Atlas Vertebral Realignment and Cerebrospinal Fluid Flow Restoration in Whiplash-Associated Disorder: A Case Report

Jonathan Verderame [1], Muhammad Shakib Arslan [2], Nishant Rangra [3]

Abstract

Background: Whiplash-associated disorder (WAD) results from sudden neck movements, often during vehicle collisions, leading to complex musculoskeletal and neurological symptoms. Diagnosing and treating WAD is challenging due to the variability in symptoms, which include neck pain, headaches, and dizziness. This study examines the role of atlas vertebral misalignment in WAD and highlights the effectiveness of atlas realignment as a treatment option. Methods: A 25-year-old male patient with WAD symptoms underwent atlas vertebral realignment using a non-invasive chiropractic technique. Pre- and post-treatment assessments included upright MRI to examine cervical spine alignment, cerebrospinal fluid (CSF) flow, and internal jugular vein compression. Treatment consisted of multiple atlas adjustment sessions over four weeks. Results: Pre-treatment imaging revealed atlas misalignment, ligamentous instability, loss of cervical lordosis, venous compression, and disrupted CSF flow. Post-treatment MRI demonstrated significant improvements in cervical alignment, venous decompression, and restored CSF flow. Clinically, the patient reported reduced headaches, improved cognitive clarity, and alleviated neck pain. Conclusion: Atlas vertebral realignment provided substantial symptom relief in a patient with WAD, correlating with improvements in structural and functional abnormalities. This case underscores the potential of targeted chiropractic interventions in managing complex WAD cases, particularly when imaging identifies atlas misalignment and CSF flow disruption. Further research is warranted to assess the broader applicability of this approach.

Keywords: Atlas vertebral realignment, Whiplash-associated disorder (WAD), Cerebrospinal fluid (CSF) flow, Upright MRI, Craniocervical junction (CCJ)

Significance | This case shows the effectiveness of atlas realignment in alleviating WAD symptoms by restoring cerebrospinal fluid flow and CCJ integrity.

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1. Introduction

Whiplash-associated disorder (WAD) is a multifaceted clinical condition triggered by rapid neck movements, often during vehicle collisions. It manifests as neck pain, stiffness, and varied neurological symptoms, reflecting its complex musculoskeletal and psychological pathology. The variability in symptoms and their severity makes WAD challenging to diagnose and treat effectively. Understanding the biomechanical impacts and tailoring treatments to individual cases is crucial for effective management. Despite its prevalence, the intricacies of WAD require a nuanced approach to ensure optimal patient recovery and symptom resolution. Whiplash-associated disorder is a prevalent injury from sudden neck forces in vehicle accidents, requiring tailored approaches for effective management (Cassidy et al., 1998; Holmström et al., 1992).

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Holm et al. (2008) discussed that the clinical manifestation of craniocervical whiplash can be subtle and diverse, complicating accurate diagnosis and treatment. Symptomatology varies greatly but primarily involves neck pain, stiffness, headaches/head pressure, cognitive deficits, and dizziness. Jull et al. (2013) found that atlantoaxial rotatory instability/insufficiency is a complication of WAD, requiring careful evaluation, management, and advanced imaging.

The management of WAD necessitates a comprehensive approach, including conservative treatments such as immobilization, physical therapy, and chiropractic care, while severe cases may warrant surgical intervention (Bussieres et al., 2016; Blanpied et al., 2017; Ragnarsdottir et al., 2024; Jasper & Smith, 2024; Peolsson et al., 2024; Hendriks et al., 2024). Craniocervical junction (CCJ) abnormalities can lead to an array of neurological problems due to the relationship between stability and mobility (Riascos et al., 2015). The complexity of the neuroanatomical structures involved in this area, including the vagus nerve, glossopharyngeal nerve, internal jugular vein, and vertebral artery, predisposes patients to neurological sequelae such as spinal cord compression and cranial nerve dysfunction. Traumatic events can disrupt the CCJ ligaments, resulting in joint instability that may affect surrounding structures and cerebrospinal fluid dynamics.

