CASE STUDY

Improvement in Sagittal Lumbar Alignment and Posture in an Asymptomatic 9-Year-Old Child Following Reduction in Vertebral Subluxation Using Chiropractic BioPhysics® Protocol: A Case Study and Review of Literature

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Abstract

Objective: The purpose of this study is to report on the structural improvements made in a pediatric patient following reduction of vertebral subluxation.

Clinical Features: An asymptomatic 9-year-old male presented for chiropractic care with no history of trauma or disease. The parents were concerned about their child's posture. A postural evaluation revealed a flexed lumbar posture. Static and motion palpation revealed hypertonicity of the lumbar paraspinal musculature and reduced active and passive ranges of motion of the lumbar spine. Lateral lumbar x-ray revealed misalignments consistent with vertebral subluxations.

Intervention and Outcomes: The patient received chiropractic care 20 times over 2 months using a combination of Mirror Image® adjustments, traction, and exercises per Chiropractic BioPhysics® technique protocols. Follow-up examination revealed an improved lumbar posture with extension, decrease in lumbar paraspinal muscle hypertonicity, and increase in active and passive ranges of motion of the lumbar spine. A post-treatment lateral lumbar x-ray revealed significant improvements and reductions in misalignments related to vertebral subluxation.

Conclusion: The results of this case study indicate that chiropractic management utilizing Chiropractic BioPhysics® protocol may be effective in correcting vertebral subluxations, abnormal pediatric sagittal lumbar spinal alignment and posture. More research is needed to determine the role and efficacy of Chiropractic BioPhysics® protocol in the correction of sagittal lumbar spinal alignment and posture in pediatric patients.

Key Words: *asymptomatic, pediatric, chiropractic, Chiropractic BioPhysics®, CBP®, Mirror Image®, adjustment, posture, lumbar, lordosis, sagittal alignment, spine, vertebral subluxation*

Introduction

Abnormal posture is common in the pediatric population and can lead to health complications.[1] In a cross-sectional study by Kratenova, et. al., 40% of children at the age of 7, 11, and 15 years may have poor posture.[2] Different variables including age, weight, physical activity, and increased loads on the body have been indicated to affect lumbar lordosis.[3,4] Race and

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gender do not seem to have a significant structural effect on lumbar lordosis.[3]

The form and structure of pelvis and sacrum are strongly affected by the sagittal lumbar spinal alignment and posture. Lumbar lordosis (LL) is mostly affected by the sacral base angle (SBA).[3] The evolution of pelvic morphology, LL, SBA, and sagittal translation varies across the pediatric population due to variations in growth rates, the age of growth spurts, and physical activities.[4] As a result, detailed studies are limited and difficult to execute.[3] LL for children ages 3 to 6 years old is 15-20% less than that of adults.[3] LL increases until 10 to 12 years of age, decreases during 13 to 15 years of age, and then increases again to adult values in the late teenage years.[3]

Harrison, et. al. compiled normative data from several studies and reported the following: For ages 4 to 15 months old, the average SBA and LL are 30° and 47.1° ± 10°, respectively.[4] For ages 4 to10 years old with a mean age of 7 years old, the average SBA and LL are 40.3° and 45.6°, respectively.[3] For age 12 years old, the average SBA and LL are 51.6° ± 7.1° and 58.2° ± 11.5°, respectively.[4] For ages 10 to 18 years old with a mean age of 13 years old, the average SBA and LL are 41.4° and 49.2°, respectively.[3]

It has been suggested that abnormal spinal alignment is closely related to poor general health, physical, emotional and social function.[5] The curves within the spine act as shock absorbers and natural resistance to gravity. They protect the spinal cord and nerve tissues by reducing forces acting on them.[5] Harrison, et. al. show that abnormal posture negatively affects neural elements and vascular supply by causing stresses and strains, which leads to deteriorated sensory, motor, and autonomic nervous system function.[6] Loading of the neural tissue for a prolonged period may result in a variety of degenerative disorders or symptoms.[6]

