

RUNNING POSTURE AND STEP LENGTH CHANGES IMMEDIATELY AFTER CHIROPRACTIC TREATMENT IN A PATIENT WITH XERODERMA PIGMENTOSUM

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ABSTRACT

Objective: This case study reports on selected measures of locomotion (running) in a 5-year-old patient with xeroderma pigmentosum after chiropractic care.

Clinical Feature: A 5-year-old female patient (16.4 kg, 99.1 cm) with xeroderma pigmentosum (type A) volunteered to participate in the experiment with the consent of her parents. The patient had well-documented signs of delayed fine motor (eg, difficulty with writing, coloring, cutting) and gross motor control (eg, balance and coordination dysfunction and falling while running), and delayed speech.

Intervention and Outcomes: Trunk forward lean angles, step lengths, and hip horizontal translations were assessed by video as the participant ran as fast as possible down a laboratory runway. After chiropractic manipulation (adjustments), the patient reduced the trunk forward lean angle to become more vertical ($P = .000$). In addition, the patient experienced an increase in step length ($P = .031$). No significant change in lateral translation was observed after the intervention.

Conclusion: For this patient with xeroderma pigmentosum, chiropractic manipulation (adjustments) resulted in immediate changes in running performance. Further investigation is needed to examine the effect of chiropractic on locomotion in both symptomatic and asymptomatic patients. (*J Manipulative Physiol Ther* 2009;32:93-98)

Key Indexing Terms: *Chiropractic; Manipulation, Spinal; Gait; Locomotion; Motor Control*

Xeroderma pigmentosum (XP) is a rare genodermatosis transmitted as an autosomal and recessive trait.¹ Patients with XP are highly photosensitive and prone to develop skin tumors in sun-exposed areas. Biochemical and genetic studies have demonstrated that nucleotide excision repair, the most versatile DNA repair mechanism, is deficient in XP cells, leading to ultraviolet-induced mutation and a predisposition of XP patients to cancer.

The mean frequency of XP newborns worldwide is estimated at approximately 1 of 500 000, but this may be increased to 1 of 40 000 in some Eastern countries such as Japan.¹ The most prominent characteristic of XP patients is their high sensitivity to sunlight.¹ Pigmentation defects (freckling) may also be observed before consequences of sun exposure. Severe skin burning in infancy remains one of the earliest signs of the disease. Later on, onset of premalignant lesions (actinic keratoses) and numerous skin neoplasms in sun-exposed area occurs very early in life—on average 6 to 8 years of age.¹ Beyond cutaneous manifestations, XP patients may also present with afflictions unrelated to sun exposure. Many XP patients not only are photosensitive, but also exhibit developmental and neurodegenerative problems (similar in nature to multiple sclerosis) and problems with motor control and coordination (eg, walking, jumping).²

Chiropractic research has demonstrated effects on many of the factors that influence motor behavior. These factors include muscular strength,³ movement time,⁴ mental reaction time,⁵ coordination,⁶ reflex activity and neurophysiologic changes,⁷⁻¹⁰ proprioception,¹¹⁻¹³ and reduced muscular inhibition,¹⁴⁻¹⁶ to name a few. In addition, an osteopathic study found gait differences before and after osteopathic manipulation in Parkinson patients.¹⁷ Human locomotion

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depends on many of the factors that chiropractic has been known to influence (eg, movement time). Therefore, we were interested in investigating the effect of chiropractic on gait in this patient with obvious locomotion dysfunction.

Gait analysis is the systematic study of human walking/running using the eye and brain of experienced observers augmented by instrumentation for measuring body movements and body mechanics. In individuals with conditions affecting their ability to run (eg, XP), gait analysis may be used to make detailed diagnoses and to plan optimal treatment. We decided to test a few of the observed measures of gait that seemed to make clinical improvements over the course of chiropractic care in our patient. Specifically, we hypothesized that our patient would have significantly reduced trunk forward lean and a longer step length after adjustments. This is considered by the authors of this study as an important improvement because the subject's parents reported that the excessive lean of the subject while running seemed to impair her ability to see what was ahead of her. This resulted in her crashing into walls and other objects while running. The authors of this study considered a reduction in trunk forward lean that would allow the subject to see what is in front of her and reduced crashes as important improvements in the subject's running technique. The purpose of this article is to report on running posture and step length changes immediately after chiropractic manipulation of a 5-year-old patient with XP.