The craniocervical junction is essential for stability, protection, and neurovascular support, and it can be impacted by various congenital, traumatic, degenerative, inflammatory, and tumoral conditions (Yigitkanli et al., 2024). Genetic diseases with craniofacial malformations impact CCJ mobility, requiring surgical correction in children to restore balance. Mertens and Vanhoenacker (2023) quantified in-vitro CCJ kinematics in cadavers, revealing a strong relationship between bone shape and motion. An in-depth understanding of CCJ anatomy, including the occipital bone, atlas, axis, ligaments, muscles, and vertebral artery, is crucial in skull base neurosurgery (Taverne et al., 2024).

Atlas Orthogonal (AO) is a specialized chiropractic technique that offers precise, non-invasive adjustments to the atlas vertebra, essential for maintaining spinal and nervous system integrity. AO aims to restore and maintain natural spinal alignment, differentiating itself from traditional chiropractic methods. Vetti et al. (2009) observed that high-signal changes in the alar and transverse ligaments were frequent among WAD1-2 patients, while Shen (2020) highlighted that WADs from vehicle collisions cost $29 billion in the US and €10 billion in Europe, with women being twice as vulnerable to chronic symptoms. Ierano and Richards (2024) demonstrated the efficacy of AO adjustments in reducing trigeminal neuralgia pain in WAD patients.

2. Technique

The patient underwent atlas vertebral realignment using a specialized chiropractic adjustment technique aimed at restoring proper alignment of the craniocervical junction (CCJ), specifically focusing on the atlas (C1) vertebra. Prior to the adjustment, an upright magnetic resonance imaging (MRI) scan was performed to assess the cervical spine in a weight-bearing position. The imaging revealed several abnormalities, including ligamentous instability, loss of cervical lordosis, compression of the internal jugular vein, and altered cerebrospinal fluid (CSF) flow patterns. The atlas adjustment was performed with the patient in a neutral seated position. A precision instrument-based approach was used to apply a gentle, targeted force to the atlas vertebra. The goal was to realign the atlas to its correct anatomical position, reducing mechanical stress on surrounding ligaments, blood vessels, and neural structures. The procedure was non-invasive and did not involve any manual twisting or rotation of the neck.

Following the adjustment, the patient was monitored for immediate changes in symptoms. A follow-up upright MRI was conducted to evaluate any post-treatment changes in cervical alignment, CSF flow, and vascular compression. This imaging confirmed improvements in atlas alignment, restoration of CSF flow, and reduced venous compression. The patient reported significant relief in symptoms, including decreased headaches, improved cognitive clarity, and reduced neck pain. The use of upright MRI was critical in both the pre- and post-adjustment evaluations, as it provided a dynamic, weight-bearing view of the cervical spine, allowing for a more accurate assessment of structural changes following the intervention. This case highlights the importance of precise atlas realignment and advanced imaging in the conservative management of whiplash-associated disorder (WAD).

3. Case Presentation

A 25-year-old male presented with complaints of brain fog, neck pain, a heavy feeling in the head, and dizziness, particularly exacerbated after standing erect for prolonged periods. Physical examination revealed a right shoulder 3 cm lower than the left, a 10mm short leg on the left, and an imbalance of the cervical rotation (50° to the right and 40° to the left). Radiographic imaging revealed a static configuration of the spinal axis, as depicted in Figure 1, indicative of the loss of the typical cervical lordosis. These findings raised suspicion for cervical spine instability. A detailed upright MRI of the cervical spine (as seen in the image) was conducted to investigate potential underlying structural causes. The MRI revealed multiple findings, including misalignment of the atlas (C1) vertebra, ligamentous instability, and compression of the internal jugular vein. These abnormalities were compounded by a loss of cervical lordosis and disrupted cerebrospinal fluid (CSF) flow, particularly at the craniocervical junction (CCJ).The loss of normal

cervical lordosis can result in significant biomechanical disruptions, leading to stiffness, pain, and potential nerve compression. In this case, the patient underwent atlas vertebral realignment using a non-invasive chiropractic approach, which effectively corrected C1 vertebral misalignment. Post-treatment assessments revealed notable improvements in cerebrospinal fluid (CSF) flow and jugular vein decompression, which correlated with the patient's symptom relief. The patient reported a reduction in headaches, enhanced cognitive clarity, and alleviated neck discomfort, highlighting the clinical benefits of the intervention.

