

**APPLIED KINESIOLOGY RESEARCH AND
LITERATURE COMPENDIUM:
NECK PAIN CAUSED BY MUSCLE WEAKNESS**

Cervical muscles strength testing: methods and clinical implications. Dvir Z, Prushansky T.

J Manipulative Physiol Ther. 2008 Sep;31(7):518-24.

BACKGROUND: Neck muscles are responsible for directing the head and for maintaining its posture. As a result, the muscular mechanical output is correspondingly moderate but not insignificant as evidenced by a positive therapeutic effect when reconditioning is indicated. **SPECIAL FEATURES:** Cervical muscle strength (CS) measurement and interpretation occupy a unique niche in the domain of muscle performance. Due to the wide variety of devices and protocols, a vast range of strength scores has been reported, denying the formation of reliable reference values. **METHODS:** A literature search based on the keywords "cervical/head/neck" strength was conducted. The search yielded 34 relevant papers which were reviewed according to preset criteria. **SUMMARY: Overall studies indicate that compared to normal subjects patients suffering from neck-related disorders present with significant reduction in CS, whereas women are weaker than men by about 40%.** Noteworthy a significant drop in CS in both sexes is delayed until the seventh decade. In terms of its reproducibility, CS findings have been investigated using primarily relative parameters, and hence, the associated error is not yet established. Therefore, application of CS as a clinical outcome measure, particularly for assessing change due to intervention, should be critically conducted. **Comment:** Evaluation of the strength of neck musculature is an important component of the total assessment of the neck-injured patient. Neurological deficits, pain, disuse, trauma, apprehension, and joint dysfunction can all contribute to strength deficits of various muscles in neck-injured patients. For in office clinical measurement of muscle strength impairments, the MMT is the best tool for this purpose.

Manual therapy in cervical dystonia: case report, Garten H.

Manuelle Medizin 2008;July: 1433-0466.

Abstract: Diagnostics and therapy of a case of cervical dystonia (spasmodic torticollis), a brain-based movement disorder, are presented as an example of a functional neurological approach with techniques of neuromuscular functional assessment (NFA). The diagnostic tools are exclusively simple clinical neurological tests; the therapy uses chiropractic and functional rehabilitative techniques. Carrick [5] presented a study on this disorder in the literature of applied kinesiology before. This case study demonstrates that the application of functional neurological models used in chiropractic neurology provides rewarding results. Therefore emphasis should be laid on the verification of these models by means of modern techniques of neuroscience (fMRI, SPECT, etc.).

Altered sensorimotor integration with cervical spine manipulation. Taylor HH, Murphy B.

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OBJECTIVE: This study investigates changes in the intrinsic inhibitory and facilitatory interactions within the sensorimotor cortex subsequent to a single session of cervical spine manipulation using single- and paired-pulse transcranial magnetic stimulation protocols. **METHOD:** Twelve subjects with a history of reoccurring neck pain participated in this study. Short interval intracortical inhibition, short interval intracortical facilitation (SICF), motor evoked potentials, and cortical silent periods (CSPs) were recorded from the abductor pollicis brevis and the extensor indices proprios muscles of the dominant limb after single- and paired-pulse transcranial magnetic stimulation of the contralateral motor cortex. The experimental