Chiropractic BioPhysics® (CBP®) protocol has the capability of restoring abnormal spinal alignment and posture to normal.[3,5] By restoring the normal alignment of the spine, CBP® restores the body's optimal function and decreases the risk of disease in the future.[3,5] The Harrison Spinal Model is a valid, evidence-based, geometric spinal model that is the foundation of the CBP®. It describes ideal sagittal spinal alignment and posture regarding the path of the posterior longitudinal ligament. According to this model, ideal posture is achieved when the center of mass of the skull, thorax, and pelvis are in vertical alignment.[7,8] In the anterior-posterior (A-P) view, ideal spinal alignment is vertically aligned. In the lateral view, ideal spinal alignment consists of a circular lordosis of the cervical spine measuring -42°, an elliptical kyphosis of the thoracic spine measuring -44°, and an elliptical lordosis of the lumbar spine measuring -40°.[5,7,8]

Review of Literature

Chiropractic BioPhysics® and Pediatrics

The literature on chiropractic management of asymptomatic pediatric patients with postural abnormalities using CBP® protocol is limited.

Cardwell and Barone reported a case of a 34-year-old male that complained of headaches, congested sinuses, and mid- and low-back pain. The patient's history showed that he had several traumas from playing rugby. Initial radiographs showed a 31° cervical curve and an 81° degree lumbar curve. The patient was treated as per CBP® protocols 33 times over 9 months. Follow-up radiographs were taken and showed a 7° improvement in the cervical region and a 6° improvement in the lumbar region. The patient also reported a decrease in headaches and sinus congestion.[1]

Fedorchuk and Mohammed reported a case of a 28-year-old female that complained of gastroesophageal reflux disease (GERD), chronic headaches, neck pain, back pain, and dry skin. The patient had a history of a rear-end motor vehicle crash when she was 15 years-old and had been experiencing back pain since. The patient was treated as per CBP® protocols 19 times over 2 months. Follow-up x-rays showed improvement in her anterior head translation of 13.5mm from 17.5mm to 4.0mm (ideal is 0.0mm), in cervical ARA of 21.8° from -6.2° to 28.0° (ideal is -42.0°), and in lumbar ARA of 14.5° from -16.7° to -31.2 (ideal is -40.0°). The patient reported a reduction in GERD, back pain, and overall improvement in the way she felt.[5]

Fedorchuk and Opitz reported a case of an 11-year-old girl who was medically diagnosed with asthma and was managing it with pharmaceuticals. The patient also complained of chronic allergies, sinus problems, dry skin, and leg cramps. The patient was treated as per CBP® protocols 27 times over 6 weeks. Follow-up x-rays revealed improvement in anterior head translation of 16.1mm from 27.8mm to 11.7mm (ideal is 0.0mm) and in the cervical of 4.8° from 38.7° to 43.5° (ideal is 42.0°). The patient reported that she no longer needed to take the pharmaceuticals for asthma. She also reported that she no longer had allergic reactions, could breathe unrestricted, her skin cleared, and her cramps were resolved. Both structural and functional improvements occurred.[9]

Fedorchuk and Cohen reported on an 8-year-old female with a 3-year history of otitis media, sinus infections, and cervicalgia. The patient was treated as per CBP® protocols 29 times over 3 months. Follow-up x-rays revealed improvements in atlas plane angle of 9.0° from -8.0° to -17.0° (ideal is -29.0°), cervical ARA of 25.0° from -6.9° to -31.9° (ideal is -42.0°), and cervical relative rotational angles (RRA) at C3-C4 of 18.1° from 14.7° to -3.4° (ideal is -8.0°) and C4-C5 of 3.5° from 3.5° to 0.0° (ideal is -8.0°). The patient reported a decrease in headaches and ear pain and resolution of sinus infections.[10]

Oakley, et. al. reported on an 8-year-old male who presented with chronic headaches, chronic sore throat, and dizziness. Initial radiographs revealed an s-shape cervical curve with the upper cervical kyphotic and the lower cervical hyperlordotic. The patient was treated as per CBP® protocols 86 times. Follow-up radiographs revealed that the cervical curve improved with a reduction in upper cervical kyphosis and lower cervical hyperlordosis towards normal. The patient reported a resolution in headaches resolved as well as many other health issues he had been experiencing.[11]