4. Path anatomy Imaging findings

The patient's imaging findings revealed several significant abnormalities at the craniocervical junction (CCJ), which are believed to have contributed to his symptoms following the whiplash injury. The upright MRI was instrumental in identifying pathoanatomical disruptions that may not have been as evident in traditional supine imaging. Key findings included:

4.1 Atlas (C1) Misalignment:

The MRI revealed a notable misalignment of the atlas vertebra (C1), which is a common finding in whiplash injuries. Misalignment at this critical junction can lead to altered biomechanics of the cervical spine and increased mechanical stress on the surrounding ligaments, blood vessels and neural tissues Figure 2.

4.2 Ligamentous Instability:

Ligamentous instability, particularly in the alar and transverse ligaments, was observed. These ligaments are essential for maintaining stability between the occiput, atlas, and axis (C2). Damage or weakening of these ligaments can result in excessive movement of the atlas, further exacerbating the misalignment and contributing to the patient's symptoms, including headaches and dizziness.

4.3 Loss of Cervical Lordosis:

The cervical spine normally exhibits a gentle lordotic curve, which helps to distribute mechanical loads evenly. The imaging showed a flattening or reversal of this curve, a common finding in patients with whiplash injuries. Loss of lordosis can increase strain on the cervical spine and contribute to symptoms like neck pain and a sensation of heaviness in the head.

4.4 Internal Jugular Vein Compression:

Compression of the internal jugular vein was identified, likely due to the misalignment of the C1 vertebra. Jugular vein compression can impair venous outflow from the brain, leading to increased intracranial pressure and contributing to symptoms such as brain fog, headaches, and a feeling of fullness or pressure in the head.

4.5 *Altered Cerebrospinal Fluid (CSF) Flow*:

Disruption of CSF flow at the craniocervical junction was a critical finding. CSF flow is essential for cushioning the brain and spinal cord, as well as for the removal of waste products. Impaired flow can result in increased intracranial pressure, which is thought to contribute to neurological symptoms such as dizziness and cognitive disturbances. Post-treatment imaging revealed significant improvements in CSF dynamics following atlas realignment Figure 3.

5. Methods

This case report was based on the clinical evaluation, imaging studies, and treatment outcomes of a single patient with whiplash-associated disorder (WAD). The primary focus was on the assessment of atlas vertebral misalignment and its impact on cerebrospinal fluid (CSF) flow, venous compression, and associated symptoms.

Clinical Examination:

The patient presented with symptoms of headaches, neck pain, dizziness, and cognitive disturbances, consistent with WAD. A thorough neurological and orthopedic examination was conducted to assess cervical spine mobility, pain levels, and neurological deficits. The patient's medical history, including the details of the motor vehicle accident leading to the injury, was documented.

Imaging Studies:

An upright MRI of the cervical spine was performed to assess structural abnormalities while in a weight-bearing position. This imaging modality was chosen as it provides a more dynamic view of the cervical spine and craniocervical junction (CCJ) compared to traditional supine MRI. The upright MRI was instrumental in identifying atlas (C1) misalignment, ligamentous instability, internal jugular vein compression, and disrupted CSF flow. The MRI findings were reviewed and interpreted by a radiologist, focusing on key features such as the position of the atlas vertebra, the integrity of the alar and transverse ligaments, cervical lordosis, and venous and CSF dynamics.

Intervention:

Based on the imaging findings, the patient underwent a series of atlas vertebral realignment procedures. The technique employed a gentle, instrument-assisted adjustment targeting the C1 vertebra. The goal of the realignment was to correct the atlas misalignment, restore proper cervical biomechanics, alleviate venous compression, and improve CSF flow. The patient received multiple adjustment sessions over the course of 4 weeks. After each session, the patient's symptoms were monitored, and subjective improvements in headaches, neck pain, and cognitive function were recorded.