	<p>measures were recorded before and after spinal manipulation of dysfunctional cervical joints, and on a different day after passive head movement. To assess spinal excitability, F wave persistence and amplitudes were recorded after median nerve stimulation at the wrist.</p> <p>RESULTS: After cervical manipulations, there was an increase in SICF, a decrease in short interval intracortical inhibition, and a shortening of the CSP in abductor pollicis brevis. The opposite effect was observed in extensor indices proprios, with a decrease in SICF and a lengthening of the CSP. No motor evoked potentials or F wave response alterations were observed, and no changes were observed after the control condition. CONCLUSION: Spinal manipulation of dysfunctional cervical joints may alter specific central corticomotor facilitatory and inhibitory neural processing and cortical motor control of 2 upper limb muscles in a muscle-specific manner. This suggests that spinal manipulation may alter sensorimotor integration. These findings may help elucidate mechanisms responsible for the effective relief of pain and restoration of functional ability documented after spinal manipulation.</p> <p>Comment: From its inception AK chiropractic methods have been discovering specific muscle-joint dysfunctions, the correction of which has resulted in immediate muscular response.</p>
<p>Neck flexor muscle fatigue in adolescents with headache - An electromyographic study. Oksanen A, Pöyhönen T, Metsähonkala L, Anttila P, Hiekkänen H, Laimi K, Salminen JJ.</p>	<p><i>Eur J Pain.</i> 2007 Oct;11(7):764-72. Epub 2007 Feb 8.</p> <p>BACKGROUND: Muscular disorders of the neck region may be of importance for the etiology of tension-type headache. However, in adolescents, there are no data on the association between neck muscle fatigue and headache. AIM: To study differences in fatigue characteristics of the neck flexor muscles in adolescents with and without headache. METHODS: A population-based sample of 17-year-old adolescents with migraine-type headache (N=30), tension-type headache (N=29) and healthy controls without headache (N=30) was examined. Surface EMG data were recorded from the sternocleidomastoid (SCM) muscles bilaterally during an isometric neck flexor endurance test. The spectral median frequency (MF) change during the total endurance time (TMF) and the initial time of 30s (IMF) was calculated. The intensity of discomfort in the neck area was assessed with the visual analogue scale (VAS). RESULTS: The rate of decline in TMF of both SCM muscles was significantly increased in the tension-type headache group compared with controls (right SCM, P=0.030, OR 2.0, 95% 1.2-3.7; left SCM, P=0.009, OR 2.5, 95% 1.4-4.9), while no significant differences were found between controls and subjects with migraine. The rate of decline in IMF, the total endurance time (P=0.050), and VAS did not differ significantly among the study groups. CONCLUSIONS: This preliminary finding shows that increased neck flexor muscle fatigue in adolescents seems to be associated with tension-type headache. Comment: In AK, the purpose of identifying muscle imbalances and weakness is to discover how to correct this problem in patients with (in this case) headache. The MMT allows this to be done with specificity.</p>
<p>Chiropractic care for a patient with spasmodic dysphonia associated with cervical spine trauma, Waddell RK.</p>	<p><i>Journal Chiro Med,</i> Winter 2005;4(1):19-24.</p> <p>Objective: To discuss the diagnosis and response to treatment of spasmodic dysphonia in a 25-year-old female vocalist following an auto accident. Clinical features: The voice disorder and neck pain appeared after the traumatic incident. Examination of the cervical spine revealed moderate pain, muscle spasm and restricted joint motion at C-1 and C-5 on the left side. Cervical range of motion was reduced on left rotation. Bilateral manual muscle testing of the trapezius and sternocleidomastoid muscles, which share innervation with the laryngeal muscles by way of the spinal accessory nerve, were weak on the left side. Pre and post accident voice range profiles (phonetograms) that measure singing voice quality were examined. The pre- and post-accident phonetograms revealed significant reduction in voice intensity and fundamental frequency as measured in decibels and hertz. Intervention and outcome: Low-force chiropractic spinal manipulative therapy to C-1 and C-5 was employed. Following a course of care, the patient's singing voice returned to normal, as well as a</p>

	<p>resolution of her musculoskeletal complaints. Conclusion: It appears that in certain cases, the singing voice can be adversely affected if neck or head trauma is severe enough. This case proposes that trauma with irritation to the cervical spine nerve roots as they communicate with the spinal accessory, and in turn the laryngeal nerves, may be contributory to some functional voice disorders or muscle tension dysphonia.</p> <p>Comment: This case report examines the result of testing bilaterally, the trapezius and sternocleidomastoid muscles, as a diagnostic indicator for possible laryngeal nerve and muscle involvement in a case of muscle tension dysphonia due to their shared nerve supply. When cervical spine subluxations were corrected, the SCM and trapezius muscles were strengthened and this correlated with resolution in the voice dysfunction.</p>
<p>Cervical muscles weakness in chronic whiplash patients. Prushansky T, Gepstein R, Gordon C, Dvir Z.</p>	<p><i>Clin Biomech</i> (Bristol, Avon). 2005 Oct;20(8):794-8.</p> <p>BACKGROUND: Isometric cervical strength has been used for assessing the severity of cervical spine pathologies. However there is a conspicuous dearth of information relating to cervical strength data in patients suffering from chronic whiplash. Therefore the objective of this study was to compare absolute and ratio-based isometric cervical strength scores in chronic whiplash patients with reported corresponding scores in healthy subjects. METHODS: Isometric cervical strength was measured in the directions of flexion, extension, right and left lateral flexion in 97 patients, 51 women and 46 men, using a wall-mounted dynamometer. FINDINGS: Compared to published values of normal subjects, whiplash patients suffered sharp reductions of about 90% in both genders and in all directions. The consistency of the isometric cervical strength scores as indicated by the mean coefficient of variation was relatively low, 17% and 20% in men and women respectively. The flexion/extension strength ratio ranged 0.8--0.9, slightly higher than the reported range for normal subjects. This ratio was highly correlated ($r=0.91$, $P=0.01$) with the mean coefficient of variation in a subgroup of 9 patients. INTERPRETATION: In the absence of an obvious reason such as severe atrophy or grossly dysfunctional neurological control the indicated weakness of the cervical muscles may be associated with learned pain avoidance behavior which is typical among this group of patients.</p> <p>Comment: This paper demonstrates what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury. Another common finding in the AK setting is that muscles that test weak during the MMT are often painful for the patient. The "construct validity" of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report.</p>
<p>Neck flexor muscle fatigue is side specific in patients with unilateral neck pain, Falla D, Jull G, Rainoldi A, Merletti R.</p>	<p><i>Eur J Pain</i>. 2004 Feb;8(1):71-7.</p> <p>Abstract: Despite the evidence of greater fatigability of the cervical flexor muscles in neck pain patients, the effect of unilaterality of neck pain on muscle fatigue has not been investigated. This study compared myoelectric manifestations of sternocleidomastoid (SCM) and anterior scalene (AS) muscle fatigue between the painful and non-painful sides in patients with chronic unilateral neck pain. Myoelectric signals were recorded from the sternal head of SCM and the AS muscles bilaterally during sub-maximal isometric cervical flexion contractions at 25% and 50% of the maximum voluntary contraction (MVC). The time course of the mean power frequency, average rectified value and conduction velocity of the electromyographic signals were calculated to quantify myoelectric manifestations of muscle fatigue. Results revealed greater estimates of the initial value and slope of the mean frequency for both the SCM and AS muscles on the side of the patient's neck pain at 25% and 50% of MVC. These results indicate greater myoelectric manifestations of muscle fatigue of the superficial cervical flexor muscles ipsilateral to the side of pain. This suggests a specificity of the effect of pain on muscle function and hence the need for specificity of therapeutic exercise in the management of neck pain patients.</p>
<p>Patients with neck pain</p>	<p><i>Spine</i>. 2004 Oct 1;29(19):2108-14.</p>

