An Osteopathic Approach to Low Back Pain and Short Leg Syndrome in a Patient with Traumatic Brain Injury Following Motor Vehicle Crash: A Case Report

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CASE REPORT

Abstract

A 16-year-old boy suffered a traumatic brain injury in a motor vehicle collision with resulting subdural hematoma, post-traumatic seizures, headaches, and cognitive dysfunction. In addition, he experienced severe acute low back, neck, and hip pain. The patient's pediatrician identified him as likely to benefit from osteopathic manipulative medicine (OMM), and he was subsequently referred to the Des Moines University (DMU) specialty care clinic for further evaluation and management.

The patient's outpatient rehabilitation was impacted by multiple somatic dysfunctions and by onset of short leg syndrome. An OMM approach with direct techniques (muscle energy; low-velocity, moderate-amplitude; soft tissue), indirect techniques (counterstrain, Still, myofascial release), and cranial techniques were utilized to minimize his pain, maximize the neuromusculoskeletal recovery, and to assist in returning him to his prior level of functioning.

The acute nature of the injury and apparent new-onset leg length discrepancy allowed for a rapid correction with a heel lift and an ongoing OMM approach to address somatic dysfunction associated with the condition. After 5 treatments with OMM and use of the heel lift, the patient's low back pain substantially improved, and his headaches completely resolved.

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Background

Acute low back pain (LBP) is a common, disabling, and costly condition and one of the most common presentations to primary care offices.[1] Acute LBP is a common complaint following major trauma, such as a motor vehicle collision (MVC).[2] In addition to a multitude of possible traumatic injuries, numerous and significant somatic dysfunctions may also result from MVCs.[3]

Short leg syndrome (SLS) also is a common etiology of LBP.[4(p488)] SLS can occur developmentally over a person's life or can be acquired, eg, following hip replacement surgery or traumatic injuries.[5,6] Classic somatic dysfunction findings of short leg syndrome have been well documented. These related dysfunctions can be global and range from foot pronation, innominate rotations and shears, compensatory spinal curves, and cervical and cranial dysfunctions.[7]

MVC is also a common cause of traumatic brain injury (TBI).[8] Clinical issues following TBI vary greatly[9] and include a variety of physical, cognitive, and neurobehavioral impairments.[10,11]

The purpose of this case report is to provide an OMM approach to a pediatric patient suffering from the traumatic results of an MVC: multiple significant somatic dysfunctions, TBI and associated sequela, and short leg syndrome.

Optimal management of the patient's recovery included addressing significant somatic dysfunctions, assessment and heel lift therapy for the acquired short leg syndrome, and a multidisciplinary rehabilitation approach focused on helping return to prior neurocognitive function.

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Report of Case

History Of Present Illness

A 16-year-old boy was the front passenger involved in a motor vehicle collision (MVC) in which the car was broadsided on the driver's side by a truck traveling at an estimated 55 mph. Loss of consciousness was reported at the scene. Non-contrast computed tomography (CT) scan was performed after arrival to the emergency department and demonstrated a small extra-axial hematoma anterior to the tip of the left temporal lobe, non-displaced left sphenoid fracture, and left parietal scalp hematoma *(see Figure 1)*.

The patient experienced seizures and was placed on levetiracetam for post-traumatic epilepsy (PTE) prevention by a pediatric neurologist. He reported memory issues and was referred to a local rehabilitation facility for outpatient neuropsychiatric evaluation and treatment. Radiographic imaging of the lumbar, thoracic and cervical spine, as well as hips and sacroiliac joints were negative for fractures. Cervical spine CT scan demonstrated straightening of the cervical lordotic curve. Musculoskeletal pain symptoms were progressively worsening, and his pediatrician referred him to the OMM clinic. He presented to the Des Moines University specialty care clinic 13 days after the MVC and reported the following complaints *(see Figure 2)*:

1. Low back pain, right side greater than left, was described as a 5 out of 10, constant, dull aching pressure that felt like a "painful stretch." The patient denied radiation of pain, numbness, or tingling into the lower limbs. Pain improved with lying down or resting and was worse with movement. He reported minimal relief with acetaminophen. He denied bowel or bladder issues.
2. Left hip pain was described as a 3 out of 10 intermittent pain. The patient felt it was likely from the center console hitting his left hip in the MVC. Pain was worse with walking down stairs and leaning on the left side.
3. Mild, intermittent, aching pain was present at the base of the neck with accompanying medial shoulder pain bilaterally.
4. Left-sided headache ipsilateral to the extra-axial hematoma and sphenoid fracture which was described as throbbing in nature and worsened with use of his mental processes such as when playing cards and performing mental calculations.