CASE REPORT

Participant

A 5-year-old female patient (16.4 kg, 99.1 cm) with XP (type A) volunteered to participate in the experiment with the consent of her parents. Patients who belong to XP complementation group A usually present with the most severe form of XP, having both severe skin symptoms and central nervous system disorders.¹⁸ The participant's parent signed an informed consent document approved by the Miami University Institutional Review Board, and assent was given by the child. The patient was being comanaged by medical personnel (including physical therapy) and had well-documented signs of delayed fine motor (eg, difficulty with writing, coloring, cutting) and gross motor control (eg, balance and coordination dysfunction and falling while running), and delayed speech. Her unsteadiness during gait, shortened strides, and widened base of support at the time of the experiment were consistent with gait ataxia.

The child's school physical therapist was contacted by the authors (DLS, JPS) to ascertain physical therapy treatment. Therapy goals were to improve function in the school environment and to become independent in walking and sitting. Treatment consisted of improving dynamic and static motor control, core strength, and range of motion at the ankle

and facilitating more age-appropriate walking and running through use of various strategies including but not limited to reciprocal arm swing training and heel to toe walk.

The parents of the child consulted one of the authors (JPS) to explain their child's problems of excessive forward lean during walking and running that resulted in collisions with walls as well as falls, muscle weakness, and muscular imbalance. Although well-developed neuromuscular signs were present, the patient did not complain of symptoms such as pain.

At the time of this study, the patient had been under chiropractic care for several months (14 previous visits) and had experienced clinical improvement in gait (walking) steadiness, upright posture, arm swing while walking, and balance while running, and absence of collisions with walls. The chiropractic care previously rendered was similar to the care rendered during this study. The parents of the child noted that the patient had also experienced greater resistance to fatigue (eg, ability to walk and run for substantially greater periods without rest). These observed gait changes were the impetus that led us to quantify the motor performance before and after chiropractic adjustments.

Two digital video cameras were used to capture kinematic data in the sagittal and frontal planes. Reflective markers were fixed to the subject's head (vertex), right hip (greater trochanter), knee (lateral epicondyle), ankle (lateral malleolus), foot (second metatarsal), shoulder (acromion process), elbow (lateral epicondyle), and wrist (styloid process of the ulna) to assist in the digitizing process (Fig 1). Data from the video cameras were collected and synchronized using SIMI motion analysis software (Unterschleissheim, Germany). Calibration of the 2-dimensional video analysis was achieved by using a 1-m metal cube placed in the center of the field of view along the runway. Analysis of running gait was performed in a laboratory with a runway sufficient to allow starting, running in steady state, and stopping. The side camera (capturing sagittal plane data) was positioned perpendicular to the length of the runway to allow capture of steady-state running, and the field of view allowed for the examination of 2 full strides. The rear camera was located behind the participant and captured continuous frontal plane data from the beginning to the end of each trial.

A single-participant ($n = 1$), prospective, AB design was used. Six running trials were recorded before and after chiropractic adjustments. A warm-up trial was given before the first recorded trial. A 1-minute rest period was allowed between trials. The participant was encouraged to run as fast as she could during each trial. She ran toward one of the authors (JPS) who provided verbal encouragement to run fast.

After the first 6 trials, the patient was assessed for spinal dysfunction and adjusted (full spine) using diversified techniques.⁴ The diversified techniques emphasized high-velocity, low-amplitude thrusts to vertebral segments.



Fig 1. The placements of reflective markers are illustrated as shown. With the exception of the head marker, all markers are located on the right side of the body. Permission to publish the photograph was given by parents.

Lumbar side-posture adjustments, supine cervical rotary (index pillar push) adjustments, and prone (bilateral thenar contact) thoracic adjustments were used in this study. Adjustments were delivered in an attempt to correct any or all of the spinal dysfunctions that the clinician (JPS) found at the time of the experiment. After the adjustments, the patient completed the remaining 6 running trials.

The examined kinematic variables in the sagittal plane included trunk forward lean angle and step length. *Trunk forward lean* was defined as the angle between a line connecting the hip marker and the shoulder marker and a horizontal line passing through the hip marker (Fig 2). Trunk forward lean angles were obtained by manual digitization of the markers at 9 events during the 2 strides. The events included were heel strike and foot flat phases for both feet during the gait cycle (beginning and ending with right heel strike). Step length was measured from ipsilateral to contralateral heel strike. The first 3 trials before and after adjustments were used for data analysis. The right hip marker was visible on all frontal plane video recordings.



Fig 2. Trunk forward lean angle (θ) is defined as the angle between the line connecting the hip marker and the shoulder marker and a straight line passing through the hip marker. Permission to publish the photograph was given by parents.

