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Case studies

Chiropractic management using a brain-based model of care for a 15-year-old adolescent boy with migraine headaches and behavioral and learning difficulties: a case report

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Abstract

Objective: The purpose of this report is to describe chiropractic management, using a brain-based model of care, of a teen who had migraine headaches and several social and learning difficulties.

Clinical features: A 15-year-old adolescent boy with a chronic history of migraines and more than 10 years of learning and behavioral difficulties, including attention-deficit/hyperactivity disorder, obsessive compulsive disorder, and Tourette syndrome, presented for chiropractic care.

Intervention and outcome: The patient received spinal manipulation and was given home physical coordination activities that were contralateral to the side of the involved basal ganglia and ipsilateral to the involved cerebellum, along with interactive metronome training. Quantitative changes were noted in neurological soft signs, tests of variables of attention Conners' Parent Rating Scale, the California Achievement Test, grade point, and reduction of medications. The patient reported qualitative improvements in ties, attention, reading, vision, health, relationships with his peers and his family, and self-esteem.

Conclusion: The patient with migraine headaches and learning difficulties responded well to the course of chiropractic care. This study suggests that there may be value in a brain-based model of care in the chiropractic management of conditions that are beyond musculoskeletal in nature.

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Introduction

Tourette syndrome (TS) is a neurodevelopmental disorder affecting approximately 1 in 300 to 400 individuals.¹ It has also been found to have genetic correlations with obsessive-compulsive disorder

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(OCD) and with attention-deficit/hyperactivity syndrome (ADHD), and that the combination of TS, OCD, and ADHD is a separate and common phenotype.² Tourette syndrome was found to be comorbid with depression,³ and there have also been high rates of migraine within the child population of TS.⁴

Tourette syndrome has been symptomatically characterized by motor and/or vocal tics along with impaired psychosocial functioning.⁵ Obsessive-compulsive disorder symptoms are often expressed as obsessions and compulsions commonly associated with cleaning, checking, repetition, aggression, and others.⁶ Attention-deficit/hyperactivity syndrome symptoms are generally described as inability to focus; impulsivity; hyperactivity; and an increase in anxiety, substance abuse, antisocial behavior, and substance abuse.⁷ Chronic migraine is characterized by the presence of clinical features of migraine in 8 of 15 days of headache per month for 3 months.⁸

It has been hypothesized that the shared pathways involved for TS, OCD, and ADHD are related developmentally to the basal ganglia.⁹ Imaging and postmortem studies suggest involvement of the cortico-striatal-thalamo-cortical pathways, and dopamine is the leading candidate for neurotransmitter involvement.¹⁰ The basal ganglia maintain 2-way communication with the cerebellum.¹¹

At present, there is little literature that describes a combination approach to chiropractic care for patients who are experiencing headaches and learning difficulties.¹² Therefore, this case study describes the chiropractic management of a male teen who was brought for symptoms of migraine headache and, while under care, reported improvements in his learning and behavior as demonstrated by quantitative measures from multiple fields including psychological, neuropsychological, educational, occupational therapy, and functional neurology along with subjective improvements while under functional neurological care.

Case report

History

A 15-year-old adolescent boy presented with a severe chronic migraine headache with the most recent episode lasting over 30 days. In addition to his headaches, the patient had been previously diagnosed with ADHD, OCD, and TS by both a local medical neurologist and a medical university-based team that

included a medical neurologist and psychiatrist. Per his mother, he has had these problems since before he started school.

He was also having difficulty in school academically with a 1.0 accumulative grade point in a 0 to 4.0 grade point scale. He had difficulties socially, causing physical altercations on a near-weekly basis with his peers. He also discussed feelings of being suicidal.

He was expected to take 6 years to complete his 4-year academic studies for high school. A Work Force Development officer expressed hope that he could be rehabilitated enough during his high school years so that he would be competent enough to “push a broom under supervision.” Educational, psychological, and pharmaceutical interventions were unsuccessful in resolution of his multiple complaints.

