Case Study: Acceleration/Deceleration Injury With Angular Kyphosis

Robert C. Kessinger, DC, and Dessy V. Boneva, DC

ABSTRACT

Objective: To discuss the case of a patient who received upper cervical chiropractic care after trauma-induced angular kyphosis in the cervical spine. A practical application of conservative management for posttrauma cervical spine injury in the private office setting is described.

Clinical Features: A 17-year-old female patient suffered an unstable C3/C4 motor segment after a lateral-impact motor vehicle collision. Additional symptoms on presentation included vertigo, tinnitus, neck and shoulder pain, and confusion.

Intervention and Outcome: Conservative management consisted exclusively of upper cervical-specific adjustments guided by radiographic analysis and paraspinal bilateral skin temperature differential analysis of the cervical spine. During 10 weeks of care and 22 office visits, all symptoms subsided and the instability of C3/C4 motor segment appeared to be completely resolved.

Conclusion: This study provides support for the use of upper cervical chiropractic management in cervical spine trauma cases. The clinical work-up consisted of physical examination, radiographic analysis, computer-administered and scored cognitive function testing, and audiometric examination. After conservative care, these examinations were repeated and demonstrated that the objective findings concurred with the subjective improvements reported by the patient. (J Manipulative Physiol Ther 2000;23:279-87)

Key Indexing Terms: Kyphosis; Cervical Spine; Instability; Whiplash; Chiropractic

INTRODUCTION

The cervical acceleration/deceleration (CAD) trauma, whiplash, has traditionally been described in association with cervical spine movements in the sagittal plane after a rear-end motor vehicle collision. There are less data concerning frontal and lateral impacts compared with rear-end collisions. However, lateral and frontal collisions can clearly produce signs and symptoms consistent with rear-end impacts. The reported data from computer models and cadaver experiments are consistent with predictions of simple physics analysis and rear-end impacts. In a rear-end collision, the head and neck are acted on with 2 to 2½ times the acceleration force as the vehicle itself. The acceleration rates are significantly more by comparison, and the deceleration rates reflect more force to the head and neck. According to the law of linear conservation of energy, the increase of energy on impact must be transferred until completely dissipated. With impacts of the same force, greater vehicular damage means less force dissipated by the occupants. Less force to the occupants logically correlates with less injury. The speed at impact and the extent of vehicular damage are often inversely proportional to the extent of neck injury in rear-end impacts.

The head weighs approximately 12 to 15 pounds and is at the end of a long, flexible lever arm, which acts like a whip in the presence of rapid acceleration and deceleration. The hyperflexion experienced by the cervical spine may be further exaggerated by the shoulder harness seat belt. Because this device prohibits the chest from coming forward, it facilitates a more forceful whipping of the head and neck.

CAD trauma is characterized by various signs and symptoms, including these radiographic features: fractures, dislocations, kyphotic angulation, reduced and reversed sagittal cervical curves, and soft-tissues injuries. In addition, vertigo, neck and shoulder pain, upper extremity paraesthesia, tinnitus, impaired cognitive function, and visual disturbances have been reported after CAD traumas.

There has been inconsistency about the diagnostic criteria for CAD injuries and indications for management and rehabilitation. The Quebec Task Force on Whiplash-Associated Disorders attempted to answer some of the basic questions concerning these type of injuries, later published in a condensed version as a supplement. The Task Force was charged with making specific recommendations about epidemiology, the mechanisms of injury, clinical definitions and syndromes, natural history, evidence of effectiveness of prevention, treatment and rehabilitation, the role of psychological factors, and the impact of the health services system in general to formulate a rational approach to the problem. More than 10,000 scientific papers were reviewed; only 62 met the criteria. This report has not been without its share of criticism; however, it may well have opened the door for better and improved research for CAD injuries.
This article documents the program of care and outcome of a patient involved in a lateral-impact motor vehicle collision with radiographic signs of a kyphotic angulation of the C3/C4 and C4/C5 motor segments along with vertigo, tinnitus, neck and shoulder pain, and confusion.

**CASE REPORT**

A 17-year-old female patient with no prior history of cervical spine trauma was involved in a motor vehicle collision. She was driving through an intersection when the vehicle was struck on the driver’s side by an oncoming vehicle. Immediately after the collision, she had neck and shoulder pain, headache, dizziness, confusion, and ear noises. Short-term memory loss and fainting spells began 2 days after trauma. The vehicle that hit her vehicle was traveling at an estimated speed of 25 to 30 mph. The patient was transported by ambulance to a local hospital and released with a diagnosis of cervical spine sprain/strain and a prescription for pain relievers and muscle relaxers.