<p>demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test, Falla DL, Jull GA, Hodges PW.</p>	<p>STUDY DESIGN: Cross-sectional study. OBJECTIVE: The present study compared activity of deep and superficial cervical flexor muscles and craniocervical flexion range of motion during a test of craniocervical flexion between 10 patients with chronic neck pain and 10 controls. SUMMARY OF BACKGROUND DATA: Individuals with chronic neck pain exhibit reduced performance on a test of craniocervical flexion, and training of this maneuver is effective in management of neck complaints. Although this test is hypothesized to reflect dysfunction of the deep cervical flexor muscles, this has not been tested. METHODS: Deep cervical flexor electromyographic activity was recorded with custom electrodes inserted via the nose and fixed by suction to the posterior mucosa of the oropharynx. Surface electrodes were placed over the superficial neck muscles (sternocleidomastoid and anterior scalene). Root mean square electromyographic amplitude and craniocervical flexion range of motion was measured during five incremental levels of craniocervical flexion in supine. RESULTS: There was a strong linear relation between the electromyographic amplitude of the deep cervical flexor muscles and the incremental stages of the craniocervical flexion test for control and individuals with neck pain ($P = 0.002$). However, the amplitude of deep cervical flexor electromyographic activity was less for the group with neck pain than controls, and this difference was significant for the higher increments of the task ($P < 0.05$). Although not significant, there was a strong trend for greater sternocleidomastoid and anterior scalene electromyographic activity for the group with neck pain. CONCLUSIONS: These data confirm that reduced performance of the craniocervical flexion test is associated with dysfunction of the deep cervical flexor muscles and support the validity of this test for patients with neck pain. Comment: This paper demonstrates electromyographically what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury.</p>
<p>Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients. Jull G, Kristjansson E, Dall'Alba P.</p>	<p><i>Man Ther.</i> 2004 May;9(2):89-94.</p> <p>Abstract: There has been little investigation into whether or not differences exist in the nature of physical impairment associated with neck pain of whiplash and insidious origin. This study examined the neck flexor synergy during performance of the cranio-cervical flexion test, a test targeting the action of the deep neck flexors. Seventy-five volunteer subjects participated in this study and were equally divided between Group 1, asymptomatic control subjects, Group 2, subjects with insidious onset neck pain and Group 3, subjects with neck pain following a whiplash injury. The cranio-cervical flexion test was performed in five progressive stages of increasing cranio-cervical flexion range. Subjects' performance was guided by feedback from a pressure sensor inserted behind the neck which monitored the slight flattening of the cervical lordosis which occurs with the contraction of longus colli. Myoelectric signals (EMG) were detected from the muscles during performance of the test. The results indicated that both the insidious onset neck pain and whiplash groups had higher measures of EMG signal amplitude (normalized root mean square) in the sternocleidomastoid during each stage of the test compared to the control subjects (all $P < 0.05$) and had significantly greater shortfalls from the pressure targets in the test stages ($P < 0.05$). No significant differences were evident between the neck pain groups in either parameter indicating that this physical impairment in the neck flexor synergy is common to neck pain of both whiplash and insidious origin. Comment: This paper demonstrates electromyographically what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury. The "construct validity" of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report.</p>
<p>Neuromuscular efficiency of the sternocleidomastoid and anterior scalene muscles in patients with chronic neck pain. Falla D, Jull G, Edwards</p>	<p><i>Disabil Rehabil.</i> 2004 Jun 17;26(12):712-7.</p> <p>PURPOSE: This study compared the neuromuscular efficiency (NME) of the sternocleidomastoid (SCM) and anterior scalene (AS) muscles between 20 chronic neck pain patients and 20 asymptomatic controls. METHOD: Myoelectric signals were recorded from</p>