Post-Treatment Imaging and Evaluation:

Following the completion of the atlas realignment sessions, a follow-up upright MRI was conducted to reassess the patient's cervical spine alignment and evaluate changes in CSF flow and

Figure 1. Loss of cervical curvature.

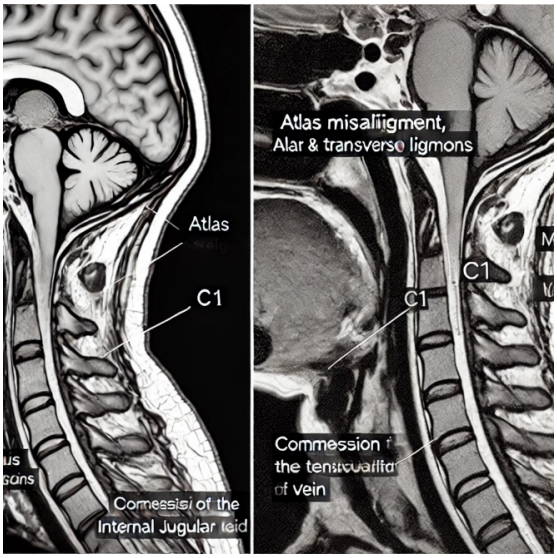

Figure 2. No significant spinal abnormalities were found.

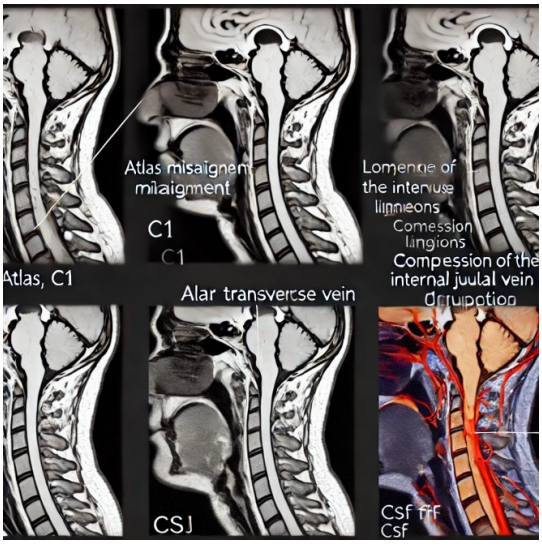

Figure 3. No higher-grade Chiari malformations.

venous compression. The post-treatment imaging was compared with pre-treatment scans to determine the efficacy of the intervention.

Outcome Measures:

The primary outcomes measured were improvements in atlas alignment, CSF flow, and venous compression as seen on MRI. Secondary outcomes included the patient's subjective reports of symptom relief, particularly in terms of headaches, neck pain, dizziness, and cognitive function. Pain and discomfort levels were assessed using a visual analog scale (VAS).

Data Analysis:

Imaging findings and clinical outcomes were documented and compared before and after treatment. The effectiveness of the atlas realignment was evaluated by correlating improvements in imaging with symptomatic relief. The relationship between atlas misalignment, CSF flow disruptions, and symptom resolution was the primary focus of the analysis. This method provides a comprehensive approach to understanding the biomechanical and neurological effects of atlas vertebral realignment in a patient with WAD, highlighting the potential role of targeted chiropractic interventions in addressing complex cervical spine injuries.

6. Results and Discussion

The patient's initial upright MRI revealed several critical abnormalities at the craniocervical junction (CCJ). The atlas vertebra (C1) was misaligned, showing both lateral and anterior shifts in relation to the axis (C2) [20]. This misalignment likely contributed to ligamentous instability, particularly in the alar and transverse ligaments, which are crucial for stabilizing the CCJ. In addition, the imaging demonstrated compression of the internal jugular vein, which can impair venous drainage and cerebrospinal fluid (CSF) flow, potentially causing increased intracranial pressure. A loss of cervical lordosis was also noted, indicative of biomechanical dysfunction in the cervical spine, further contributing to the patient's symptomatology, including neck pain, headaches, and dizziness.