Initial examination findings

Results of the patient’s standard orthopedic findings were negative. Dermatomes and deep tendon reflexes were symmetrical and within normal limits. Upper and lower extremity muscle strength was 5/5 from all nerve roots of upper and lower extremities.

Neurological soft signs

Neurological soft signs (NSSs) are mild neurological deficiencies found on clinical examination.¹³ The term *soft* was originally used to distinguish between a general vs specific localization but now is used to indicate signs that do not indicate a pathology.¹³ Neurological soft signs suggest underlying changes in the neurological substrate related to the NSSs, specifically decreased volume in gray and white matter.¹⁴ Brain imaging supports that NSSs may be related to specific brain regions and connections.¹⁵ Neurological soft signs and neurocognitive tests have both been found to measure brain function.¹⁶ An increase in NSSs has been found in a variety of mental disorders.¹⁷ Soft neurological findings have been found to have good interrater reliability.¹⁸

The patient had 21 soft neurological findings on his initial examination (Table 1) using methods of evaluation discussed by Beck¹⁹ taught by approved institutions of the Commission of the Accreditation of Graduate Education in Neurology and consistent with testing by the American Chiropractic Neurology Board. A second board-certified chiropractic neurologist confirmed the soft neurological findings observed by the practitioner. The patient demonstrated soft

Table 1 Neurological soft signs ^a

| | 3/28 | 7/20 |
|--|------|------|
| Pons findings | | |
| Diminished left forehead tone | 1 | |
| Diminished left cheek tone | 1 | |
| Left corner of the mouth droop | 1 | |
| Webber test lateralized stronger to right (right ear tube) | 1 | |
| Cerebellum findings | | |
| Increased sway to left | 1 | |
| Increased dysmetria to left | 1 | 1 |
| Diminished balance on standing heel to shin on left | 1 | |
| Diminished left dysdiadochokinesia capacity on left | 1 | |
| Pursuit hypermetria to the left | 1 | |
| Left gaze preference on rightward OKT | 1 | |
| Mesencephalon findings | | |
| Left foot increased sweat (per patient) | 1 | |
| Left fast fail on indirect light reflex | 1 | |
| Right slowness on indirect light reflex | 1 | |
| Right inferior rectus weakness on 3-step evaluation | 1 | |
| Right eye weakness on convergence | 1 | |
| Cortex findings | | |
| Diminished right arm swing with gait | 1 | |
| Diminished right finger dexterity (piano playing movement) | 1 | |
| Diminished right finger extensor strength | 1 | 1 |
| Diminished right finger abduction strength | 1 | |
| Right piriformis spasm (sciatic entrapment) | 1 | |
| Right gluteus medius spasm (sciatic entrapment) | 1 | |
| Number of positive soft nonablativ neurological findings | 21 | 2 |

OKT, optokinetic tape (a cloth tape of alternating red and white squares used for evaluating eye movements).

^a Fewer NSSs are better.

neurological findings suggestive of a relative decrease in his right cortical and left cerebellar function.

Tests of variables of attention

The test of variables of attention (TOVA) is a computerized continuous performance test used by neuropsychologists to measure vigilance, response inhibition, and signal detection.²⁰ The patient scored at normal levels on both commission and omission within his visual TOVA evaluation. His auditory TOVA omission errors were normal; however, his commission errors were 4 standard deviations away from *z*. These auditory commission scores from this test were not within normal limits for his age and were “suggestive of an attention disorder” as scored by the computer-programmed analysis.

Interactive Metronome Long Form

The pacemaker for motor functions is the inferior olive of the cerebellum and for the cognitive functions is the thalamus.²¹ Interactive Metronome (IM) is a tool that measures the individual’s internal clock applied to motor movements by occupational therapists in ADHD patients for their ability to plan, execute, and correct.²² Scoring on the IM Long Form (IMLF) consists of an age-adjusted scale based on the average of 14 sensory-motor activities requiring balance, coordination, and timing. Additionally, early and late hits are measured. This score indicates hyperanticipatory if elevated above 50% or hypoparticipatory if less than 50%.²² This patient’s initial score was average for his age.