Additional conditions following the MVC included PTE, cognitive issues, and mental health issues. Seizures were exacerbated by physical and mental fatigue; his first day back to school was the day before his initial visit to the OMM clinic, and he was only capable of attending classes for 3 hours. The patient reported extreme memory loss and confusion. Mental health concerns included increased anxiety when he was traveling in the car.

Medical History and Review of Systems

Patient did not have a history of any surgeries. Medical and social history were also non-contributory.

Physical Examination

The patient's vital signs were stable. Upon cognitive examination, the patient was alert, oriented, and in no acute distress. He followed commands without difficulty. Mood and affect were appropriate, and he was well groomed. Language was normal in fluency, content, context, intelligibility, and response latency. Cranial

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Figure 1. *A non-contrast CT scan on the day of the accident shows a small extra-axial hematoma anterior to the tip of the left temporal lobe, non-displaced left sphenoid fracture, and left parietal scalp hematoma.*

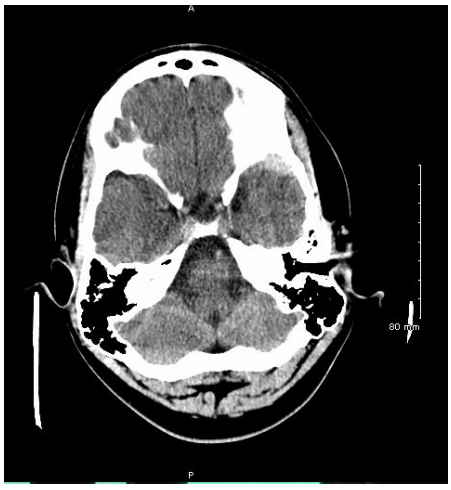
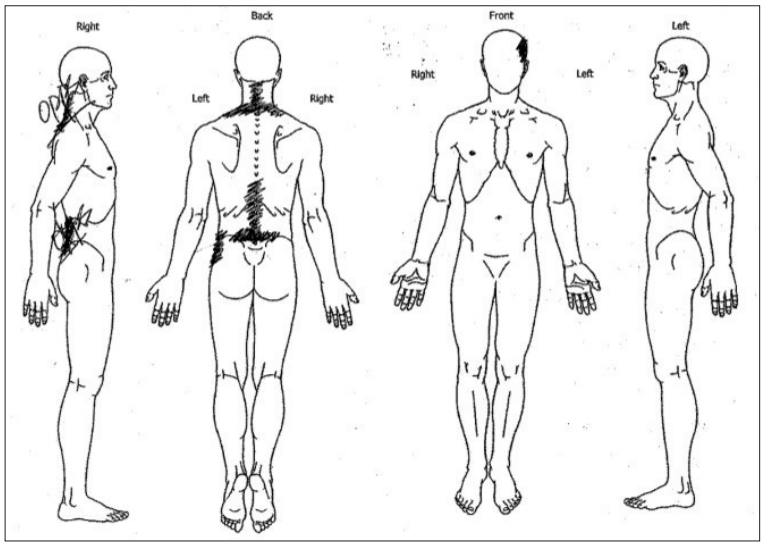


Figure 2. *Pain diagram on initial visit intake form. Legend: ▲ ▲ ▲ = aching; /// = stabbing; # # # = weakness*



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nerves were grossly intact, including extraocular movements intact without evidence of nystagmus. Head was tender with extracranial hematoma appreciated in the left parietal region. Gait exam revealed slight tilt of torso to left; otherwise, no ataxia or imbalance was appreciated. Heel and toe walking were without weakness or difficulty.

A modified ASIA (neurologic) exam[12] was performed. Sensation was intact to light touch in the bilateral C3-T1 and L2-S2 dermatomes. Deep tendon reflexes were 2/4 in the bilateral upper limbs (biceps, brachioradialis, and triceps). Lower limb revealed 3/4 reflexes in the bilateral patella and 2/4 in the bilateral Achilles. A motor exam revealed 5/5 full strength in upper and lower limb muscles assessed, including elbow flexion (C5), wrist extension (C6), elbow extension (C7), long finger flexion (C8), fifth-digit abductors (T1), hip flexors (L2), knee extensors (L3), ankle dorsiflexors (L4), great toe extensors (L5), and knee flexors (S1). Hoffman sign was positive (present) on the right, negative on the left. Plantar reflex responses were downward bilaterally. Clonus in the ankle was 0 beats on the right and 2 beats on the left.