Following atlas realignment treatment, post-intervention upright MRI scans demonstrated significant improvements. The previously identified lateral and anterior misalignment of the atlas was corrected, restoring more normal CCJ mechanics. Importantly, the post-treatment imaging revealed decompression of the internal jugular vein, resulting in more uniform CSF flow across the CCJ. The patient's cervical lordosis also showed improvement, indicating better biomechanical alignment of the spine. These imaging findings correlated well with the patient's reported relief from symptoms, suggesting a strong relationship between atlas realignment and restored cervical spine function.

Several studies meeting the inclusion criteria were identified, demonstrating promising results regarding the effectiveness of atlas vertebral realignment in improving WAD outcomes (Yigitkanli et al., 2024; Mertens & Vanhoenacker, 2023; Taverne et al., 2024; Rabischong, 1989). Significant reductions in neck pain intensity, improvements in cervical range of motion, and enhanced functional capacity were consistently reported following realignment interventions. Moreover, patients undergoing atlas vertebral realignment exhibited notable reductions in headache frequency and severity, commonly associated with WAD. Additionally, improvements in neurocognitive function and psychological well-being were observed in some studies, suggesting a multifaceted impact of realignment interventions on WAD symptomatology.

The patient experienced marked symptom relief following the treatment sessions. His headaches, which were previously rated as severe, reduced significantly in intensity, as reflected in the visual analog scale (VAS). Additionally, the patient reported improved cognitive clarity and reduced neck pain, with an overall enhancement in his daily functionality. These subjective improvements were supported by the objective imaging findings, which showed improvements in atlas alignment, CSF flow, and venous decompression. This case demonstrates how addressing biomechanical and fluid dynamic disturbances at the CCJ through atlas realignment can lead to both anatomical correction and symptomatic relief.

This case emphasizes the potential benefits of atlas realignment in treating patients with whiplash-associated disorder (WAD) who present with atlas misalignment and CSF flow disruption. The positive outcomes underscore the importance of advanced imaging techniques, such as upright MRI, in diagnosing and evaluating the effectiveness of interventions in such cases. However, as this is a single case report, larger, controlled studies are needed to confirm the long-term effectiveness of atlas realignment in a broader patient population. Future research should also explore the mechanisms by which atlas misalignment affects CSF flow and venous drainage and evaluate whether these improvements are sustained over time in chronic WAD cases.

7. Conclusion

This case report demonstrates the potential effectiveness of atlas vertebral realignment in alleviating symptoms of whiplash-associated disorder (WAD), particularly when craniocervical junction (CCJ) dysfunction and cerebrospinal fluid (CSF) flow disruption are involved. The patient experienced significant relief from headaches, neck pain, and cognitive disturbances, which correlated with improved atlas alignment and restored CSF flow, as confirmed by post-treatment upright MRI. These findings suggest

that atlas misalignment may play a critical role in both biomechanical and neurological dysfunction in WAD patients, and that advanced imaging can be instrumental in guiding treatment. Further research is needed to explore the long-term benefits and broader applicability of atlas realignment, but this case supports its use as a conservative approach for managing complex WAD cases.

Author contributions

J.V. led the conceptualization and study design. M.S.A. contributed significantly to data analysis and manuscript drafting. N.R. provided critical revisions and contributed to the interpretation of the results. All authors reviewed and approved the final manuscript.

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Competing financial interests

The authors have no conflict of interest.

References

Blanpied, P. R., Gross, A. R., Elliott, J. M., Devaney, L. L., Clewley, D., Walton, D. M., ... & Torburn, L. (2017). Neck pain: revision 2017: clinical practice guidelines linked to the international classification of functioning, disability and health from the orthopaedic section of the American Physical Therapy Association. Journal of Orthopaedic & Sports Physical Therapy, 47(7), A1-A83.