California Achievement Test

The California Achievement Test (CAT) is a standardized test of academic achievement.²³ The CAT was administered to the patient by Sylvan Learning Center. The patient was age 15 and, at the time of testing, completing his ninth grade classes. He scored at fourth grade–fifth month grade equivalents up to eighth grade–one month grade equivalents prior to his care.

Conners’ Parent Rating Scale

The Conners’ surveys are well-established behavioral and emotional measures.²⁴

The Conners’ Parent Rating Scale comes in versions that can be filled out by a teacher, parent, or adolescent. The Long Form version scored by the parent was used. T-scores are used as a method of standardizing across multiple behavioral measures such as oppositional, hyperactivity, perfectionism, and anxious-shy; so they can be viewed and compared on the same scale. T-scores higher than 60% are significant.²⁵ His T-scores for 11 of the 14 measures were in the 80% to 90% level. These scores for his age rated him as positive for ADD and ADHD.

Chiropractic treatment and rehabilitation

His treatment consisted of a spinal manipulation applied to the cervical, lumbar, and pelvic regions of the left side of his body; IM training sessions; and exercises such as rightward pursuits with saccades back to center along with left-sided coordinated activities. Using concepts described by Hebb²⁶ and Kandel,²⁷ the

purpose of this care was to increase receptor activation via sensory-motor and proprioceptive inputs to increase input to the regions identified via NSSs (left pons/cerebellum-right basal ganglia/cortex) so as to drive an increase in plasticity of these identified regions by increasing their metabolic activity. His treatment for these concerns consisted of 42 visits over 19 weeks.

Quantitative improvements

Over the course of 19 weeks, there was a 90% improvement in his NSS findings as measured by a reduction of 21 different signs down to 2. His previous auditory TOVA that was suggestive of an attention disorder was normal at the end of his care (Table 2). His IMLF evaluation improved 39%, moving him from an average category to above average; additionally, his early hits were reduced (Table 3). His Conners' survey scores had an average improvement of 34%, moving him from being positive in his ADHD scorings into normal scores (Table 4). His CAT tests demonstrated improvements of 2.5 to 7.1 grade equivalents (Table 5).

Qualitative improvements

Posttreatment (4 months and 1 week), the patient stated his headaches were gone, his vision had improved (requiring a change in his corrective lenses), he was not sick as often, his asthma was better, and his tics were gone except in extremes of stress or emotion. While initially on 6 different medications, he was now medication free. His local medical neurologist released him from care and advised return to the treating practitioner/author if he had a return of his problems.

He reported that his relationships improved with both his parents and peers. This was objectified by the fact that he was elected to his prom court and was voted as most outgoing and most academically inclined by his school peers for graduation awards.

Postcare, the patient stated he understands things better and his academic successes make him feel proud. Where he would previously fall asleep after reading for

Table 2 Tests of variables of attention ^a

| Auditory | ADHD score | Subcategory | Week | Week |
|----------|-------------------|-------------|------|--------------|
| | | | 11 | 18 |
| | Omission errors | SD (z) | 0.51 | 0.29 |
| | Commission errors | SD (z) | <-4 | -0.26 |
| Visual | Omission errors | SD (z) | 0.54 | ^b |
| | Commission errors | SD (z) | -0.9 | ^b |

^a Less SD from z is better.

^b Not repeated since initially within normal limits.

Table 3 Interactive Metronome Long Form ^a

| Week of care | 14 | 16 | 18 |
|-----------------|------|----|------|
| Long Form score | 63.4 | 52 | 38.6 |
| Early hit % | 42 | 41 | 49 |

^a Lower Long Form score is better; closer to 50% is better on early hit percentage.

a few minutes, he is now able to read "1500-page Tom Clancy novels." He was expected to take 6 years to graduate from a 4-year high school, and he instead graduated in 3 years. He left ninth grade with a 1.0 grade point average and graduated with a 3.76 grade point.