Fedorchuk and Wheeler reported a 13-year-old male who complained of a 4-year history of cervicogenic headaches. The patient was treated as per CBP® protocols for 1 month. Follow-up x-rays revealed improvement in anterior head translation of 12.0mm from 29.6mm to 17.6mm (ideal is 0.0m), in cervical ARA of 39.6° from -3.8° to -43.4° (ideal is -42.0°), and in cervical RRAs at C2-C3 of 15.6° from 1.6° to -14.0° (ideal is -10.0°) and at C6-C7 of 6.6° from 5.1° to -1.5° (ideal is -8.0°). The patient reported a resolution of his headaches resolved and overall improvement in health.[12]

Fedorchuk reported on a 6-year-old girl who presented with a 3-year history of uncontrolled asthma that she was trying to manage with several different pharmaceuticals taken daily. The patient was treated using CBP® Mirror Image® adjustments over four weeks. Follow-up examination revealed improvements in paraspinal surface electromyography (sEMG) from mostly readings of severe paraspinal hypertonicity to mostly readings of normal paraspinal hypertonicity and improvements in forced vital capacity (FVC), forced expiratory lung volume in 1 second (FEV1), and forced expiratory lung volume in 3 seconds (FEV3). The patient reported resolution of asthma symptoms with no use of asthma medications, increased activity level and participation in sports. At a 3-year follow-up, over which time the patient continued maintenance chiropractic care, the patient reported that she had neither been sick nor has she had an asthma attack since the follow-up examination mentioned above.[13]

Fedorchuk, Wetterlin, and McCoy reported on a series of seven cases of childhood idiopathic scoliosis using CBP® technique. Initial radiographs revealed that 4 of the 7 cases had lateral flexion spinal posture with a mean Cobb angle of 16.2° (ideal is 0.0°), and the remaining 3 had lateral translation spinal posture with a lumbar-dorsal angle deviation of 4.6° (ideal is 0.0°). The patients were treated using CBP® protocols for approximately three months. Follow-up radiographs revealed that the four patients with lateral flexion spinal posture showed a mean Cobb angle of 11.6° (28.4% improvement) and the three patients with lateral translation spinal postures showed a lumbar-dorsal angle of 2.3° (54.6% improvement). Paraspinal thermography and sEMG also showed improvements in all 7 cases.[14]

Peet reported on a case of a 12-month-old male medically diagnosed with Down's Syndrome and was suffering from a brachial plexus injury since birth, lack of upper body control and arm movement, inability bring his hand to his mouth to feed himself or to sit up unsupported, and difficulty sleeping. The patient was treated using CBP® Mirror Image® adjustments for 23 visits over four months. Follow-up exam revealed that the patient's significant right lateral flexion of the head and thorax had been corrected to a normal vertical position. The patient's parents reported that the patient was sleeping uninterrupted, lifting his arms over his head, feeding himself, improving coordination, and developing normally for his age for the first time.[15]

Peet reported on a case of a 5-year-old male with a 2-year history of recurring otitis media with effusion every 3-6 weeks in frequency. The patient was treated using CBP® Mirror Image® adjustments for 13 visits over one month until the re-exam. Follow-up exam revealed the patient's mild right head rotation, right lateral flexion of the head, anterior head translation, and left thoracic lateral flexion were corrected to normal. A follow-up nasium x-ray showed improvement in atlas laterality of 1.0° from 1.0° left to 0.0° (ideal is 0.0°) and in the complementary angle (C2-C5) of 6.5° from 7.0° right to 0.5° right (ideal is 0.0°). The patient reported resolution of ear drainage, mild effusion, and one occurrence of otitis media in a 6-month follow-up from the initial visit.[16]

Peet reported on a case of a 3-year-old female complaining of acute stomach problems, loss of appetite, indigestion, and pain. A pre-treatment nasium x-ray revealed atlas laterality measuring 2.0° right (ideal is 0.0°), a complimentary angle (C2-C5) of 4° right (ideal is 0.0°), and a cervical-dorsal (CD) angle measuring 7° left (ideal is 0.0°). The patient was treated using CBP® Mirror Image ® adjustments for 10 visits over four weeks until the re-exam. Follow-up exam revealed the patient's left head translation, left lateral flexion of the head, and left thoracic lateral flexion were corrected to normal. The patient reported resolution of stomach problems, loss of appetite, indigestion, and pain.[17]