<p>S, Koh K, Rainoldi A.</p>	<p>the sternal head of SCM and the AS muscles as subjects performed sub-maximal isometric cervical flexion contractions at 25 and 50% of the maximum voluntary contraction (MVC). The NME was calculated as the ratio between MVC and the corresponding average rectified value of the EMG signal. Ultrasonography was used to measure subcutaneous tissue thickness over the SCM and AS to ensure that differences did not exist between groups. RESULTS: For both the SCM and AS muscles, NME was shown to be significantly reduced in patients with neck pain at 25% MVC ($p < 0.05$). Subcutaneous tissue thickness over the SCM and AS muscles was not different between groups. CONCLUSIONS: Reduced NME in the superficial cervical flexor muscles in patients with neck pain may be a measurable altered muscle strategy for dysfunction in other muscles. This aberrant pattern of muscle activation appears to be most evident under conditions of low load. NME, when measured at 25% MVC, may be a useful objective measure for future investigation of muscle dysfunction in patients with neck pain. Comment: This paper demonstrates electromyographically what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury. The “construct validity” of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report.</p>
<p>Lack of correlation between sternocleidomastoid and scalene muscle fatigability and duration of symptoms in chronic neck pain patients. Falla D, Rainoldi A, Jull G, Stavrou G, Tsao H.</p>	<p><i>Neurophysiol Clin.</i> 2004 Oct;34(3-4):159-65.</p> <p>AIMS OF THE STUDY: Despite the evidence of greater fatigability of the superficial cervical flexor muscles in neck pain patients, the relationship between duration of neck pain and muscle fatigue has not been investigated. This study examined the relationship between myoelectric manifestations of sternocleidomastoid (SCM) and anterior scalene (AS) muscle fatigue and duration of neck pain in a group of patients with chronic neck pain. MATERIALS AND METHODS: Twenty chronic neck pain patients with a history of pain ranging between 1 and 25 years (mean 6.15, S.D. 5.48 years) participated in this study. Myoelectric signals were recorded from the SCM and AS muscles from the side of greatest pain as patients performed sustained sub-maximal isometric cervical flexion contractions at 25% and 50% of the maximum voluntary contraction (MVC). The initial value and slope of the mean frequency (MNF), average rectified value (ARV) and conduction velocity (CV) of the EMG signals were calculated. Correlation analysis was applied to determine whether a relationship existed between the duration of neck pain and estimates of EMG variables. RESULTS AND CONCLUSIONS: No significant correlation was found between duration of pain and estimates of the MNF, ARV and CV for either SCM or AS contracting at 25% and 50% MVC. The length of history of neck pain does not appear to correlate with the extent of SCM and AS muscle fatigability in patients with chronic neck pain. This finding may be due to an increase of muscle fatigability occurring within the first few years of neck pain, which is not followed by signs of increased fatigue after this time. This was supported by the finding of significant correlations between duration of pain and AS fatigability on a subgroup of patients with pain duration less than 5 years. Future studies are warranted to examine how early signs of cervical muscle fatigability are evident after the onset of neck pain as this will have implications for rehabilitation. Comment: This paper demonstrates electromyographically what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury. The “construct validity” of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report. Additionally, it appears that both early in the course of neck injury and after the condition is chronic, muscle fatigability is present. Muscles that are weak produce the symptoms for patients with neck syndromes whether at the beginning or after 25 years of the syndrome.</p>
<p>Impaired trunk muscle function in sub-acute neck pain: etiologic in the subsequent development of low back pain? Moseley GL.</p>	<p><i>Man Ther.</i> 2004 Aug;9(3):157-63.</p> <p>Abstract: Low back pain (LBP) and neck pain are associated with dysfunction of the trunk and neck muscles, respectively, and may involve common or similar mechanisms. In both cases, dysfunction may compromise spinal control. Anecdotally, neck pain patients commonly</p>