She sought care at our chiropractic clinic 16 days after trauma. Initial physical examination revealed a series of positive orthopedic neurologic findings. Valsalva’s maneuver produced pain in the neck and shoulders bilaterally; cervical distraction relieved pain in the neck and shoulders; shoulder depression on the left and right elicited pain in the left lower cervical region and upper left shoulder; Soto-Hall sign manifested pain in the lower cervical region; and maximal foraminal compression could not be performed because of pain. A grade 4 deficit was found in the left middle deltoid and left psoas. Palpation demonstrated pain, tenderness, and edema throughout the cervical spine and edema in the lower lumbar region, and her right upper abdominal quadrant was tender. A ½-inch apparent right short leg was recorded on prone examination. There was a loss of light-touch sensitivity in the left C6 and C7 dermatome patterns as tested by Morton’s pinwheel; her grip strength, as tested by JAMAR dynamometer, was 25 lbs in the left hand and 48 lbs in the right hand.

The initial radiographic examination demonstrated a reversed cervical curve with an arcan kyphosis at the C3/C4 and C4/C5 motor segments. There was a 4-mm anterior horizontal displacement of C3 on C4 with 14 degrees of angular displacement. A 2.5-mm anterior horizontal displacement was noted at C4 on C5 with 9 degrees of angular displacement (Fig 1). The measurement procedures for determining horizontal displacement and angular displacement have been described. This research concluded that no motion segment with less than 2.7 mm of translation could be considered unstable. In addition, acute horizontal displacements exceeding 3.5 mm on neutral lateral roentgenogram of the cervical spine of the acutely injured adult population can be considered abnormal, indicating that the spine is unstable or on the brink of instability. The upper limit of physiologic angular displacement was determined to be 10.7 degrees with the conclusion that angulation of more than 11 degrees of the vertebra in question is unstable. The C3/C4 motor segment was determined to be unstable or on the brink of instability with these measurements.

Flexion/extension radiographs of the cervical spine were obtained from the initial examination with close supervision because of positive neurologic findings (Fig 2. Left and Right). The flexion view demonstrated an increase in horizontal translation of C3 on C4, whereas the extension view slightly reduced it with no apparent change to the C4/C5 motor segment. The flexion/extension views were used to aid in determining the extent of injury to the cervical spine and to measure the intersegmental motion at each motor segment. Webb et al noted that when horizontal and angular displacement are present on neutral lateral projections and not exaggerated with flexion, this represents less tearing of the ligamentous structures and delayed instability may be less frequent in these patients. Sche noted that results may be obscured by muscle spasm and/or associated pain.

The Penning study was performed to evaluate intersegmental motion in the cervical spine. Significant cervical spine hypomobility suggests that muscle spasm may have played a role in stabilizing the acute injury. Although the C3/C4 and C4/C5 motor segments have a significantly reduced intersegmental motion, they are hypermobile relative to the rest of the cervical spine. The Penning analysis is accomplished with the flexion and extension neutral, lateral cervical radiograph. In this study, the flexion film was superimposed onto the extension film. A 14 in x 17 in transparent film was anchored between the superimposed films for the purpose of recording. With C7 matched up between the flexion and extension radiographs, a line was drawn across the top of the flexion radio-
graphs onto the transparent film. This same procedure was repeated for C6 and each vertebrae in the cervical spine, including C1. An angle was measured at the intersection of the lines formed from the superimposing of C7 and C6. This procedure was duplicated for each motor segment in the cervical spine. Care was taken to restrict any movement of the extension radiograph or the transparent film. The extension radiograph was taped to the view box and the transparent film was fastened to the view box. Dvorak et al. have found clinical value in the evaluation of functional flexion/extension radiographs measured according to previous research. They found statistically significant differences between cervical-related disorders and a healthy population.