Peet reported on a case of an 8-year-old female medically diagnosed with chronic asthma and allergies that she was trying to manage with two different inhaler medications up to 3 times per day. The patient was treated as per CBP® protocols for 11 visits over 4 weeks until the re-exam. Follow-up exam revealed the patient's left lateral flexion of the head and right lateral flexion of the thoracic cage were corrected to normal. A follow-up nasium x-ray showed improvement in atlas laterality of 1.0° from 1.0° right to 0.0° (ideal is 0.0°), in the complementary angle (C2-C5) of 0.5° from 1.0° right to 0.5° right (ideal is 0.0°), and in the CD angle of 4.0° from 5.0° left to 1.0° left (ideal is 0.0°). The patient reported resolution of asthma symptoms and discontinued use of asthma medication.[18]

Peet, Marko, and Piekarczyk conducted a pilot study on the effects of CBP® treatment on 8 patients medically diagnosed with asthma and taking at least two forms of medication to control the condition. The patients were treated using CBP® Mirror Image® adjustments for 15 visits over 7 weeks. Follow-up examinations shows mean increases in peak expiratory flow (PEF) lung volume of 25.38%. Follow-up radiographic analyses showed significant improvements in abnormal spinal alignment in each case. According to follow-up parent questionnaires, 7 out of the 8 patients reported a significant reduction in medication usage; 4 patients did not require any medication at all.[19]

Oakley and Harrison conducted a systematic review of the available evidence on the improvement of the cervical lordosis in pediatric patients undergoing chiropractic care. The inclusion criteria were that the studies needed to be peer-reviewed, related to correcting cervical lordosis, and involved pediatric patients. There was a total of 11 papers retrieved based on a search with keywords. Of those 11 papers, 7 use x-ray analysis. Of those seven papers, five are studies that used an evidence-based, reliable analysis and all of them were CBP® cases. The systematic review concluded that the amount of evidence for the efficacy of chiropractic techniques is small but promising for CBP® procedures.[20]

Case Report

History

An asymptomatic 9-year-old male accompanied by his parents presented for a chiropractic consultation with no complaints or history of trauma. His parents were concerned with the patient's posture in the lumbar region. The parents reported that the boy seemed to be slouching and hunching all the time. The patient reported feeling well overall with no pain associated with the abnormal posture. This was the patient's first visit to a chiropractic office.

Chiropractic Examination

Inspection and static and motion palpation revealed decreased passive and active lumbar range of motion and hypertonicity of lumbar paraspinal musculature. A postural evaluation revealed a flexed lumbar posture.

Radiographic Examination

A LL x-ray (Figure 1) was taken and analyzed using PostureRay® EMR software (PostureCo, Inc., Trinity, FL, USA) (Table 1). RRAs of T12-L1, L1-L2, L2-L3, L3-L4, L4-L5, and L5-S1 measured 0.5°, 0.6°, 1.0°, -2.1°, -8.3°, -33.7° (ideal is -1.0°, -5.0°, -6.0°, -9.0°, -19.0°, and -33.0°) respectively. SBA measured 20° (ideal is 40.0°). ARA of T12-L5 measured -8.8° (ideal is -40.0°). The LL analysis shows that the lumbar curve is very hypolordotic in the lower lumbar region with a kyphosis in the upper lumbar region. The Harrison posterior tangent x-ray line drawing is an evidence-based, reliable, and valid method of spinal alignment analysis for comparison to the ideal Harrison Spinal Model.[7]

Chiropractic BioPhysics®

The primary goal of the chiropractic adjustment is the correction of vertebral subluxations. Vertebral subluxations inhibit healing and recovery, and their correction results in improved neurological and biomechanical function.[21] Per CBP® protocol, posture and x-ray examinations are performed to evaluate the spine. The primary goal of CBP® is to restore ideal spinal alignment and posture which results from correction of subluxations.[22,23] CBP® is a system of spinal analysis and treatment focused on structural outcomes beyond the relief of symptoms.[22]