He was awarded the American Citizen Award from the State Bar Association, and he was listed in *Who's Who in American High School Students*. He was once withdrawn, rarely saying more than 5 words to anyone about anything. Now he says he is comfortable to talk to others. He says that he looks at the world much more positively since he has overcome his conditions.

Discussion

To the best of our knowledge, this case study is the first in the published literature to describe the chiropractic management of a teen with migraine headaches and learning disabilities using a brain-based model. The response of this patient to care demon-

Table 4 Conners' rating scale T-scores ^a

| Measure | Week | Week | Week |
|---|------|------|------|
| | 11 | 14 | 18 |
| Oppositional | 81 | 56 | 46 |
| Cognitive problems/inattention | 79 | 61 | 51 |
| Hyperactivity | 90 | 69 | 56 |
| Anxious-shy | 68 | 45 | 45 |
| Perfectionism | 63 | 45 | 40 |
| Social problems | 84 | 55 | 46 |
| Psychosomatic | 90 | 58 | 48 |
| Conner' ADHD Index | 87 | 64 | 55 |
| Conner' Global Index: restless-impulsive | 90 | 64 | 54 |
| Conner' Global Index: emotional lability | 90 | 67 | 43 |
| Conner' Global Index: total | 90 | 67 | 51 |
| DSM-IV inattentive | 83 | 64 | 56 |
| DSM-IV hyperactive-impulsive | 90 | 71 | 53 |
| DSM-IV total | 90 | 69 | 55 |
| Conner's' rating scale average T-score | 84 | 61 | 50 |

DSM-IV: *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*.

^a Lower scores are better.

Table 5 California Achievement Test grade equivalents^a

| | Week 1 | Week 11 | Week 19 | Total % improvement |
|-----------------------------|-----------|------------|------------|------------------------|
| Vocabulary | 6.7 | 9 | 12.7 | 90% |
| Total reading | 8.1 | 10 | 10.6 | 31% |
| Computation | 4.5 | 7.8 | 8.6 | 91% |
| Concepts and application | 5.3 | 7.2 | 12.4 | 134% |
| Total math | 4.8 | 7.6 | 10.1 | 110% |

^a Higher score is better; numbers are read as “grade year.month of school year.”

strates quantitative and qualitative improvements in health, behavior, and education using measures and/or opinions from different professional disciplines including psychology, neuropsychology, education, occupational therapy, medical, and chiropractic. This case also received input from multiple evaluators including his mother, an independent educational test center, 2 computerized evaluations, medical evaluation, a chiropractic neurologist in addition to the practitioner-author, and the adolescent himself.

The chiropractic profession has long theorized that the nervous system is essential to health and well-being. Although there are a variety of techniques in chiropractic, there is generally a common thread among them of “adjusting” by hand or instrument. The change in structure or movement caused by the “adjustment” is hypothesized to change nervous system function, resulting in improved health.²⁸

To determine where to manipulate, chiropractic relies on a wide variety of techniques that may include radiographs, biomechanics, leg length, palpation, and many others.²⁹

This case describes the inclusion of a functional neurology approach that theoretically evaluates for low-functioning components within a “circuit” or pathway. The low-functioning components of the nervous system may not be pathological, but they may not be functioning optimally. This dysfunction may be referred to as a *functional disconnection*.³⁰

A functional disconnection can be thought of as cells from a region of interest (ROI) that have an altered resting state threshold (either too close or too far away from the normal threshold), is asynchronous in its firing within its “functional circuit” known as a module, or some other change in plasticity. It can also be mathematically described as the temporal coherence or statistical dependence of activity between different nerve cells or their circuits.³⁰