The method of Jochumsen and Yochum and Rowe was used to measure the cervical sagittal curve. A line is drawn from the anterior border of the atlas anterior tubercle to the anterosuperior corner of the 7th cervical body. The distance from this line to the anterior border of the 5th cervical body is then measured, with 3 to 8 mm average, 1 mm minimum, and 9 mm maximum. Anything less than 1 mm is considered a hypolordotic cervical curve; measurements greater than 9 mm are considered hyperlordotic. Jochumsen studied 500 neutral, lateral cervical radiographs to compare his constructed method with the Drexler method of measuring the cervical curve in which the degree of flexion between each individual cervical vertebrae is measured. The Drexler method has been considered an accurate, although laborious, way to measure the cervical curve. Jochumsen identified 6 distinct shapes of cervical curves: hyperlordosis, mean lordosis, hypolordosis, alordosis, kyphosis, and kypholordosis. The kypholordosis represents a cervical spine kyphotic in the lower cervical spine and lordotic in the upper region. Jochumsen demonstrated through analysis of the 500 cervical lateral spinographs that his proposed technique correlated well with the Drexler method in identifying 5 of the 6 distinct shapes of the cervical spine. The Jochumsen method does not compare as well in identifying the kypholordotic cervical curve.

The initial neutral lateral radiograph was performed before the intervention of an upper cervical adjustment. The Jochumsen measurement was -8 mm (Fig 3) and was considered kyphotic.

A cognitive function test was ordered to evaluate specific neurocognitive function. The examination was performed with the Microcog: Assessment of Cognitive Functioning (MACF), a computer-administered and scored test that assesses important neurocognitive functions in adults. Attention/mental control, memory, reasoning/calculation, spatial processing, reaction time, information-processing speed and accuracy, general cognitive functioning, and proficiency are profiled. Reliability for the index scores ranges from .83 to .95. Decision consistency percentages also suggest that decisions made about individuals over time are consistent. Studies about the specificity and sensitivity of MACF to discriminate among a variety of clinical groups and studies of special clinical groups have been performed. The results of these studies provide evidence of the convergent and discriminate validity of MACF.

Initial symptoms of confusion and short-term memory loss were the rationale for requisition of the MACF examination. Medication and/or pain have been documented to create variables in the neurocognitive examination. Therefore MACF was not ordered until 2 weeks after the start of
The STDA records readings on a graph display. STDA graphs are interpreted by analyzing the similarity to the patients' previous graphs. Constant breaks that are significantly similar within the graph readings are identified and collectively compose the patient's specific subluxation pattern. Each person with an upper cervical subluxation is presumed to display a unique asymmetrical temperature differential considered to be his or her subluxation pattern. Before the first upper cervical adjustment is performed, 2 or more graphs are recorded to establish a static and persistent constant pattern to confirm the presence of a vertebral subluxation. An STDA was performed for the patient during each office visit and was the criterion used to determine the presence or absence of the upper cervical subluxation and when to administer an upper cervical adjustment.

The atlas (C1) listing was determined through radiographic analysis to be posterior, inferior, and right (PIR), representing the misaligned position of the atlas in relation to the occipital condyles. The atlas had misaligned posterior to the occipital condyles on both articulations, with the right lateral mass tracking on the right condyle and the left lateral mass sliding underneath the left condyle. When the atlas moves posterior in relation to its corresponding condyle, it must also move inferior as a result of the anatomic shape of the condylar-atlantal joint. As the atlas tracked posteriorly on the right condyle along its convergence angle, it was moving with right laterality. Therefore there was a 3-directional or torqued misalignment of the atlas with a PIR spinal listing.

Each upper cervical subluxation has a unique torqued misalignment because of the different shapes and sizes of the atlas and axis from one person to the next. For example, a PIR on one patient will differ from a PIR on another patient because one may have more laterality whereas the other has more posteriority and inferiority. These percentages are calculated before a specific adjustment is performed. The 3 directions of misalignment should be considered for consistent correction of the upper cervical subluxation.

The upper cervical adjustments were performed on a knee-chest table with a solid head piece. With PIR spinal listing, the patient was instructed to place her mid-sternal notch on the front of the knee-chest table while turning her head to the right. The left side of her head was placed on the table. She was instructed to relax, laying her shoulders and left side of her neck on the table. The first adjustment performed on the 2nd office visit was challenging because of the pain level of the patient but was performed without incident. For the thrust, a contact was made with the pisiform of the right hand on the soft tissue covering the posterior arch of atlas. A tissue pull and roll in of the right arched hand preceded the contact of the right posterior arch of atlas. This procedure was performed to remove slack from the soft tissue covering the contact point, permitting a smoother set. The left hand was placed over and around the right hand in a criss-cross fashion to produce the mechanics necessary for a torque toggle action at the moment of the thrust to correct the 3-directional misalignment. A high-velocity, low-amplitude torque and toggle thrust was administered. Immediately after the spinal adjustment (Sept 12, 1997).