Normal posture is characterized in CBP® as a "perfectly straight spine in the frontal plane, featuring sagittal curves in which the segments comprise arcs of circles, the radii of which would conform to specified boundary conditions."[24] In this normal spinal model, any deviation from the normal posture results in abnormal spinal dynamics and vertebral subluxations. According to Harrison, et. al., the restoration of normal alignment and musculoskeletal structure assumes "there is a normal static spinal configuration; abnormal structural alterations of the spine and posture, whether produced through macro or microtraumatic events, result in abnormal function within the homeostatic balance of the human organism; and altered resting static posture results in altered dynamics."[25]

The objective of the CBP® is to address spinal alignment and posture directly affecting ligaments, muscles and tendons, vertebrae, intervertebral discs, facet joints, and neural elements.[25] Structural rehabilitation protocol in CBP® applies the concept of Mirror Image® to human posture. Mirror Image® adjustments, exercises, and traction address all tissues and structures involved in the alignment of the spine and optimal posture.[25]

Intervention and Outcomes

The patient received CBP® care during 20 visits over 10 weeks. CBP® defines an adjustment as an "application of force to bones of the spine (or extremity) which causes a change in alignment towards normal."[26] The patient was placed in the overcorrected, opposite postural alignment as he presented with before care.

Adjustments were delivered to the patient in Mirror Image® position using a Diversified, high-velocity, low-amplitude (HVLA) manual maneuver, a drop-table adjustment using an OMNI elevation drop-table, or an instrument-assisted adjustment using an Impulse® adjusting instrument (Neuromechanical Innovations, Chandler, AZ, USA). The Impulse® adjusting instrument is a device approved by the Food and Drug Administration (FDA).[27] Mechanoreceptors and proprioceptors are responsible for relaying the position of the body to the brain so that the brain knows where all parts of the body are at in space.[28] The purpose of stimulating these types of sensory receptors in the patient's body during adjustments is to retrain the patient's CNS to adapt to normal posture according to the Harrison Spinal Model.[9]

The patient also received Mirror-Image® traction using the Lumbar Denneroll Spinal Orthotic (Denneroll Spinal Orthotics, New South Wales, Australia). The purpose of the lumbar traction was to reverse the patient's abnormal posture to normal by stressing relaxation of the lumbar ligaments, tendons, and muscles and initiating muscle creep therefore creating permanent restorative, plastic change.[9] Mirror Image® exercises are performed by the patient to strengthen weak musculature and lengthen tight musculature that have adapted to unhealthy posture to correct and maintain corrections in spinal alignment and postural abnormalities.[22]

At the end of the 20 visits, follow-up physical examination revealed a reduction in lumbar paraspinal muscle tone and improved lumbar posture with extension. A post-treatment LL x-ray (Figure 2) was compared with pre-treatment assessments (Table 1) and significant improvements are noted. There were improvements in RRAs at L1-L2 from 0.6° to -1.1°, L2-L3 from 1.0° to -6.3°, L3-L4 from -2.1° to -8.3, and L4-L5 from -8.3° to -18.6° (Table 1). SBA improved 8.5° from 20° to 28.5° and ARA from T12-L5 improved 24.9° from -8.3° to -33.2°.

Discussion

Loss of the distal lumbar lordosis has been associated with decreased quality of life and deterioration of physical, emotional and social function. In patients presenting with reduced lumbar lordosis, an improvement of the lumbar curve may positively affect the patient's quality of life and overall health.[29]

Any alterations in normal posture or spinal structure in the sagittal plane have direct effects on the biomechanics of the axial skeleton and neural tissues that it contains. Postural flexion of the spine generates axial tension and exerts longitudinal pressure along the entire spinal cord.[30] Spinal flexion applies a postural load exerting the most significant amount of pressure on the spinal cord.[6]

The clinical and biomechanical foundation for structurally focused chiropractic care has been well established beyond the resolution of neuromusculoskeletal complaints and symptoms.[31] The type of mechanical loading in the spine and degree of impact on neural tissue has significant implications for the tissue's optimal function. This loading is mainly determined by the presence of the normal spinal alignment.[30,31] A normal spinal model has been well established in the chiropractic literature along with the biomechanical and clinical implications of deviations from the normative values.[32,33]

