

# Resolution of Concussion Symptoms After Osteopathic Manipulative Treatment: A Case Report

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**A concussion is the result of a biomechanical force directed toward the head, causing neurologic dysfunction. The inflammatory response and the production of reactive oxygen species are proposed mechanisms for the symptoms and long-term sequelae of concussion. Osteopathic manipulative treatment (OMT) may help reduce inflammation by improving glymphatic flow. The authors describe the effect of OMT on a patient with mild concussion symptoms, including nausea, dizziness, tinnitus, and imbalance. The patient was evaluated with the Sensory Organization Test before and after undergoing a 25-minute session of OMT. After the session, the patient reported resolution of symptoms, and his sensory organization test score improved by 6 points. The role of OMT must be further investigated as an essential and cost-effective tool in the management of concussions.**

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**A** mild concussion, or mild traumatic brain injury (TBI), is challenging for physicians to manage, as it is undetectable by traditional imaging techniques and limited treatment options exist. A concussion refers to an impairment in the level of consciousness from a biomechanical force directed toward the cranium that results in neurologic dysfunction.<sup>1</sup>

The Centers for Disease Control and Prevention estimated that roughly 1.4 to 3.8 million concussions occur annually in the United States.<sup>2,3</sup> From 2007 to 2010, TBI-related emergency department visits increased from 567 to 824, respectively, for every 100,000 people in the United States, representing a 54% increase.<sup>3</sup> The Centers for Disease Control and Prevention's 2015 report to Congress<sup>3</sup> suggests that 3.2 to 5.3 million people in the United States live with concussion-related disability. These figures should be considered an underestimate, as persons with milder injuries often do not seek treatment.<sup>4</sup>

The mechanism of concussion involves a primary and secondary phase of tissue injury. The primary injury is immediate and irreversible, resulting from acceleration/deceleration forces that cause mechanical damage. Secondary injuries occur at the cellular level, indicated by neuronal cell membrane disruption and axonal stretch.<sup>5</sup> The membrane defects result from secondary injury and lead to ionic influx and accumulation of toxic substances in the nervous system, such as glutamate.<sup>6</sup> Patients with mild concussion recover within a few days; however, 15% of patients with mild concussion have long-term complications, largely due to the secondary phase of injury.<sup>5</sup>

Studies have shown that inflammation leads to the production of reactive oxygen species that not only contribute to the initial injury but also potentiate its own pathological course.<sup>7,8</sup> The mechanism of injury could, hypothetically, be targeted with osteopathic manipulative treatment (OMT). The confirmation of the glymphatic system helps to support the potential role of OMT as a treatment option.<sup>9</sup> Located in the dural sinuses and around the meningeal arteries, the lymphaticlike vessels drain immune cells into deep cervical lymph nodes.<sup>9</sup> This discovery suggests an anatomical justification for how OMT may aid in the clearance of reactive oxygen species and other inflammatory molecules from the brain.

A 2014 review<sup>10</sup> of the management of sport-related concussion found inconclusive evidence that rest or exercise is better; however, it emphasized a more individualized treatment approach. Our literature search for the effects of OMT on concussions found a 2015 retrospective medical record review by Chappell et al.<sup>11</sup> The authors found that 26 records documented improvement in 10 of 22 concussion symptoms in athletes after OMT using the Sport Concussion Assessment Tool (SCAT) 2.<sup>11</sup> Other studies have looked at the effect of OMT on concussionlike symptoms, such as headache, vertigo, and imbalance. Researchers found a positive effect of OMT on concussionlike symptoms such as vertigo and imbalance.<sup>12,13</sup> Anderson and Seniscal<sup>14</sup> found that OMT reduced the number of days without headaches compared with relaxation exercises alone.<sup>14</sup>

We report a case in which OMT was used to manage postconcussion symptoms. Symptoms were objectively quantified before and after OMT with the Sensory Organization Test (SOT) and the SMART Balance Master. The SMART Balance Master (Natus Medical Incorporated) has the ability to measure specific changes in balance, and it has been used to help quantify improvements in balance after a concussion or TBI.<sup>15</sup>