	<p>develop LBP. This study investigated the possibility that trunk muscle function is compromised in neck pain patients and that compromised trunk muscle function is associated with increased risk of LBP. Fifty-four neck pain patients and 52 controls were assessed on an abdominal drawing-in task (ADIT) and on self-report tests. Performance on the ADIT was able to detect neck pain patients with 85% sensitivity and 73% specificity. Catastrophizing and McGill pain questionnaire (affective) scores were higher in patients with an abnormal task response than in patients with an uncertain or normal response, although the self-report data did not predict task performance. Fifty subjects from each group were contactable by telephone at 2 years. They were asked whether they had experienced persistent or recurrent LBP since the assessment. Subjects (patients and controls) who obtained an abnormal response on the ADIT were 3 to 6 times more likely to develop persistent or recurrent LBP than those who obtained an uncertain or normal response. ADIT performance was the main predictor of development of LBP in patients. The results suggest that reduced voluntary trunk muscle control in neck pain patients is associated with an increased risk of developing LBP.</p> <p>Comment: Impairment of abdominal muscle strength in patients with neck and low back pain are common findings in AK settings. The “construct validity” of the manual muscle test in the evaluation of patients with cervical and low back pain syndromes is presented in this report.</p>
<p>Association of neck pain, disability and neck pain during maximal effort with neck muscle strength and range of movement in women with chronic non-specific neck pain. Ylinen J, Takala EP, Kautiainen H, Nykänen M, Häkkinen A, Pohjolainen T, Karppi SL, Airaksinen O.</p>	<p><i>Eur J Pain.</i> 2004 Oct;8(5):473-8.</p> <p>Abstract: Several studies have reported lower neck muscle strength in patients with chronic neck pain compared to healthy controls. The aim of the present study was to evaluate the association between the severity of neck pain and disability with neck strength and range of movement in women suffering from chronic neck pain. One hundred and seventy-nine female office workers with chronic neck pain were selected to the study. The outcome was assessed by the self-rating questionnaires on neck pain (visual analogue scale, Vernon's disability index, Neck pain and disability index) and by measures of the passive range of movement (ROM) and maximal isometric neck muscle strength. No statistically significant correlation was found between perceived neck pain and the disability indices and the maximal isometric neck strength and ROM measures. However, the pain values reported during the strength tests were inversely correlated with the results of strength tests ($r=-0.24$ to -0.46), showing that pain was associated with decreased force production. About two-thirds of the patients felt pain during test efforts. Pain may prevent full effort during strength tests and hence the production of maximal force. Thus in patients with chronic neck pain the results do not always describe true maximal strength, but rather the patients' ability to bear strain, which may be considerably influenced by their painful condition. The results of the present study suggest that rehabilitation in cases of chronic neck pain should aim at raising tolerance to mechanical strain.</p> <p>Comment: This paper demonstrates what AK physicians find consistently: impairment of neck flexor muscle strength in patients with neck and head pain, or with a history of neck or head injury. Another common finding in the AK setting is that muscles that test weak during the MMT are often painful for the patient. The “construct validity” of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report.</p>
<p>Decreased isometric neck strength in women with chronic neck pain and the repeatability of neck strength measurements. Ylinen J, Salo P, Nykänen M, Kautiainen H, Häkkinen A.</p>	<p><i>Arch Phys Med Rehabil.</i> 2004 Aug;85(8):1303-8.</p> <p>OBJECTIVES: To evaluate neck flexion, extension, and, especially, rotation strength in women with chronic neck pain compared with healthy controls and to evaluate the repeatability of peak isometric neck strength measurements in patients with neck pain. DESIGN: Cross-sectional. SETTINGS: Rehabilitation center and physical and rehabilitation medicine department at a Finnish hospital. PARTICIPANTS: Twenty-one women with chronic neck pain and healthy controls matched for sex, age, anthropometric measures, and occupation. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: Peak isometric strength of the cervical muscles was tested in rotation, flexion, and extension. RESULTS: Significantly lower flexion</p>