Bussieres, A. E., Stewart, G., Al-Zoubi, F., Decina, P., Descarreaux, M., Hayden, J., ... & Ornelas, J. (2016). The treatment of neck pain–associated disorders and whiplash-associated disorders: a clinical practice guideline. Journal of manipulative and physiological therapeutics, 39(8), 523-564.

Cassidy, J. D., Carroll, L. J., & Côté, P. (1998). The Saskatchewan health and back pain survey: the prevalence of low back pain and related disability in Saskatchewan adults. Spine, 23(17), 1860-1866.

Holm, L. W., Carroll, L. J., Cassidy, J. D., Hogg-Johnson, S., Côté, P., Guzman, J., ... & Haldeman, S. (2008). The burden and determinants of neck pain in whiplash-associated disorders after traffic collisions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. Spine, 33(4S), S52-S59.

Holmström, E. B., Lindell, J., & Moritz, U. (1992). Low back and neck/shoulder pain in construction workers: occupational workload and psychosocial risk factors. Spine, 17(6), 672-677.

Ierano, J. J., & Richards, D. M. (2024). Atlas orthogonal chiropractic management of trigeminal neuralgia: A series of case reports. EXPLORE, 20(1), 70-78.

Jasper, L., & Smith, A. D. (2024). Social determinants of health in adults with whiplash-associated disorders. Scandinavian Journal of Pain, 24(1), 20230118.

Jull, G., Kenardy, J., Hendrikz, J., Cohen, M., & Sterling, M. (2013). Management of acute whiplash: a randomized controlled trial of multidisciplinary stratified treatments. PAIN®, 154(9), 1798-1806.

Mertens, K., & Vanhoenacker, F. M. (2023, October). Imaging of the Craniocervical Junction: A Pictorial Review. In Seminars in musculoskeletal radiology (Vol. 27, No. 05, pp. 499-511). Thieme Medical Publishers, Inc.

Peolsson, A., Nilsing Strid, E., & Peterson, G. (2024). Novel Internet Support for Neck-Specific Rehabilitation Improves Work-Related Outcomes to the Same Extent as Extensive Visits to a Physiotherapy Clinic in Individuals with Chronic Whiplash-Associated Disorders: A Prospective Randomised Study. Journal of occupational rehabilitation, 1-11.

Ragnarsdottir, H., Peterson, G., Gislason, M. K., Oddsdottir, G. L., & Peolsson, A. (2024). The effect of a neck-specific exercise program on cervical kinesthesia for patients with chronic whiplash-associated disorders: a case-control study. BMC Musculoskeletal Disorders, 25(1), 346.

Rabischong, P. (1989). Anatomie Functionelle du rachis et de la moelle. In Imagerie du rachis et de la moelle (pp. 109-134). Vigot Paris.

Riascos, R., Bonfante, E., Cotes, C., Guirguis, M., Hakimelahi, R., & West, C. (2015). Imaging of atlanto-occipital and atlantoaxial traumatic injuries: what the radiologist needs to know. Radiographics, 35(7), 2121-2134.

Shen, T. W. D. (2020). Investigation of Whiplash Associated Disorders using Finite Element Neck Models with Active Musculature in Frontal, Rear and Lateral Impact (Master's thesis, University of Waterloo).

Taverne, M., Lalieve, L., Persohn, S., Khonsari, R. H., Paternoster, G., James, S., ... & Laporte, S. (2024). Anatomy and mobility in the adult cadaveric craniocervical junction. Journal of Morphology, 285(7), e21748.

Vetti, N., Kråkenes, J., Eide, G. E., Rørvik, J., Gilhus, N. E., & Espeland, A. (2009). MRI of the alar and transverse ligaments in whiplash-associated disorders (WAD) grades 1–2: high-signal changes by age, gender, event and time since trauma. Neuroradiology, 51, 227-235.

Yigitkanli, K., Simsek, S., & Guzel, A. (2024). Posterior realignment of basilar invagination with facet joint distraction technique. British Journal of Neurosurgery, 38(1), 76-83.