A musculoskeletal exam revealed iliac crest and greater trochanter elevated on the right side. Active lumbar range of motion revealed decreased lumbar flexion with reproduction of pain in the right low back region. Trunk sidebending to the left produced pain in the left hip region, and sidebending to the right produced right paraspinal low back pain. Extension and bilateral rotation were without restriction or pain. Straight leg raise and Bragard test were negative bilaterally. An Adams forward bend test was negative for rib hump or signs of scoliotic curvature. Unilateral supine hip flexion was pain-free; however, a mildly positive Thomas sign was present bilaterally. Hip and sacroiliac joint range of motion and provocative testing were otherwise negative.

A focused structural exam was performed at the first visit. The following somatic dysfunctions were appreciated: right quadratus lumborum (QL) tender point; L1-4 neutral, sidebent right, rotated left; left on right (backward) sacral torsion; right anterior innominate rotation; and right superior innominate shear (upslip). Significant lower limb strains with tender points were also appreciated in the left iliacus and left piriformis.

Concerns

Problems related to the mild-moderate TBI following MVC with left subdural hematoma (SDH) included post-traumatic left-sided headaches, PTE, and mental health/cognitive issues including anxiety when in the car coupled with memory loss and confusion.

Neurological exam was abnormal with 3/4 patellar reflexes, Hoffman sign was positive asymmetrically on the left, and the patient was leaning to the left with unassisted gait.

Additionally, the patient suffered from multiple painful musculoskeletal injuries and somatic dysfunctions, including acute strain lumbosacral region, QL strain, upslip of right innominate, left hip strain, left iliacus and piriformis strains, SI dysfunction, neck and shoulder pain likely related to lateral whiplash injury suffered in above MVC, and apparent short left leg.

Medical Decision-Making

While the patient suffered a TBI, which would require time and supportive care for healing, there were also significant musculoskeletal injuries and somatic dysfunctions present upon initial presentation to DMU's specialty care clinic. During his initial evaluation, 5 of the 6 "dirty-half-dozen" somatic dysfunctions, as originally described by Dr. Greenman,[4(p488)] were identified.

Recommendations

Neurology recommended continuing levetiracetam for PTE prophylaxis, re-imaging of the brain in 2 months, and no driving for 6 months. Additionally, they consulted neuropsychiatry for evaluation of cognitive deficits, as well as screening and recommendations for the anxiety/PTSD related to the MVC.

After initial evaluation at DMU's specialty care clinic, OMM was discussed as having the potential to help alleviate the musculoskeletal injuries associated with the identified somatic dysfunctions. It was agreed that the patient could significantly benefit from OMM. The patient and his mother consented and were very interested in initiating a treatment plan with OMM.

First Treatment

OMM provided on the initial visit for the somatic dysfunctions previously mentioned included counterstrain; muscle energy (lumbar and sacral dysfunctions); Still technique; and low-velocity, moderate-amplitude (innominate) leg tugs. The apparent leg length discrepancy, short left leg, was discussed with the patient and his mother, but it was recommended to re-visit this after completing a trial of OMM.[4(p513)]

Second Treatment

The first follow-up visit occurred 1 week later. The patient reported that he felt significant improvement with minimal pain for nearly 5 days after the first treatment. He stated his hip pain was much better with almost no pain, and he reported that when the pain began to return, it was less severe and had centralized to his low

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back. He rated the pain as a 5 out of 10. He continued to struggle with focus at school, and he found that concentrating too hard aggravated his headaches.

The patient received a broader osteopathic structural examination, which revealed somatic dysfunction in the head, cervical, thoracic, lumbar, sacrum, pelvis, lower and upper extremities, and ribs *(see Table 1)*. OMM was provided, including a focus on the thoracic inlet for increased drainage from the head and neck. Additionally, generalized cranial restriction was appreciated, and venous sinus drainage (VSD) technique[4(p177)] was utilized to both improve cranial bone mobility and promote venous and lymphatic return. This technique involved decreasing tension in the occipital sinus myofascial, decompressing the condylar parts, opening the transverse, straight, and superior sagittal sinuses.