Manual digitization of the right hip marker in the frontal plane at each of the above-mentioned 9 events (eg, heel strike and foot flat) was performed. The absolute change in the linear hip horizontal distance between the gait cycle events was computed.

The statistical analysis consisted of 3 separate paired *t* tests using the before and after data for trunk forward lean angles, step lengths, and hip horizontal distances, respectively. The paired *t* tests were based on pairings of identical conditions (eg, right foot flat, left foot flat) between trials. All 3 paired *t* tests were 2-tailed, and α was set to .05.

The average reduction in trunk forward lean angle was 4.68°, and the average increase in step length was .09 m after adjustments. Figure 3 shows the average trunk forward lean angle across trials before and after adjustments, Figure 4 shows the average step length across trials before and after adjustments, and Figure 5 shows the average absolute difference in hip horizontal distance

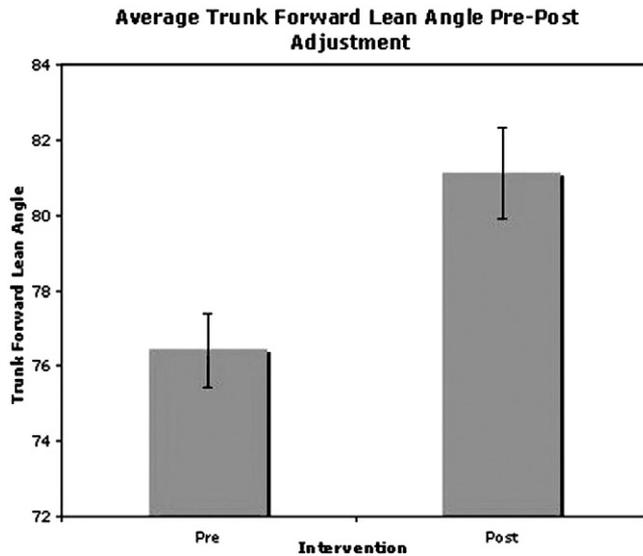


Fig 3. Average trunk forward lean angle (θ) is shown for the 3 trials pre- and postadjustments. Trunk forward lean increases with decreasing angles (eg, 90° represents a perfectly vertical trunk, 0° represents a perfectly horizontal trunk). Error bars represent standard error of the mean.

across trials before and after adjustments. The average reduction in hip horizontal translation after adjustments was 1.74 cm. Serial dependency of data was examined by calculating autocorrelation coefficients with a lag of 1. None of the variables including forward lean angles, step length data, and hip horizontal distance revealed a significant autocorrelation coefficient. We therefore used paired *t* tests to examine the single-subject data.

After the adjustments, the patient significantly reduced her trunk forward lean angle to become more vertical ($t[26] = 7.16$, $P = .000$). She also experienced a significant increase in her step length ($t[11] = 2.48$, $P = .031$). Finally, she reduced her hip horizontal translation by more than half, postadjustments, although this finding was not statistically significant ($t[23] = 1.64$, $P = .116$).

DISCUSSION

Our results demonstrate a significant change in one patient's ability to run in a more upright posture immediately after chiropractic adjustments. The patient also displayed a greater step length immediately after adjustments. These significant results along with the reduced horizontal hip translation suggest that the patient was more stable after chiropractic adjustments.

This single-subject study demonstrates that a biomechanical analysis of gait could be used as a means to detect potential benefits produced with chiropractic adjustments, even after a single session. Wells et al¹⁷ showed that a single session of an osteopathic manipulation therapy

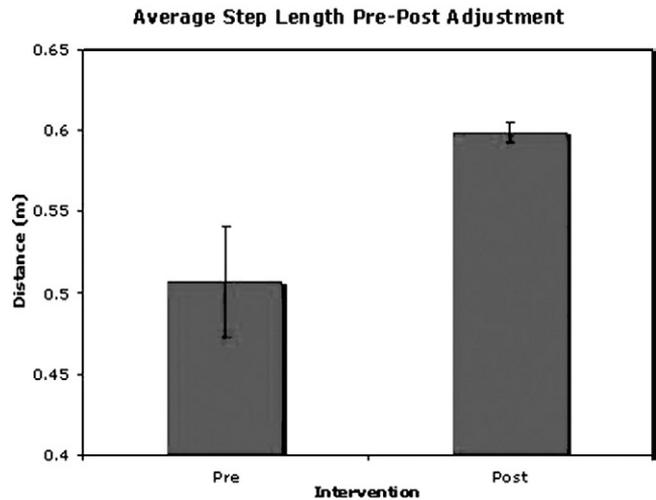


Fig 4. Average step length distance (in meters) across the pre- and postadjustment trials is shown. Error bars represent standard error of the mean.

protocol has an immediate impact on parkinsonian gait. They concluded that osteopathic manipulation may be an effective physical treatment method in the management of movement deficits in patients with Parkinson disease. In addition, Robinson et al¹⁹ found that, in a group of patients with sacroiliac joint dysfunction, there was a distinct tendency toward improved gait symmetry (as assessed by force platform measures) after treatment in those cases where the gait was asymmetric before the treatment. These studies show the potential of spinal manipulation to impact locomotion.