The initial examination was performed 4 days after the first adjustment. Our clinical opinion was that the former concerns about the introduction of variables as a result of medication and pain outweighed the latter concerns about assessments conducted after short-term clinical improvements had been realized.

An audiometric examination was performed with a Beltone Series 109 instrument and ear cups (Beltone, Chicago, Ill). We tested 11 different frequencies: 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 dB. At each frequency, the instrument was calibrated so that 0 dB, the loudness for which a normal hearing person can barely perceive sound at a given frequency, was considered normal. When loudness of the tone must be increased to 40 dB above the normal detection, for example, that patient is said to have a hearing loss of 40 dB at the frequency level. The initial examination was performed 4 days after the first upper cervical adjustment.

A bilateral skin temperature differential analysis (STDA) performed paraspinally was used to detect aberrant neurophysiologic function in the cervical spine interpreted as a vertebral subluxation. Skin temperatures are constantly changing as a function of the adaptive processes throughout the entire human system. Although changing, temperatures should remain symmetrical from one side to the other. Asymmetrical, static, and persistent temperature differentials observed paraspinally indicate aberrant neurophysiology because thermal adaptation is a function of the nerve system.

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correction, the patient was instructed to rest supine in a rest-

The clinician, with the patient’s consent, decided to stop all

All the entrance symptoms stopped after the 10 weeks of
care and 22 office visits. A physical examination revealed no
abnormal findings, with the exception of tenderness in the
right upper cervical region on palpation. Evidence from
thermographic readings (STDAs) indicated normal neuro-
physiologic function in the cervical spine. A normal cervical
sagittal curve was achieved with the arcual kyphosis initially
described at the C3/C4 and C4/C5 motor segments com-
pletely resolved within 5 weeks after the first upper cervical
adjustment (Fig 4). A second set of flexion/extension cervi-
cal radiographs were made 5 weeks after the initiation of
care and revealed improved intersegmental motion in the
cervical spine. Four weeks after the first cognitive function
test, a second test was performed. A 2nd examination was
performed 7½ months after the first audiometric examina-
tion and revealed improved audiologic function in the lowest
and highest frequencies. Normal balance was recorded in
the 7th week of the care program.

DISCUSSION

Arcual Kyphosis

Arcual kyphosis has been characterized by Green et al42
with the following 6 radiographic findings: (1) a localized
kyphotic angulation of the cervical spine limited to the
level(s) of the ligamentous disruption; (2) anterior rotation
and/or slight (1- to 3-mm) displacement of the subluxed
vertebra; (3) anterior narrowing and posterior widening of the
intervertebral disk space; (4) increase in the distance between
the posterior cortex of the articular masses of the subjacent
vertebra; (5) anterior and superior displacement of the su-
perior facets of the involved interfacetal joints with respect to
their contiguous inferior facets with resultant widening of the
posterior aspect of the interfacetal joint space; (6) abnormal
widening of the involved interspinous space (“fanning”).

In a retrospective study,\textsuperscript{42} 25 out of 25 cases displayed 1,
2, 3, and 6 of the six radiographic findings. A total of 16 of
25 displayed 4 and 5 of the six radiographic findings. Our
case demonstrates all 6 criteria for C3/C4 and criteria 1, 2, 3,
and 6 for the C4/C5 motor segment.

Flexion of the cervical spine exaggerates these findings.
Extension can either reverse or reduce the angular kyphosis.

Dynamic stress studies in flexion/extension should be per-
formed after ruling out fracture and dislocation. Extreme
cautions should be taken when there is evidence of positive
neurologic findings in the presence of an arcual kyphosis.\textsuperscript{43}

Arcual kyphosis is a ligamentous flexion injury involving
the posterior longitudinal ligament and the posterior liga-
ment complex.\textsuperscript{16} The C5/C6 motor segment is the most
commonly affected area. There is an approximately 20% inci-
dence of delayed instability because of an inability of the
injured tissues to repair.\textsuperscript{42} In this case, the angulated
superior vertebra remains free to move within its abnormal
range of motion. This occurs in flexion in particular, making
further deterioration of the radiographic findings likely at a
later date. Regardless of whether there is a delayed instabili-
ty, without proper management in a reasonable period of
time the patient is likely to experience the effects of exag-
gerated degenerative changes as a part of the aging process.