	<p>(29%), extension (29%), and rotation forces (23%) were produced by the chronic neck pain group compared with controls. When the repeated test results were compared pairwise against their mean, considerable variation was observed in the measures on the individual level. Intratester repeatability of the neck muscle strength measurements was good in all the 4 directions tested in the chronic neck pain group (intraclass correlation coefficient range, .74-.94). The coefficient of repeatability was 15N, both in flexion and extension, and 1.8 Nm in rotation. On the group level, improvement up to 10% due to repeated testing was observed. CONCLUSIONS: The group with neck pain had lower neck muscle strength in all the directions tested than the control group. This factor should be considered when planning rehabilitation programs. Strength tests may be useful in monitoring training progress in clinical settings, but training programs should be planned so that the improvement in results is well above biologic variation, measurement error, and learning effect because of repeated testing. Comment: This paper demonstrates what AK physicians find consistently: impairment of neck flexor, extensor, and rotator muscle strength in female patients with chronic neck pain distinguishes them from those without pain. The “construct validity” of the manual muscle test in the evaluation of patients with cervical syndromes is presented in this report.</p>
<p>Dishman JD, Burke J. Spinal reflex excitability changes after cervical and lumbar spinal manipulation: a comparative study.</p>	<p><i>Spine J.</i> 2003 May-Jun;3(3):204-12.</p> <p>BACKGROUND CONTEXT: Spinal manipulation (SM) is a commonly employed nonoperative treatment modality in the management of patients with neck, low back or pelvic pain. One basic physiologic response to SM is a transient decrease in motoneuron activity as assessed using the Hoffmann reflex (H-reflex) technique. Previous research from our laboratory indicates that both SM with a high-velocity, low-amplitude thrust and mobilization without thrust produced a profound but transient attenuation of motoneuronal activity of the lumbosacral spine in asymptomatic subjects. To date, effects of cervical SM procedures on the excitability cervical motoneuron pools are unknown. PURPOSE: The objective of this research was to gain a more complete understanding of the physiologic effects of SM procedures on motoneuron activity, by comparing the effects of regional SM on cervical and lumbar motoneuron pool excitability. STUDY DESIGN/SETTING: Maximal H-reflex amplitudes were recorded before and after SM in both the cervical and lumbar regions of asymptomatic subjects in two successive experimental sessions. PATIENT SAMPLE: Asymptomatic, young healthy volunteers were used in this study. OUTCOME MEASURES: Changes in flexor carpi radialis and gastrocnemius H-reflex amplitudes before and after SM procedures. METHODS: H-reflexes recorded from the tibial and median nerves were evaluated before and after lumbar and cervical SM, respectively. RESULTS: Both Lumbar and cervical SM produced a transient but significant attenuation of motoneuron excitability. The attenuation of the tibial nerve H-reflex amplitude was proportionately greater than that of the median nerve, which occurred after cervical SM. CONCLUSIONS: SM procedures lead to transient suppression of motoneuron excitability, as assessed by the H-reflex technique. Lumbar spine SM appears to lead to greater attenuation of motoneuron activity compared with that of the cervical region. Thus, these two distinct regions of the spine may possess different responsiveness levels to spinal manipulative therapy. Comment: There are numerous reports in this compendium showing the measurable and immediate physiological effects of spinal manipulative therapy on motor system function. Regardless of the mechanisms that make this occur, the physiological effects of SMT on motoneuronal activity have been inferred from evoked responses from peripheral muscles. This is the method of measurement used in AK for the past 43 years as well.</p>
<p>Development of motor system dysfunction following whiplash injury, Sterling M, Jull G, Vicenzino B, Kenardy J, Darnell R.</p>	<p><i>Pain.</i> 2003 May;103(1-2):65-73.</p> <p>Abstract: Dysfunction in the motor system is a feature of persistent whiplash associated disorders. Little is known about motor dysfunction in the early stages following injury and of its progress in those persons who recover and those who develop persistent symptoms. This study measured prospectively, motor system function (cervical range of movement (ROM),</p>

