

Logan College of Chiropractic

Senior Research Project

A Literature Review of the Effect of Loss of
Cervical Lordosis on the Spinal Cord and
Nervous System

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Abstract

Objective: To provide a review of the literature on the effects on the spinal cord of losing the natural cervical lordosis.

Introduction: The loss of cervical lordosis is a common finding when a radiograph is taken of the cervical spine. There is a percentage of chiropractic physicians who use the measurement of the cervical lordosis as a primary outcome measurement, regardless of symptoms. It is important to understand the true effects of losing the cervical curve on the spinal cord if restoration is a primary outcome measurement. It is also important to understand if this is a treatment of a condition or a prevention of future conditions or a combination of the two.

Data Collection: The sources for this literature review were found using Pub Med, various journals and articles, and radiology textbooks

Data Synthesis: Loss of cervical lordosis is a complicating factor in treatment of the cervical spine. Understanding the effects and prognosis of a loss of cervical lordosis is crucial to the treatment of the cervical spine.

Conclusion: Given the severity of long term effects noted from losing the cervical lordosis, chiropractors must consider cervical lordosis restoration or maintenance a primary treatment outcome measure in the treatment of patients with cervical lordosis measurements less than 35 degrees. Authors have noted that there is currently a lack of clinical evidence of the chiropractors' ability to significantly change the cervical lordosis. However, lack of evidence for effective treatment does not reduce the significance of the spinal cord pathology associated with loss of cervical lordosis.

Key Words: *Cervical lordosis, cervical spine*

Introduction

Cervical lordosis has become a significant outcome measure for many chiropractic practitioners. The condition of the cervical lordosis (or curve) is an important concern that is gaining more support among practicing doctors of chiropractic. Many authors have stressed the lack of correlation between altered cervical spine curvature to symptomatology and its limitations as a prognostic indicator¹. However, many clinicians agree that symptom reduction should not be the primary goal of treatment.

The cervical lordosis should measure between 35 and 45 degrees radiographically measured using the Drexler Method¹. In 1977, Bagnall et al² demonstrated that the cervical lordotic curve is formed at 9.5 weeks in intrauterine life. In 195 fetuses, Bagnall et al found that by 9.5 weeks, 83% of fetuses have a cervical lordosis, 11% have a military configuration, and only 6% of fetuses are in the kyphotic position of the cervical spine. In other words, by 9.5 weeks 94% of the fetuses are starting to use their posterior cervical muscles to begin forming the cervical curve, even before the extra uterine effects of gravity begin to train the anti-gravity muscles of the posterior cervical spine. The lordosis begins to form before birth and once the child begins to lift his/her head, the lordosis becomes more apparent. The cervical lordosis has been theorized to exist for biomechanical reasons of weight distribution, structural support, energy efficiency, and shock absorbing. The cervical lordosis is utilized to better disperse forces introduced by daily activity as opposed to a cervical spine which has lost its normal lordosis³.

Loss of the cervical lordosis can be the result of trauma, degenerative processes, congenital defects, posture or post surgical complications⁵. Women are more likely to lose

the cervical lordosis with an odds ratio of 2.81¹³. Loss of normal cervical lordosis has been theorized to contribute to decreased range of motion, precipitate pain, and lead to other health problems⁴. Authors have noted the relationship between flexion of the cervical spine and abnormal changes in the spinal cord⁶, cervical spondylotic myelopathy associated with forward flexion of the cervical spine⁷, decreased spinal cord width while in forward flexion⁸, decreased length of the spinal cord while in flexion⁹, degeneration of the dura¹⁰, demyelination of the spinal cord and neuronal loss¹¹, and possibly an early death¹².

Discussion

A reduction from the normal 35-45 degree cervical curve or a complete loss of cervical curve is common in the general population. The gold standard for measuring cervical lordosis is utilizing the Drexler¹. The Drexler Method is just one of many ways of measuring the cervical lordosis, which makes inter examiner reliability questionable if practitioners are using different methods.

In the cervical spine a neutral lateral cervical film is taken in order to evaluate the curvature of the cervical spine.. Once this measurement has been made, there are numerous methods to measure the cervical lordosis in a weight bearing position.