The significant question with these injuries is about sta-
bility. How stable is each individual case? There have been
definitions offered and criteria to follow to understand this
issue. Researchers\textsuperscript{13,14} have defined clinical instability as
"the loss of the ability of the spine under physiologic loads
to maintain relationships between vertebrae, in such a way
that there is neither damage nor subsequent irritation to the
spinal cord or nerve roots and, in addition, no development
of deformity with excessive pain."

White et al\textsuperscript{15} submitted guidelines for the evaluation of
clinical stability of the adult cervical spine. If any of the 3
following conditions exist, the spine is unstable or on the
brink of instability.

\textbf{Fig 4. Third cervical lateral radiograph taken after 5 weeks of spe-
cific chiropractic care (Oct 17, 1997).}
1. Either all the anterior elements or all the posterior elements are destroyed or unable to function.
2. More than 3.5 mm horizontal displacement of 1 vertebra in relation to an adjacent vertebra, anteriorly or posteriorly, measured on resting lateral or flexion/extension roentgenogram of the spine.
3. More than 11 degrees of rotational difference to that of either adjacent vertebra, measured on a resting lateral or flexion/extension roentgenogram.

Measurement reveals that this patient entered the clinic in an unstable condition or on the brink of instability 16 days after trauma. She was released from the hospital with a diagnosis of sprain/strain of the cervical spine and was placed on over-the-counter and prescription pain relievers and muscle relaxers. The muscle spasm is a defense mechanism the nervous system may use to support an unstable condition and can be viewed as a protective mechanism. Hubbard noted that muscle spasm occurred in 42.8% of patients with unstable injuries. Muscle spasm was found in only 3.5% of stable injuries. In the presence of a suspected unstable condition, any detected muscle spasm should not be reduced chemically; artificial reduction may further destabilize the injury.

At first glance, the flexion/extension cervical radiographs taken 5 weeks after the initiation of care appear to be moving toward normal intersegmental motion. Although the C3/C4 and C4/C5 motor segments have motion within normal limits, a closer examination reveals that relative to the other units measured, there is an overall increase in motion at these segments. Dvorak et al described relative hypermobilities and hypomobilities as meaningful when analyzing the stability of an individual motor segment. They suggest that although a motion may not appear to behave abnormally, the results should be compared with those of the surrounding segments to determine if abnormality exists at a certain level. When comparing the initial flexion/extension radiographs with the flexion/extension radiograph performed 5 weeks after the beginning of chiropractic care, the initial flexion/extension radiographs demonstrate a greater relative difference between hypermobility of the C3/C4 and C4/C5 motor segments compared with the rest of the cervical spine.

The neutral, lateral cervical radiograph taken 5 weeks after the initiation of care depicts a normal cervical curve with a normal relation between each motor segment. The second neutral lateral film taken 4 days after one upper cervical adjustment demonstrates a cervical spine that is stable according to the definitions recorded, although a reduced cervical curve is present.

Cognitive Function

Cervical spine trauma can lead to impaired cognitive function. Attentional deficits are the most common; however, particular attention and deficient memory may exist. Radanov and Dvorak observed attentional functioning in a nonselected symptomatic group of 117 whiplash patients for 2 years after trauma. They concluded that cognitive disturbances caused by whiplash injury show a fair rate of recovery. However, their statistics demonstrate a “breakdown” of cognitive functioning after the initial improvements seen in the first 6 months.

Whiplash trauma can potentially cause injury to the medulla. Hammer and Alistair and McCleary propose that the medulla may receive insult by the posterior arch of the atlas or the base of the occipital condyles. The anatomic relation between the medulla and upper cervical spine gives credence to this mechanism. Guyton and Hall recorded that the brain must receive impulses from the brain stem on a continual basis to function properly. Altered brain stem function may account for the attentional deficits, particular attention, and deficient memory. Edema, the natural response to injury, may occur as a result of damage to structures protecting the medulla, possibly increasing the pressure in the neural canal, foramen magnum, and even the cranial vault. The increase of pressure in this closed system would be temporary and could account for short-term altered central nervous system function. In addition, injury to neuronal tissue may cause interruption of neural pathways leading to disturbances of specific mental functions. When neuronal and surrounding support tissue repair, it may well bring mental function back to its original state. This mechanism appears to be consistent with the Radanov and Dvorak statistical data that recovery is often noted in the first 6 months after trauma. These investigators postulated that impaired cognitive function was directly or indirectly caused by pain. However, somatic symptoms have been shown to continue for extended periods of time after cervical acceleration/deceleration trauma, whereas impaired cognitive function “sho[s] a fair rate of recovery.”