	<p>joint position error (JPE) and activity of the superficial neck flexors (EMG) during a test of cranio-cervical flexion) as well as a measure of fear of re-injury (TAMPA) in 66 whiplash subjects within 1 month of injury and then 2 and 3 months post injury. Subjects were classified at 3 months post injury using scores on the neck disability index: recovered (<8), mild pain and disability (10-28) or moderate/severe pain and disability (>30). Motor system function was also measured in 20 control subjects. All whiplash groups demonstrated decreased ROM and increased EMG (compared to controls) at 1 month post injury. This deficit persisted in the group with moderate/severe symptoms but returned to within normal limits in those who had recovered or reported persistent mild pain at 3 months. Increased EMG persisted for 3 months in all whiplash groups. Only the moderate/severe group showed greater JPE, within 1 month of injury, which remained unchanged at 3 months. TAMPA scores of the moderate/severe group were higher than those of the other two groups. The differences in TAMPA did not impact on ROM, EMG or JPE. This study identifies, for the first time, deficits in the motor system, as early as 1 month post whiplash injury, that persisted not only in those reporting moderate/severe symptoms at 3 months but also in subjects who recovered and those with persistent mild symptoms.</p> <p>Comment: Patients who have experienced cervical trauma from whiplash dynamics often have perplexing symptoms. The standard orthopedic and neurologic examination often does not find a cause for the bizarre symptoms about which some patients complain. Manual muscle testing is a method for evaluating the function of the nervous system; it often reveals the cause, giving an understanding of the patient's many complaints. Failure to recognize problems in the motor system in whiplash patients, and failure to correct it is often the reason a patient is labeled as being a malingerer or having a psychoneurotic overlay to his condition, and is one of the reasons why symptoms from whiplash injuries can persist for many years.</p>
<p>Neck muscle fatigue affects postural control in man, Schieppati M, Nardone A, and Schmid M.</p>	<p><i>Neuroscience</i>, 2003;121(2):277-285.</p> <p>Abstract: We hypothesized that, since anomalous neck proprioceptive input can produce perturbing effects on posture, neck muscle fatigue could alter body balance control through a mechanism connected to fatigue-induced afferent inflow. Eighteen normal subjects underwent fatiguing contractions of head extensor muscles. Sway during quiet stance was recorded by a dynamometric platform, both prior to and after fatigue and recovery, with eyes open and eyes closed. After each trial, subjects were asked to rate their postural control. Fatigue was induced by having subjects stand upright and exert a force corresponding to about 35% of maximal voluntary effort against a device exerting a head-flexor torque. The first fatiguing period lasted 5 min (F1). After a 5-min recovery period (R1), a second period of fatiguing contraction (F2) and a second period of recovery (R2) followed. Surface EMG activity from dorsal neck muscles was recorded during the contractions and quiet stance trials. EMG median frequency progressively decreased and EMG amplitude progressively increased during fatiguing contractions, demonstrating that muscle fatigue occurred. After F1, subjects swayed to a larger extent compared with control conditions, recovering after R1. Similar findings were obtained after F2 and after R2. Although such behavior was detectable under both visual conditions, the effects of fatigue reached significance only without vision. Subjective scores of postural control diminished when sway increased, but diminished more, for equal body sway, after fatigue and recovery. Contractions of the same duration, but not inducing EMG signs of fatigue, had much less influence on body sway or subjective scoring. We argue that neck muscle fatigue affects mechanisms of postural control by producing abnormal sensory input to the CNS and a lasting sense of instability. Vision is able to overcome the disturbing effects connected with neck muscle fatigue.</p>
<p>Myoelectric manifestations of sternocleidomastoid and anterior scalene muscle fatigue in chronic neck pain patients, Falla D, Rainoldi A, Merletti</p>	<p><i>Clin Neurophysiol.</i> 2003 Mar;114(3):488-95.</p> <p>OBJECTIVE: This study compares myoelectric manifestations of fatigue of the sternocleidomastoid (SCM) and anterior scalene (AS) muscles between 10 chronic neck pain subjects and 10 normal matched controls. METHODS: Surface electromyography (sEMG)</p>

<p>R, Jull G.</p>	<p>signals were recorded from the sternal head of SCM and AS muscles bilaterally during sub-maximal isometric cervical flexion contractions at 25 and 50% of the maximum voluntary contraction (MVC). The mean frequency, average rectified value and conduction velocity of the sEMG signal were calculated to quantify myoelectric manifestations of muscle fatigue. RESULTS: For both the SCM and AS muscles, the Mann-Whitney U test indicated that the initial value and slope of the mean frequency in neck pain patients were greater than in healthy subjects ($P < 0.05$). This was significant both at 25 and 50% of MVC. CONCLUSIONS: These results suggest: (a) a predominance of type-II fibres in the neck pain patients and/or (b) greater fatigability of the superficial cervical flexors in neck pain patients. These results are in agreement with previous muscle biopsy studies in subjects with neck pain, which identified transformation of slow-twitch type-I fibres to fast-twitch type-IIB fibres, as well as the clinical observation of reduced endurance in the cervical flexors in neck pain patients.</p>
<p>Decreased strength and mobility in patients after anterior cervical discectomy compared with healthy subjects. Ylinen JJ, Savolainen S, Airaksinen O, Kautiainen H, Salo P, Häkkinen A.</p>	<p><i>Arch Phys Med Rehabil.</i> 2003 Jul;84(7):1043-7.</p> <p>OBJECTIVE: To evaluate whether patients acquired normal physical function after cervical disk prolapse and surgery compared with healthy matched controls. DESIGN: Cross-sectional study. SETTING: Hospital in central Finland. PARTICIPANTS: Fifty-three patients with cervical discectomy and 53 healthy matched controls. INTERVENTIONS: Not applicable. Main Outcome Measures: Postoperative physical function was studied by measuring muscle strength and range of motion (ROM) values of the neck and grip strength. Disability was assessed by the neck and shoulder pain index and by the Oswestry index, mood by the Short Depression Inventory; and pain on a visual analog scale (VAS). RESULTS: Most patients recovered well after the operation. Forty-three percent of the patients still experienced moderate or high pain (VAS score, >30mm). Subjective pain and disability were associated with decreased neck movement and strength. Both ROM and cervical muscle strength values were significantly lower ($P < .001$) in all the measured directions in cervical disk surgery patients compared with healthy controls. ROM was mostly confined in extension (25%). Muscle strength of the neck was mostly confined in both rotation directions (38%). No statistically significant difference in grip strength was found between the groups. CONCLUSION: The loss of muscle strength and ROM is clearly visible postoperatively and thus the effectiveness of the early identification and rehabilitation of these deficits merits further studies.</p>
<p>Chronic neck pain disability due to an acute whiplash injury. Nederhand MJ, Hermens HJ, IJzerman MJ, Turk DC, Zilvold G.</p>	<p><i>Pain.</i> 2003 Mar;102(1-2):63-71.</p> <p>Abstract: Several theories about musculoskeletal pain syndromes such as whiplash-associated disorder (WAD) suggest that pain and muscle activity interact and may contribute to the chronicity of symptoms. Studies using surface electromyography (sEMG) have demonstrated abnormal muscle activation patterns of the upper trapezius muscles in the chronic stage of WAD (grade II). There are, however, no studies that confirm that these muscle reactions are initiated in the acute stage of WAD, nor that these muscle reactions persist in the transition from acute neck pain to chronic neck pain disability. We analyzed the muscle activation patterns of the upper trapezius muscles in a cohort of 92 subjects with acute neck pain due to a motor vehicle accident (MVA). This cohort was followed up in order to evaluate differences in muscular activation patterns between subjects who have recovered and those subjects who have not recovered following an acute WAD and developed chronic neck pain. sEMG parameters were obtained at 1, 4, 8, 12, and 24 weeks after an MVA. The level of muscle reactivity (the difference in pre- and post-exercise EMG levels) and the level of muscle activity during an isometric and a dynamic task were used as EMG parameters. The results revealed no elevated muscle reactivity either in the acute stage, or during the follow-up period. The results of both the isometric and dynamic task, showed statistically significant different EMG levels between four neck pain disability subgroups (analysis of variance reaching P-levels of 0.000), with an inverse relationship between the level of neck pain disability and EMG level. Furthermore, follow-up assessments of the EMG level during these two tasks, did not show a time related</p>