- Method of Drexler—from a neutral lateral cervical spine projection these measurement may be assessed. This is a more laborious but accurate method. Each individual segment is assessed by drawing lines along the body endplates and measuring the resultant angle. The lordosis measurement is the cumulative of each individual measurements.

- Method of Gore—from a neutral lateral cervical spine projection, a line is drawn through the posterior surface of the C2 body and another line through the posterior surface of the C7 body. The angle formed by these two lines is measured.
- Cervical gravity line—from a neutral lateral cervical spine projection, a vertical line is drawn through the apex of the odontoid process. This line should pass through the body of the seventh cervical vertebrae. The line will intersect any portion of the C7 vertebral body. The cervical gravity line allows a gross assessment of where the gravitational stresses are acting at the cervicothoracic junction
- Depth of Cervical Curve—from a neutral lateral cervical spine projection, a line is drawn from the superior posterior aspect of the odontoid to the posterior inferior corner of C7. The greatest transverse distance between this line and the posterior vertebral bodies is measured.
- Method of Jochumsen—from a neutral lateral cervical spine projection, a line is drawn from the anterior border of the atlas anterior tubercle to the anterosuperior corner of the C7 body. The distance from this line to the anterior border of the C5 body is then measured.
- Angle of the cervical curve—from a neutral lateral cervical spine projection, two lines are drawn. One line is drawn through and parallel to the inferior endplate of the C7 body and the other line is drawn through the midpoints of the anterior and posterior tubercles of the atlas. Perpendiculars are then constructed to the point of intersection, the resultant angle is measured

Non-radiographic methods of analyzing cervical lordosis

Due to the fact that radiography is sometimes contraindicated or a chiropractic physician may not have access to an x-ray unit, other means of analyzing the cervical lordosis can be utilized. One application which can be used on Apple products such as the iPhone or iPad is the Posture Screen Mobile. The doctor can see functional muscle imbalances, static postural distortions, anterior head carriage and uneven weight distributions all from the Posture Screen Mobile application. However, the doctor is unable to determine the degree of cervical curvature or if the patient has a full reversal of the cervical spine. Depending on the practitioner and the technique utilized, this may or may not influence treatment.

With poor posture, prolonged periods of sitting, sedentary lifestyle, and obesity all acting as contributing factors⁵, it's easy to see why many individuals no longer have an intact cervical lordosis. The condition is common but it is not normal¹. Authors have noted spinal cord changes which result from flexion of the cervical spine and cervical kyphosis^{6,7,8,9,10,11,12}. However, the clinical significance in a chiropractic office remains controversial. Traditionally, the clinical implication of a reduced cervical lordosis is secondary to a muscle spasm or muscle imbalance. Muscle imbalances are common with sedentary lifestyle and prolonged periods of sitting throughout life, however there is a specific term used to describe a pattern of muscle imbalance called "upper crossed syndrome" which causes one to lose the cervical lordosis due to muscle imbalance in the neck.

Upper Crossed Syndrome

Upper crossed syndrome is a result of weak deep neck flexors (anterior scalene) and scapular stabilizers to the tightening (shortening) of the anterior chest muscles and the posterior neck muscles. Upper crossed syndrome has become more prevalent with the increased occurrence of sedentary lifestyle. With a sitting posture, the shoulder blades roll forward, the head shifts anteriorly, the shoulder blades round out, the anterior neck muscles shorten, the anterior deltoids shorten and the posterior neck muscles elongate. Upper crossed syndrome creates a host of biomechanical problems and significantly contributes to many musculoskeletal problems such as shoulder problems, thoracic outlet syndrome, carpal tunnel syndrome, myofascial pain syndrome and tension, migraine and cervicogenic headaches.