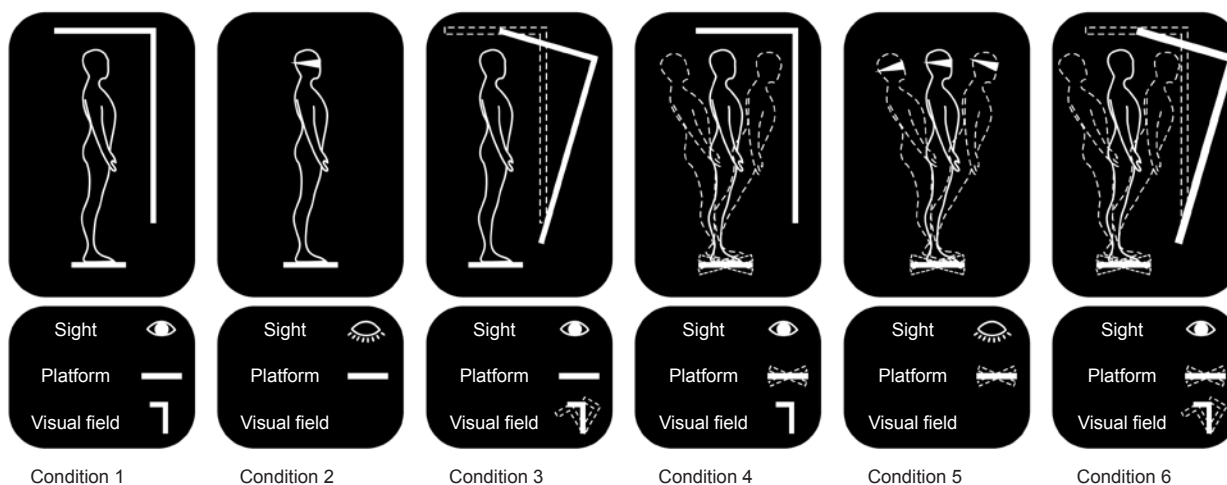
## Case Report

A 27-year-old man presented to the clinic with a 2-day history of dizziness, nausea, fogginess, and a “blowing sensation in the ear.” Symptoms started 3 days earlier after a fall while snowboarding without a helmet, during which he hit the left posterior aspect of his head. The patient denied loss of consciousness but admitted to a headache, nausea, dizziness, and tinnitus after the fall. He described his dizziness as “the room was spinning.” He denied vomiting, visual changes, or memory loss.

The patient had an unremarkable medical history and denied a history of migraines, attention problems, anxiety, or depression. The patient denied taking medication, including over-the-counter pain medication, after the accident.

In the clinic, the patient appeared uncomfortable. His vital signs were within normal limits, and physical examination findings, including that of the cardiopulmonary system, were unremarkable. A neurologic examination revealed pupils equally round and reactive to light and extraocular muscles full without evidence of nystagmus. Cerebellar signs were absent, sensation was intact in all extremities, and he was able to ambulate without assistance. The remainder of the examination findings were nonfocal.

An osteopathic structural examination revealed a right sphenobasilar synchondrosis torsion, an inferior vertical strain, left temporal bone externally rotated; C3 extended, rotated, and sidebent left; C4-5 extended, rotated, and sidebent right; right first rib inhalation dysfunction; T2-3 flexed, rotated, and sidebent right; L4 extended, rotated, and sidebent left; and a left unilateral sacral flexion. The patient was also evaluated with the SOT on the SMART Balance Master because of his balance complaints. *Figure 1* provides a schematic drawing of the sensory conditions assessed by the SOT. On the basis of the patient’s history of trauma and the physical examination findings, mild concussion was diagnosed.



**Figure 1.**

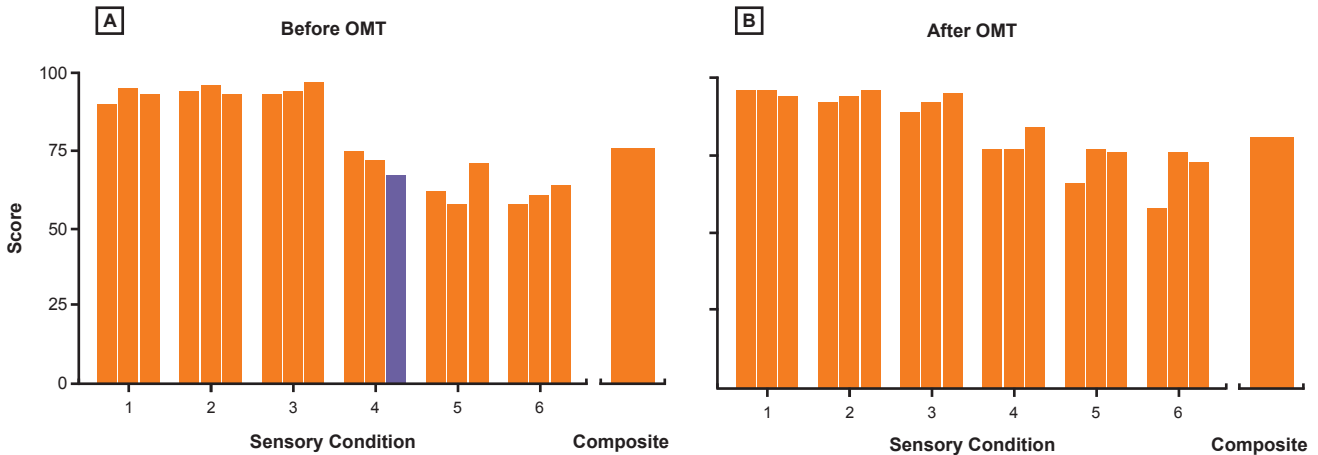
Schematic drawing of the 6 sensory conditions based on 3 variables (eyesight, platform stability, and visual field) used during the Sensory Organization Test.