Audiometric Function

Hulse investigated 259 patients with well-defined functional deficits of the upper cervical spine. Cervical vertigo and subjective hearing loss occurred in 15%, whereas audiometric threshold shifts of 5 to 25 dB, most often in lower frequencies, were observed in 40%. A total of 62 patients underwent chiropractic care directed at the upper cervical spine. Hulse further concluded that chiropractic management was the care of choice for this disorder. Palmer and Sherman demonstrated an increase in the audiologic function in a population of 1029 cases before and after upper cervical-specific chiropractic care.

We were unable to quantify the symptoms of vertigo objectively. However, normal balance was recorded by the 7th week of the care program. Vertigo has been reported as the result of whiplash injury. Other authors have studied the relation between the upper cervical spine and vertigo.

CONCLUSION

The purpose of this case study was to document changes after upper cervical-specific chiropractic adjustments in a cervical trauma case and to note a practical application of conservative care for cervical spine injury after trauma. It is noteworthy that no cervical adjustments were directly administered to the C3/C4 motor segment that was deter-
minded unstable or on the brink of instability, yet complete repair was observed.

Spontaneous remission is possible considering the radiographic changes. However, a few factors weigh against this conclusion. The amount of horizontal translation and angular displacement observed in this case depicted significant injury to the posterior ligaments. Twenty percent of these types of injuries that are not already unstable become unstable in the future. Kyphotic angulation is evidence of injury to the posterior ligaments and is also observed in the chronic phase of injury. Therefore the reduction of muscle spasm is not likely to have corrected the cervical sagittal curve, horizontal translation, and angular displacement. A muscle spasm in the cervical spine would have a tendency to increase the sagittal curve or produce rotational displacement as a result of the stronger extensor musculature in the cervical region. Helliwell et al reported that the loss of cervical sagittal curve does not indicate muscle spasm.

The first specific atlas adjustment was administered 17 days after trauma; four days later, pivotal changes were confirmed by neutral lateral radiography. The patient had taken muscle relaxers and prescription medication for 16 consecutive days before with presumably little relief of the symptoms. Our opinion is that the atlas subluxation correction and all its ramifications caused the cervical curve to return to normal and repair the C3/C4 and C4/C5 motor segments. A combination of improved neuronal function and return of the gravity center to a more conducive position for cervical curve restoration occurred when the atlas misalignment was reestablished to its normal articular pattern. This is consistent with the relatively rapid recovery of postural integrity in the cervical spine.

The occipito-atlanto-axial junction is pivotal in determination of the gravity center. With upper cervical malposition, inherent deviations in the center of gravity occur as a result of the alteration of the cranio-vertebral junction. In the event of an upper cervical subluxation, the rest of the spine and pelvis can be used through compensatory curves and misalignments to resume gravity weight-bearing. With injured cervical spine soft tissue, such as the posterior longitudinal ligament noted here, a balanced cranio-vertebral junction may be necessary for curve restoration. Shifts in the balance of the upper cervical region may be necessary for curve restoration and may cause further destruction to the postural integrity of the cervical spine. Neuronal dysfunction may also interfere with the normal healing process of injured supporting soft tissue in the cervical spine. Our opinion is that weight bearing shifted to a more normal position and neuronal function improved with the correction of the atlas subluxation.

Some investigators have found a link between the function of the medulla and postural control of the entire system, especially the spinal column. Palmer noted that curvatures in the spine resulted from adaptation of a torqued misalignment of C1 and/or C2, causing neurologic interference. The negative influence that a torqued misaligned C1 and/or C2 can have on the function of the medulla may interfere with the normal recovery of the postural integrity. There appears to be an interrelation between spinal balance and neuronal function.

Upper cervical-specific care should be considered for the management of the classic CAD whiplash injury. Many of the syndromes associated with CAD traumas can be attributed to the upper cervical region. In contrast to the findings of the Quebec Task Force on Whiplash-Associated Disorders, the adjustment had a significant role in the long-term correction of this case. The Task Force panel of experts took into consideration only two of the more than 10,000 studies concerning manipulation considered for review. Both studies consisted of nonspecific gross manipulation without any objective criteria as to where, when, or how to make the manipulation. They observed short-term proprioceptive response without long-term benefit.

A case study is limited to what conclusions may be drawn from its results but does provide a starting point. Much investigation is necessary to make definite conclusions about the effectiveness of any care program. Further research is necessary to determine what role the upper cervical spine has in such trauma cases and what mechanisms are at work.

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