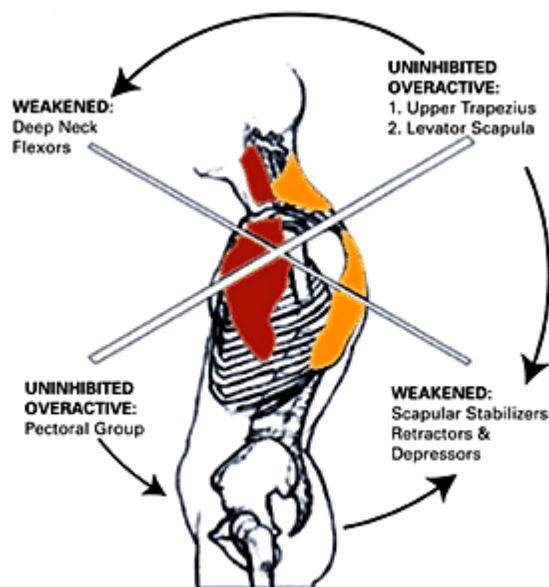


Figure 1: Illustration of upper crossed syndrome and the associated muscle imbalances

Shoulder Problems

An anterior tilt and abduction of the shoulder blades occur, producing an uneven biomechanical strain on the glenoid fossa. The humerus now requires additional stabilizations from muscles that typically are not used for stabilization such as the levator scapulae, upper

trapezius, subscapularis, pectoralis minor, sub-occipitals and supraspinatus muscles. Upper crossed leads to further shoulder complications later in life if not treated such as shoulder impingements, tendonitis and bursitis syndromes. Due to poor ergonomics, people who sit at a desk all day are most susceptible.

Headaches

Headaches known as Tension Type Headaches, the most frequent type of headache in adults, are caused by the tension in the posterior cervical musculature. Studies suggest one-year prevalence rates of 38.3% for episodic tension headaches and 2.2% for chronic tension headaches²⁸.

Excessive forward head posture has been related to cervicogenic headaches as well²⁹. Cervicogenic headaches are different from tension type headaches in their diagnosis and treatment. Jensen reports cervicogenic headaches are reported to have an incidence as high as 18% of the general population³³. However, other sources estimate a prevalence rate between 0.4% and 2.5%. Authors say that pain management clinics see a prevalence as high as 20% of patients with chronic headache³⁴. Cervicogenic headaches are referred from bony structures or soft tissues in the neck. They are often from head or neck injury but may also occur without trauma. The Cervicogenic Headache International Study Group developed a criteria for diagnosing cervicogenic headaches. There are three diagnostic criteria which fortifies the diagnosis of cervicogenic headaches. These three diagnostic criteria are³⁶:

1. Precipitation of head pain, similar to the usually occurring (provocation)

- a. By neck movements and/or sustained awkward head positioning (suffices as the sole criterion for positivity within the group, and/or:
 - b. By external pressure over the upper cervical or occipital region on the symptomatic side
2. Restriction of range of motion in the neck
 3. Ipsilateral neck, shoulder, or arm pain of a rather vague nonradicular nature, or occasionally arm pain of a radicular nature.

Figure 2 illustrates additional findings which can help to rule in or rule out the diagnosis of cervicogenic headaches..

Checklist

MAJOR CRITERIA

■ Point I—Symptoms and Signs of Neck Involvement

(listed in a surmised sequence of importance; obligatory that one or more of phenomena are present)

- Precipitation of head pain, similar to the usually occurring (suffices as the sole criterion for positivity)*:
 - by neck movement and/or sustained awkward head positioning (suffices as the sole criterion for positivity within group, and/or:
 - by external pressure over the upper cervical or occipital region on the symptomatic side

(Provisionally, the combination of the following two points has been set forth as a satisfactory combination within Point 1)

- Restriction of the range of motion (ROM) in the neck*
- Ipsilateral neck, shoulder, or arm pain of a rather vague nonradicular nature or, occasionally, arm pain of a radicular nature*

■ Point II—Confirmatory Evidence by Diagnostic Anesthetic Blockades

(This is an obligatory point in scientific works.)

■ Point III—Unilaterality of the Head Pain, Without Sideshift

(For scientific work, Point III should preferably be adhered to.)

HEAD PAIN CHARACTERISTICS

■ Point IV

(None of the following points is obligatory)

- Moderate to severe, nonthrobbing, and nonlancinating pain, usually starting in the neck
- Episodes of varying duration, or
- Fluctuating, continuous pain

OTHER CHARACTERISTICS OF SOME IMPORTANCE

■ Point V

(None of the following points is obligatory)

- Only marginal effect or lack of effect of indomethacin
- Only marginal effect or lack of effect of ergotamine and sumatriptan succinate
 - (c) female sex
 - (d) not infrequent occurrence of head or indirect neck trauma by history, usually of more than only medium severity

OTHER FEATURES OF LESSER IMPORTANCE

■ Point VI

- Various attack-related phenomena, only occasionally present:
 - nausea
 - phonophobia and photophobia
 - dizziness
 - ipsilateral “blurred vision”
 - difficulties on swallowing
 - ipsilateral edema, mostly in the periocular area

*The presence of all three points indicated with asterisk fortifies the diagnosis (but still Point II is an additional obligatory point for scientific work).