The patient consented to receive a single 25-minute session of OMT for his concussion symptoms. Techniques included balanced membranous tension, cranial bone lifts, venous sinus drainage, balanced ligamentous tension of the thoracic outlet, muscle energy and myofascial release to the cervical and upper thoracic spine, and high-velocity, low-amplitude to the cervical, thoracic, lumbar, and sacral spine segments.

Immediately after treatment, the patient reported resolution of the dizziness, tinnitus, and nausea. He denied further sensation of the room spinning. The SOT showed an increase in the composite equilibrium from 76 before treatment to 81 after treatment. The equilibrium score in conditions 4 and 5, which are associated with the visual and vestibular aspects of balance, improved the most after treatment (*Figure 2*). One week after treatment, the patient returned for a follow-up visit and denied any symptoms. No further follow-up was documented.

## Discussion

The secondary phase of injury in concussion results in an inflammatory response and production of reactive oxygen species, which are proposed to perpetuate concussion symptoms. With the discovery of the glymphatic system providing a potential anatomical justification, we hypothesize that OMT improves symptoms of concussions by increasing glymphatic drainage. Studies have reported that biomarkers, produced as a result of tissue damage from concussions, pass through the glymphatic system into the cervical lymphatic vessels.<sup>10,16</sup> It has been demonstrated that cranial manipulation can have an effect on the Traube-Hering-Mayer oscillation and autonomic nervous system, which can directly affect the flow of cerebrospinal fluid through the glymphatic system.<sup>17</sup> Dreha-Kulaczewski et al<sup>18</sup> also found that inspiratory thoracic pressure changed cerebrospinal fluid flow. In other regions of the body, OMT has been demonstrated in animal models to improve lymphatic flow<sup>19</sup>



**Figure 2.**

Results from the SMART Balance Master (Natus Medical Incorporated) immediately before (A) and after (B) osteopathic manipulative treatment (OMT) in a 27-year-old man with mild concussion. For each sensory condition, 3 trials were run. Orange bars indicate that the patient performed above the average score for age, sex, and height; the purple bar indicates that the patient performed below the average score. Conditions are shown in *Figure 1*.

and, in combination with the findings of Dreha-Kulaczewski et al,<sup>18</sup> a potential mechanism of action for OMT's effect on glymphatic flow can be theorized. We believe this information supports our hypothesis and provides a strong foundation for future research to uncover the exact mechanism of action and quantify the effect OMT has on glymphatic flow in patients with concussion.

Although the effect of OMT on glymphatic flow is a possible explanation for improved concussion symptoms in the current case, techniques applied to other body regions may also have affected the patient's symptoms. For instance, evidence suggests that mechanoreceptors in cervical vertebral facets are involved in proprioception.<sup>20</sup> The OMT techniques that targeted the cervical spine in the current case, including myofascial release, muscle energy, and high-velocity, low-amplitude, could have improved signaling from cervical mechanoreceptors. Other mechanisms could explain the patient's symptom relief and should be investigated to determine all possible mechanisms of action of OMT on concussion symptoms.

The findings in the current case have limited value. No standardized assessment tool such as Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT; ImPACT Applications, Inc) or the SCAT-3 were used to objectively quantify the severity of the concussion. The SOT results from the SMART Balance Master were able to provide an objective measure of balance; however, further studies are required to validate this tool as a measure of OMT's effect on balance in patients with concussion. Furthermore, the patient was not followed up beyond 1 week, which prevented us from determining whether he remained asymptomatic.

The pathophysiologic process of concussions is complex, and researchers globally are investigating this topic.<sup>21</sup> For OMT, future mechanistic studies should examine the physiologic effects of OMT on different processes, such as cerebral blood flow, lymphatic drainage, and levels of inflammatory markers. Moreover, a case series or a pilot study that looks at how patients respond to OMT would be the next logical step in quantifying the effect of OMT. These results would provide a strong foundation to sup-

port research comparing OMT with other treatment options. Furthermore, one must validate the use of SOT scores for (1) quantifying changes in balance after a concussion and (2) serving as an objective tool in OMT research. Other standardized assessment tools, such as ImPACT and the SCAT-3, could also be used to better quantify the effects of OMT. The effect of OMT on concussion symptoms and the return to normal activities needs to be investigated to justify the use of OMT as a preferred treatment option for patients with concussions.

## Conclusion

A comprehensive approach to patients with concussions, including OMT, can potentially provide symptom relief, decrease recovery time, and improve patient outcomes. The current case provides justification for further research into the efficacy of OMT using objective, validated measures.

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