.
26. Fedorchuk C, Opitz K. Improvement in Quality of Life and Improved Cervical Curve in an 11-year-old Child with Asthma Following Chiropractic Intervention: A Case Study. J Pediatr Matern & Fam Health - Chiropr. 2014;2014(2):37-46.
27. Fedorchuk C, Cohen A. Resolution of Chronic Otitis Media, Neck Pain, Headaches & Sinus Infection in a Child Following an Increase in Cervical Curvature & Reduction of Vertebral Subluxation. J Pediatr Matern & Fam Health - Chiropr. 2009;2009(2):1-8.
28. Nektalov B. Improvement in a Patient with Scoliosis Undergoing Chiropractic Care: A Case Study. J Pediatr Matern & Fam Health - Chiropr. 2012;2012(1):31-37.
29. Soriano W, Apatiga A. Resolution of Fibromyalgia & Polypharmacy Concomitant with Increased Cervical Curve & Improved Quality of Life Following Reduction of Upper Cervical Subluxation: A Case Study. J Pediatr Matern & Fam Health - Chiropr. 2014;:61-67.
30. Plaugher G, Cremata EE, Phillips RB. A retrospective consecutive case analysis of pretreatment and comparative static radiological parameters following chiropractic adjustments. J Manipulative Physiol Ther. 1990;13:498-506.

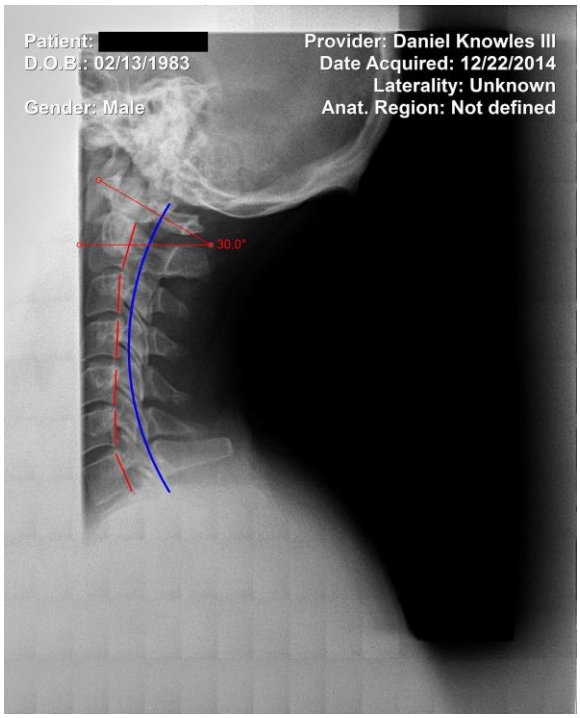
31. Harrison DD, Jackson BL, Troyanovich S, Robertson G, de George D, Barker WF. The efficacy of cervical extension-compression traction combined with diversified manipulation and drop table adjustments in the rehabilitation of cervical lordosis: a pilot study. J Manipulative Physiol Ther. 1994;17:454-64.
32. Leach RA. An evaluation of the effect of chiropractic manipulative therapy on hypolordosis of the cervical spine. J Manipulative Physiol Ther. 1983;6:17-23.
33. Oakley P, Chaney SJ, Chaney TA, Maddox A. Resolution of chronic headaches following reduction of vertebral subluxation in an 8-year-old utilizing chiropractic biophysics technique. J Pediatr Matern & Fam Health - Chiropr. 2011;:82-86.
34. Harrison DE, Cailliet R, Harrison DD, Troyanovich SJ, Harrison SO. A review of biomechanics of the central nervous system-part II: spinal cord strains from postural loads. J Manipulative Physiol Ther. 1999;22:322-32.

APPENDIX

Chart 1. Radiographs.



1a. Initial lateral cervical film demonstrating decreased cervical lordosis.



1b. Lateral cervical film taken after 6 months of care demonstrating the restoration of the lordotic cervical curve.

Chart 2. Heart Rate Variability

HRV Scan	*Initial Outcome*	*After 6 Months of Network Care*
Mean IBI	825.97	735.6
Mean BPM	73	82
STD of IBI	77.96	77.4
Sympathetic Response	in Normal Range	in Normal Range
Parasympathetic Response	in Normal Range	in Normal Range
Autonomic Activity	73.58	70.8
Autonomic Balance	72.22(S)	67.73(S)

Chart 3. sEMG and Thermography

Type of Examination	*Initial Outcome*	*Improvements After 6 Months of Network Care*
sEMG	reduced muscle tension at T10 (R), T12(R)	normal muscle tension at T10(R), T12(R)
	mild elevation of muscle tension at C1(L)	normal muscle tension at C1(L)
	moderate elevation of muscle tension at C1(R)	normal muscle tension at C1(R)
	asymmetry at T2(L), L1(R), S1 (R)	no asymmetry at T2(L), L1(R), S1(R)
Thermal Scan	mild asymmetries at C7(L), T1 (L), T4(L), T10(L)	no asymmetries at C7(L), T1(L), T4 (L), T10(L)
	moderate asymmetries at C6(L), T5(L)	no asymmetries at C6(L), T5(L)
	severe asymmetries at T6(L)	no asymmetries at T6(L)