Figure 2: *The Cervicogenic Headache International Study Group Diagnostic Criteria. (Modified from Biondi DM: Cervicogenic headache: mechanisms, evaluation, and treatment strategies. J Am Osteopath Assoc. 2000;100(9 Suppl):S7-14. Source: Sjaastad O, Fredriksen TA, Pfaffenrath V. Cervicogenic headache: diagnostic criteria. Headache. 1998;38:442-445.)*

The Journal of Manual and Manipulative Therapy found manipulation to be effective in the treatment of cervicogenic headaches³⁵. Given that upper crossed syndrome has been associated with cervicogenic headaches and the loss of cervical lordosis, the condition of upper crossed syndrome is a significant contributing factor in the causality and symptomatology associated with the loss of cervical lordosis.

Myofascial Pain Syndrome

Myofascial pain syndrome is characterized by chronic pain caused by multiple trigger points and fascial problems³⁷. With myofascial pain syndrome, the pain radiates with trigger point pressure and there is often a feeling of pseudo-weakness in involved musculature with restrictions in motion following approximately 5 seconds of sustained pressure. Pain intensity can range from mild intensity to “lightning-like” pain. Poor posture might contribute to the cause of myofascial pain syndrome or irritate an already existing condition³⁸. Upper crossed syndrome alters posture and may contribute to myofascial pain syndrome.

Thoracic Outlet Syndrome

Due to the muscle imbalances created by upper crossed syndrome, thoracic outlet syndrome can be caused by upper crossed syndrome. One of the chief muscles involved is the pectoralis minor. When the pectoralis minor becomes shortened due to overactive anterior musculature and anteriorly rounding of the shoulders, the nerves and arteries exiting the thoracic outlet can become compromised due to abnormal compression from the pectoralis minor, clavicle or anterior scalene³⁹. Other causes of thoracic outlet exist such as a cervical rib, pancoast tumor or abnormal pressure effects from pregnancy. However, authors suggest that a primary

non-traumatic or non-congenital cause of many nerve entrapment syndromes may be from muscle imbalances such as upper crossed syndrome⁴⁰.

Effects on Neurology

Altered patterns of cervical lordosis can also be from patient positioning, ligament damage, or post surgical complications¹⁹. While there cause can be as simple as a muscle spasm, the effects of prolonged flexion and loss of the normal cervical lordosis can be damaging to the spinal cord. Shimizu et al used an animal model to analyze spinal kyphosis and its relation to the spinal cord. The authors analyzed animals who had laminectomy and bilateral facetectomy at the C4-C5 level. The animals developed a progressive kyphotic deformity of the cervical spine. The angle of the cervical lordosis decreased progressively for 3 weeks post surgery. The authors found that a progressive kyphosis of the cervical spine resulted in demyelination of nerve fibers and neuronal loss in the anterior horn due to chronic compression of the spinal cord. The authors concluded that the histologic changes seemed to be associated with both continuous mechanical compression and vascular changes in the spinal cord. The authors noted a significant correlation between the kyphotic angle and the degree of spinal cord flattening. The demyelination also progressed as the kyphotic deformity became more severe, initially affecting the anterior funiculus and later extending to the lateral and then the posterior funiculus¹¹.

Yuan et al studied human subjections and found that the cervical spinal cord elongates and displaces significantly during head flexion²¹. Unlike the study done by Shimizu, this study does not measure the amount of spinal cord damage or demylenation as it would be hard to measure this with in vivo subjects. Dynamic studies of the cervical spinal cord in flexion showed

the same adverse mechanical tension Yuan et al found in their study²³. When the cervical spine is in flexion, a narrowing of the ventral subarachnoid space of up to 43% occurs along with a widening of the dorsal subarachnoid space of up to 89%²⁴.