Table 1. *Second OMM treatment, given 1 week after initial visit.*

Body area	Somatic dysfunctions	Technique applied
Lower extremity	Iliacus tenderpoint (tp) left Biceps femoris tp left	Counterstrain (CS) CS
Lumbar	L1-4 NSrRl Quadratus lumborum tp right Lumbopelvic roll right, Iliac crest high left	Muscle energy CS Muscle energy; low-velocity, moderate-amplitude (LVMA)
Thoracic	Thoracolumbar shift left, Iliac Crest high left T12 FRrSr	LVMA, muscle energy Muscle energy
Pelvis	Anterior rotation left innominate Upslip on right	LVMA Still
Sacrum	Right extension	Muscle energy
Ribs	Posterior 10th rib left Posterior 11, 10, 5, 4, 3, right	LVMA LVMA
Inlet	T1 FRlSl, first rib elevated on right	Still, muscle energy
Cervical	Paraspinal muscles tight bilaterally	Soft tissue
Head	Occipito-atlantal ESrRl Generalized cranial restriction	Muscle energy, LVMA Venous sinus drainage

At the end of the second visit, the patient's standing iliac crest and greater trochanter heights were visually assessed and found to still be lower on the left side. Considering the acuity of his traumatic injury, it was determined he would likely tolerate a near-full correction of the lower limb length discrepancy. After evaluating with shims of differing heights, the patient was provided a 5 mm heel lift. As with typical heel lift therapy, recommendations included monitoring closely for worsening symptoms and providing OMM as his body adjusted to the postural correction.

Treatment Course

At the third visit, the patient reported tolerating the heel lift well. The pain continued to localize to his low back; however he now described it as "soreness" that worsened with activity. An MRI of the brain was performed on day 24 post-injury, and it was determined that the previously seen small extra-axial hematoma anterior to the tip of the left temporal lobe had resolved *(see Figure 3)*. OMM was provided with very similar structural exam findings and treatment as during the prior visit.

At the fourth visit, the patient reported his low back pain was "much better," rating his pain 2 out of 10. He was tolerating full days of school with some assistance with his math work. OMM was provided to 9 body regions. Persistent somatic dysfunctions included right innominate upslip, sacral dysfunction that resisted anterior nutation, and right QL strain. Additionally, cranial VSD technique to address the generalized cranial restriction and to improve venous and lymphatic return *(see Table 2)*.

Figure 3. *MRI of the brain (T2 Axial) on day 24 post-MVC shows a left subdural hematoma.*

At the end of the fourth visit, a self-stretch for the right QL was prescribed and demonstrated, and a patient education handout was provided. The goal of this self-stretch was to help address the leg length discrepancy and to assist in maintaining long-term balance of his pelvis. Similarly, a prone press-up self-correction exercise[4(p498)] was prescribed and demonstrated, and a patient education handout

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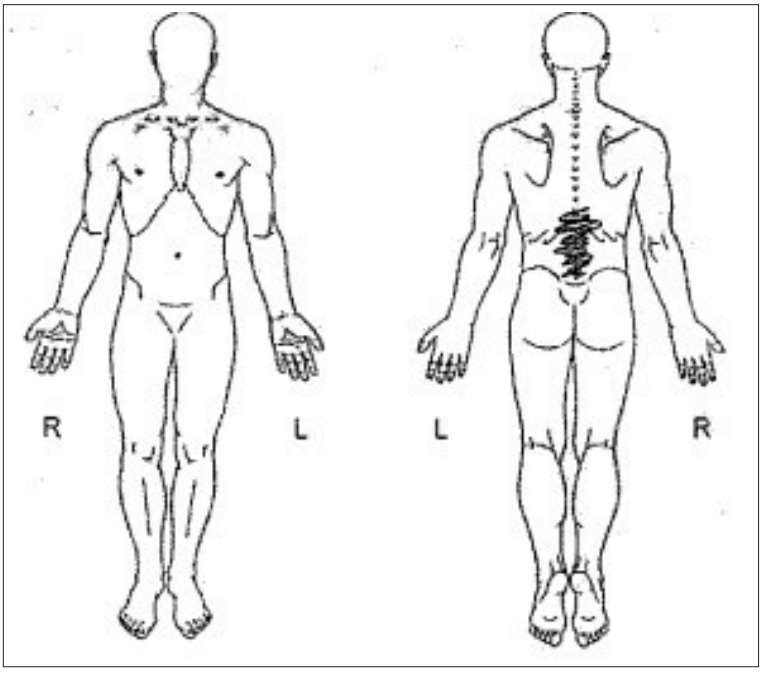
Table 2. *Fourth OMT treatment, given 3 weeks after initial visit.*