The chiropractic literature is continuing to grow in the area of motor behavior. Human locomotion is a significant component of motor behavior that virtually everyone engages daily. Numerous researchers are interested in ways to improve the untoward effects of dysfunctional locomotion (eg, falls). There is now sufficient evidence from several researchers that chiropractic can affect components of the locomotor system.³⁻¹⁶ However, there is little experimentation that directly addresses the effects of the chiropractic adjustment on motor behavior, specifically movement kinematics (including coordination, movement time, velocity, acceleration, frequency, etc). Instead, there is an abundance of anecdotal reports—"We adjust patients and they feel and move better!" Research investigations of how chiropractic affects motor behavior are long overdue. There is a shortage of evidence supporting common positive changes in motor outcome after chiropractic care that many practitioners observe in daily practice. For instance, the authors (DS, JPS) have observed that many patients in their practice have greater mediolateral trunk stability during both standing postures and locomotion after chiropractic care. It is recommended that well-designed observational studies and/or controlled trials be the next

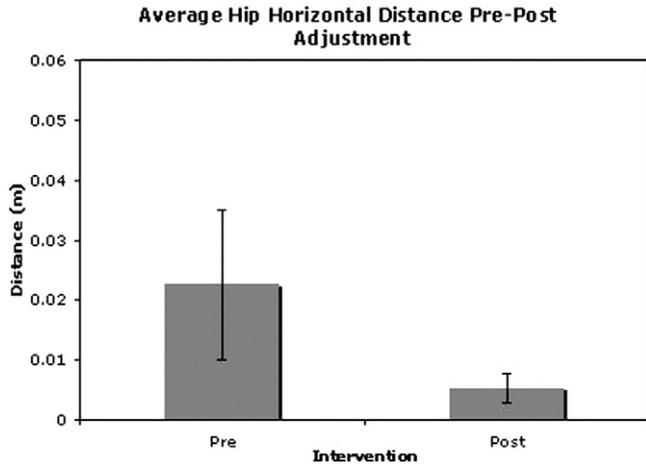


Fig 5. Average linear horizontal distance (in meters) of hip marker between events, across the 3 trials, pre- to postadjustment is shown. Error bars represent standard error of the mean.

step in determining the relationship between chiropractic care and locomotion.

LIMITATIONS

It cannot be stated with certainty if the changes seen can be attributed directly to the chiropractic adjustments. These reservations are related to the fact that it is possible that changes after treatment may have occurred despite the introduction of the intervention. We are confident that a change occurred given that both the parents and the chiropractor noticed immediate improvements in the outcome measures after every chiropractic visit over a period of a few months since the beginning of chiropractic care. It is uncertain if the changes will remain over time, and it is also unknown if the previous chiropractic treatment of this patient influenced the examination findings of this study.

Another limitation of this study was the number of subjects. Having only 1 subject poses obvious problems for determining cause and effect or knowing if these findings might be found with other patients. Because XP is so rare, it would be difficult to gather a number of subjects for a larger study. Another limitation was that there were no similar previous data to compare our results, so we can only infer from data that were collected from 1 child. Formal comparison of XP patients' motor control abilities with age-matched children has not been done to our knowledge. In addition, there is a large degree of variability within XP patients; so such comparisons are difficult. It is possible that the subject experienced fatigue that may influence differences in pre- to postadjustment measurements. We attempted to reduce this possible error by providing the subject with sufficient rest between trials and by asking her if she was feeling rested enough to continue. Because the subject was 5 years old, one could question the accuracy of her responses.

However, one would think that technique would deteriorate with fatigue; and her technique seemed to improve, which strengthens our impression that her fatigue was not enough to affect the results.

CONCLUSION

The results of this study demonstrated changes in locomotion in a patient with XP receiving chiropractic treatment. Further investigation is needed to examine the effect of chiropractic on locomotion in both symptomatic and asymptomatic patients.

Practical Applications

- The results of this study demonstrated changes in running performance in a patient with XP receiving chiropractic adjustments.
- Further investigation is needed to examine the effect of chiropractic on locomotion in both symptomatic and asymptomatic patients.

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