The literature has demonstrated significance of global spinal alignment, however, spinal manipulation alone has not yet been proven as an effective intervention for restoring normal spinal alignment and posture.[31,33] It has been therefore suggested that the chiropractic profession focuses on restoring and maintaining normal global alignment of the spine and include evidenced-based interventions with reproducible procedures to assure comparability of results across studies. CBP® offers such a framework, with evidence-based, valid, and reliable diagnostic tools and protocols.[22,34,35]

The function of the lumbar spine is directly correlated with its structure.[22] The chiropractic literature describing CBP® management of spinal alignment in pediatric patients is limited. Additionally, most CBP® pediatric studies do not focus on the lumbar spine.[5,9-12,20] According to Fedorchuk and Opitz, if abnormal posture has been present for a long period, changes within the bone may occur which over time may encroach on the spinal cord.[9] CBP® literature emphasizes that abnormal postures and subluxations of the spine may result in variety of illnesses.[9-12,20,29] CBP® recognizes the importance of proper posture and removal of subluxation to restore optimal afferent and efferent conduction along the nerves, hence restoring the patient's health and optimal function.[9]

Limitations

There is no control group to compare the outcomes of this case. As such, there is no way to establish the correction of spinal alignment and posture in this case as a preventative measure for disease and dysfunction. The asymptomatic nature of the patient provided few functional or symptomatic outcome measures to compare to pre-treatment values. Additionally, the retrospective nature of the case allows for selection bias.

Conclusion

CBP® technique has the unique ability to conservatively correct abnormal spinal alignment and posture. Spinal alignment and postural distortions result in adverse mechanical tension and distortion of tissue.[24] Abnormal biomechanics leading to increased loading of the spine deleteriously affects processes such as tissue growth and repair.[36] Long term postural distortions place undue strain on the neural tissues surrounding these distortions.

Increasing tension in the spinal cord stresses the CNS by increasing intramedullary and cerebrospinal fluid pressure, coupled with a decrease in afferent and efferent nerve conduction.[37] In this case study, the patient's posture and spinal alignment were corrected and as a result, the lumbar lordosis was improved. By reducing the adverse gravitational loading from the patient's lumbar hypolordosis and kyphosis, aberrant stresses and strains on the neuromuscular tissues were minimized and so too were their associated symptoms.[28]

This case report suggests that CBP® care may be an effective conservative, non-surgical treatment for abnormal spinal alignment and posture and neuromusculoskeletal symptoms in asymptomatic pediatric patients such as poor posture, restricted active and passive range of motion, and lumbar paraspinal muscle hypertonicity. Once more, CBP® care may serve as prevention to lumbar degenerative diseases and the consequences that arise from such pathologies. By using CBP® care to improve postural distortions, the need for medical or invasive surgical procedures may be negated.

More research needs to be done concerning the connection between pediatric populations and ideal and abnormal spinal alignment and posture with disease and dysfunction. To extend the research on chiropractic care and its effects on pediatric patients, clinical trials should be conducted.

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Figure 1. Pre-Treatment Lumbar X-ray. LL x-ray of a 9-year-old male prior to chiropractic care. The green line represents ideal spinal alignment; the red line represents the patient's actual spinal alignment. This x-ray shows posterior displacement of T12 to S1, kyphotic segments of the lumbar spine with an overall lumbar hypolordosis, and a decreased sacral base angle.

Figure 2. Post-Treatment Lumbar X-ray. LL x-ray of a 9-year-old male following Chiropractic BioPhysics® care. The green line represents ideal spinal alignment; the red line represents the patient's actual spinal alignment. This x-ray shows maintained posterior displacement of T12 to S1, but significant improvements in lumbar segmental and over angles, and sacral base angle from the pre-treatment x-ray.

Measurement	Normal Values	X-ray 1 Values	X-ray 2 Values
RRA T12-L1	-1°	0.5°	-0.9°
RRA L1-L2	-5°	0.6°	-2.4°
RRA L2-L3	-6°	1.0°	-6.2°
RRA L3-L4	-9°	-2.1°	-7.7°
RRA L4-L5	-19°	-8.3°	-16.0°
RRA L5-S1	-33°	-33.7°	-29.2°
SBA	40°	20.0°	32.4°
ARA L1-L5	40°	-8.3°	-33.2°

Table 1. PostureRay® Comparison Evaluation of LL X-ray 1 and 2 Values