Another pathology associated with cervical spine flexion and loss of the cervical lordosis is cervical spondylotic myelopathy. Cervical spondylotic myelopathy is the most common disease of the spinal cord among middle-aged people²⁵. In the pathogenesis of cervical spondylotic myelopathy, mechanical factors have been attributed mainly to a series of clinical symptoms such as protruding discs, cervical stenosis and spondylotic bars. Some authors blame flexion of the cervical spine (kyphosis)^{25,26}. Penning reported the occurrence of adaptive changes in the spinal cord and subarachnoid space in flexion which could contribute to cervical spondylotic myelopathy. Henderson et al concluded that the presence of spinal cord compression in association with abnormal motion or kyphosis strongly predicts clinical progression of cervical spondylotic myelopathy⁷. Henderson describes a “tethering” of the spinal cord which occurs as a result of abnormal stresses from biomechanical changes of the cervical spine creating a local stenosis and causing abnormal shearing and strain in constituent axons. He states that “axonopathy and myelin injury seem to represent the histopathological consequences of stretch-related injury”. Henderson emphasizes the importance of eliminating deformation of the spinal cord, minimizing abnormal mobility and restoring sagittal spinal cord contour. His emphasis on the need for structural correction highlights the need for chiropractors to take an active role in cervical lordosis restoration. Not only do chiropractors increase mobility (as Henderson underscored the need) but chiropractors also aid in restoring sagittal spinal cord contour. Another study by Fujimoto demonstrated similar findings in that degenerative changes of the dura mater were associated with cervical flexion myelopathy¹⁰. Cervical flexion myelopathy is a rare

condition that mainly affects adolescent boys. Avoidance of neck flexion has been advocated as the treatment for cervical flexion myelopathy, and treatment with a cervical collar and surgery in which fusion of the cervical spine is performed have been found to be effective²⁷.

Alfred Brieg, MD stated that “Loss of the cervical curve stretches the spinal cord 5 to 7cm and produces pathological tension”²². Brieg, a neurosurgeon, showed that losing the natural curve resulted in abnormal tension on the hind-brain, cervical cord and cervical nerve roots. Studies have been done on the cervical spinal cord and dura between the levels of C2-T1 to find out how much compressive force is exerted on the cord during flexion of the cervical spine. The force was found to reach 30-40 pound per square inch for a displacement of 3 mm depending on the force exerted by the spinal cord and dura under various degrees of tension⁶. The authors found that this stretched and put pressure against the spinal canal and any projection within it such as a protruding disc. The authors concluded that the anterior component of force exerted on the cord is significant in the pathogenesis of myelopathy and radiculitis, particularly in cervical spondylosis.

Kuwazawa et al found that not only does the spinal cord lengthen and compress against the anterior bodies of the vertebra but also the area of cross sectional view of the cervical cord is also posture-dependant⁸. The examiners had a group of 20 male volunteers. They took an MRI of the volunteers while laying supine and again while erect. They found that area in cross sectional view of the cervical cord was different and posture-dependent. Kuwazawa also found that the length of the cervical cord is longest in cervical flexion⁹ which confirms previous studies.

Conclusion

Studies of the spinal cord in patients who have a radiographically demonstrated kyphotic cervical spine have not been performed. Most of the studies finding histological and pathological effects of the spinal cord due to abnormal posture are done using in vivo subjects in cervical spine flexion. These studies cannot predict the actual biomechanical changes which happen in subjects who lose the natural cervical lordosis. However, given the deteriorative effect demonstrated by prolonged flexion of the cervical spine the practitioner should take note of the subclinical effects of losing the cervical lordosis. Also, given the severity of spinal cord changes from a complete reversal of the cervical curve as demonstrated by the neck flexion studies, chiropractors must consider cervical lordosis restoration or maintenance a primary treatment outcome measure in the treatment of patients with cervical lordosis measurements less than optimal. Chiropractic treatment must also focus on treating the upper crossed syndrome which may be a causative factor in the development of cervical kyphosis. Due to the pathological spinal cord changes associated with chronic flexion and loss of the cervical lordosis, chiropractors must strongly consider structuring wellness treatment protocols to ensure proper spinal maintenance and normal cervical spine configuration. More research must be done to ensure efficacy of treatment in regarding cervical lordosis restoration.

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