Body area	Somatic dysfunctions	Technique applied
Lower extremity	Biceps femoris tp bilaterally	CS
Lumbar	Tight paraspinals bilaterally Quadratus lumborum tp right Lumbopelvic roll right, Iliac crest high left	Soft tissue CS LVMA
Thoracic	Thoracolumbar shift left T4 FRrSr	LVMA LVMA
Inlet	T1 FRlSl, first rib elevated on right	MFR, muscle energy
Cervical	Paraspinals tight bilaterally C3 ERlSl C2 FRrSr	Soft tissue Still Still
Head	OA ESrRl Generalized cranial restriction Occiput down left	Muscle energy Cranial (VSD) Myofascial r elease (MFR)
Pelvis	Posterior rotation left Innominate Upslip on right	LVMA Still
Sacrum	Left on right backward sacral torsion	Muscle energy
Ribs	Posterior 7, 10 rib left Posterior 5, 6, 10 rib right	LVMA LVMA
Upper extremity	Levator scapulae tp right Upper trapezius tp bilateral	CS CS

Figure 4. *Pain diagram on follow-up after 5 visits for OMT (over approximately 2 months) following MVC. Legend: ▲ ▲ ▲ = aching; /// = stabbing; # # # = weakness*



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was provided to help address his recurrent "stuck-backwards," sacral dysfunctions.

Upon returning for the fifth treatment, the patient's headaches had resolved. His low back and neck pain had transitioned to being intermittent, specifically worsened with increased exercise *(see Figure 4)*. He also reported that the at-home exercises for the sacrum and QL were helping. He denied any other pain issues.

The patient continued to use the heel lift at all times. Additionally, he continued to adhere to neurology's driving restriction and the PTE prophylactic levetiracetam recommendations. He also continued to see neuropsychology for ongoing treatment of his cognitive deficits and education on strategies for mood disorders related to the TBI. It was recommended to continue with OMM on an as-needed basis, with the anticipation that his musculoskeletal pain issues would continue to improve.

Discussion

This case presents an example of the utility of OMT in a pediatric patient with a mild-to-moderate TBI and significant post-traumatic low back pain. He presented with numerous significant somatic dysfunctions contributing to his condition that according to Greenman[4] may have failed other traditional (non-OMM) treatment approaches.

The patient's pediatrician correctly identified the patient as being likely to benefit from care in an OMM specialty clinic. Some of the dysfunctions found were consistent with the typical postural response to sacral base unleveling,[13] such as the anterior innominate rotation on the left, the side of the shorter lower limb. However, these dysfunctions are also frequently seen in patient contralateral to an anatomic short leg.

Interestingly, the initial finding of an anterior innominate rotation on the right, which was the same side of his long leg and innominate upslip, was an atypical presentation. This

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suggests the patient may have had a leg length discrepancy predating the MVC, and his compensatory postural changes, which allowed him to be asymptomatic prior to the MVC, were altered by the traumatic forces of the injury.[14] It is possible a lower limb in contact with the floor boards of the car could have caused asymmetric shearing and torsion-like forces, which may have contributed to multiple dysfunctions in the pelvis.

Alternatively, due to the acuity of the traumatic injury, perhaps there had not been enough time for the patient's innominates to assume the more typical rotatory-compensation pattern seen in chronic cases of leg length discrepancy. It may have been the combination of strains, core fascial twists, and other somatic dysfunctions that caused the departure from the classic pattern.

OMM was provided on 6 occasions. Treatments focused on key somatic dysfunctions in the lumbar and pelvic regions to address the postural dysfunction and low back pain. Additionally, basic cranial treatments, as well as evaluation and treatment of fascial pattern dysfunctions at the transitional regions of the spine, were used to promote venous and lymphatic return. The patient was evaluated and successfully treated with a heel lift for his acquired leg length discrepancy. Focused home exercises were prescribed to address recalcitrant somatic dysfunctions. His rehabilitation continued to progress with neuropsychology providing strategies for improving his concentration and stamina as well as education for monitoring mental health issues. Addressing structural issues with OMM helped facilitate his neuromusculoskeletal recovery and assist in returning him to his prior level of functioning.

Conclusion

This case illustrates the importance of looking for leg length discrepancy. It also demonstrates how a clinical visual assessment can efficiently and inexpensively (and without the need for radiographic imaging) allow a provider to diagnose and treat a patient suffering from a short leg syndrome. Third, it highlights how exercise prescription can be utilized—even in small doses—to augment treatment benefits between visits and ultimately provide patients with tools for self-management. Finally, the case demonstrates how OMM can be implemented effectively in an interdisciplinary approach to a complex patient.

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