Functional disconnections have been hypothesized in mild cognitive impairment,³¹ schizophrenia,³² Parkinson disease,³³ multiple sclerosis,³⁴ neglect,³⁵ autism,³⁶ Alzheimer disease,³⁷ behavioral changes,³⁸ alexia,³⁹ and more. The common trait between these conditions is the altered function of the nervous system that creates a functional loss of capacity in a patient’s health or behavior. Functional disconnections may sometimes be called a *longitudinal lesion* by functional neurologists and may be identified by subjective symptoms described by the patient, psychological instruments, NSSs, or the ROI when evaluated via functional imaging such as quantitative electroencephalography, functional magnetic resonance imaging, single photon emission computed tomography, and positron emission tomography. Once a functional disconnection (ie, longitudinal lesion/ROI/change in central integrated state) is isolated, one can use the activation of receptors that lead to it as a form of exercise for it and its module, thus creating a change in its plasticity and therefore function.¹⁹ If this is done within the metabolic (fuel and recovery) capacity of the tissue, a rehabilitative process is accomplished.¹⁹

The tests that localized the functional disconnection can potentially provide an outcome measure for the rehabilitation process. Improvements in symptoms, NSSs, and other measures such as psychological instruments or functional imaging can provide evidence of change.

It is not certain how these connections are related. We hypothesize for the patient in this case that there is a relation to brain function and patient symptoms. For example, the patient in this case had been previously diagnosed with TS. Tourette syndrome has been linked to cerebellum,¹³ basal ganglia,⁹ and the thalamocortical¹⁰ pathways. It was found in this case via NSSs that the patient’s left cerebellum, right basal ganglia, and the right cortex were involved, thus creating a match with the areas of expected involvement (Table 1). A possible explanation for how the patient may have responded to chiropractic manipulation is also through neurological pathways. Changes to the brain by manipulation have been documented via positron emission tomography⁴⁰ and evoked potentials.^{41,42} These changes include vascular changes⁴⁰ as well as altered cortical integration.^{41,42}

Perhaps, the most impressive is the change in grade equivalent measures without concurrent educational interventions. This may be due to improved functional connectivity, plasticity, and synchronization of the involved central structures⁴³; however, this is conjecture and beyond the measures performed on this case.

It was postulated that, in this case, left-sided adjustments and coordinated activities could provide activation of the involved pathways and structures because this would cause a cascade of activation via the gamma afferents associated with the muscle spindles and joint mechanoreceptors, which would transmit among other areas to the dorsal roots, cord, brainstem, cerebellum ipsilaterally and contralaterally to the basal ganglia, and on to the cortex. Thus, an adjustment could be used as a tool for rehabilitating the patient. Additionally, because the tension within the muscle spindle is changed by the adjustment, additional benefit remains after the initial thrust, as the adjustment provides an ongoing altered sensory input at a low level during normal activities in the field of gravity.

Similarly, it was postulated that, by improving the patient's internal timing using the interactive metronome, a decrease in functional asynchrony neurologically within the involved modules might be possible, as the same components (cerebellum, basal ganglia, and cortex) involved in sensory-motor function are also involved in behavior and cognitive function. The results of this case appear to support these suppositions.

Limitations

This is a report of only one patient; therefore, results cannot be extrapolated to other patients. It is not clear if the treatment provided was responsible for the patient's positive response in that other factors may have contributed to his improvement. It is possible that the patient may have improved in spite of treatment provided. We cannot say for certain that the treatments directed affected his neurological function, as these hypotheses were only underpinning the treatment approach. To test if the treatments had a direct effect on his neurological function, the patient should have been evaluated by pre-post functional diagnostics such as quantitative electroencephalography or functional magnetic resonance imaging. It is recognized that this is only a single case with no separation of treatment modalities, and no generalizations can therefore be made or immediately transferred to other cases.

Conclusion

The patient in this report seemed to improve under chiropractic management using brain-based model of treatment. Additional cases and/or trials will be necessary to verify this as a useful paradigm in care

for these and/or other conditions that may have components that are brain based.

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