	<p>change. In conclusion, in subjects with future disability, the acute stage is characterized by a reorganization of the muscular activation of neck and shoulder muscles, possibly aimed at minimizing the use of painful muscles. This change of motor control, is in accordance with both the (neurophysiological) 'pain adaptation model' and (cognitive behavioral) 'fear avoidance model'.</p> <p>Comment: This paper shows that in patients less disabled by whiplash associated disorder injuries that upper trapezius underactivity is the norm.</p>
<p>Cervical muscle dysfunction in chronic whiplash-associated disorder grade 2: the relevance of the trauma, Nederhand MJ, Hermens HJ, IJzerman MJ, Turk DC, Zilvold G.</p>	<p><i>Spine.</i> 2002 May 15;27(10):1056-61.</p> <p>STUDY DESIGN: Surface electromyography measurements of the upper trapezius muscles were performed in patients with a chronic whiplash-associated disorder Grade 2 and those with nonspecific neck pain. OBJECTIVE: To determine the etiologic relation between acceleration-deceleration trauma and the presence of cervical muscle dysfunction in the chronic stage of whiplash-associated disorder. SUMMARY OF BACKGROUND INFORMATION: From a biopsychosocial perspective, the acceleration-deceleration trauma in patients with whiplash-associated disorder is not regarded as a cause of chronicity of neck pain, but rather as a risk factor triggering response systems that contribute to the maintenance of neck pain. One of the contributing factors is dysfunction of the cervical muscles. Considering the limited etiologic significance of the trauma, it is hypothesized that in patients with neck pain, there are no differences in muscle activation patterns between those with and those without a history of an acceleration-deceleration trauma. METHODS: Muscle activation patterns, expressed in normalized smooth rectified electromyography levels of the upper trapezius muscles, in patients with whiplash-associated disorder Grade 2 were compared with those of patients with nonspecific neck pain. The outcome parameters were the mean level of muscle activity before and after a physical exercise, the muscle reactivity in response to the exercise, and the time-dependent behavior of muscle activity after the exercise. RESULTS: There were no statistical significant differences in any of the outcome parameters between patients with whiplash-associated disorder Grade 2 and those with nonspecific neck pain. There was only a tendency of higher muscle reactivity in patients with whiplash-associated disorder Grade 2. CONCLUSIONS: It appears that the cervical muscle dysfunction in patients with chronic whiplash-associated disorder Grade 2 is not related to the specific trauma mechanism. Rather, cervical muscle dysfunction appears to be a general sign in diverse chronic neck pain syndromes.</p> <p>Comment: This is another paper by Nederhand et al that is very important for AK. In terms of the etiology of symptoms from chronic whiplash disorders, this study suggests that the performance of the upper trapezius muscle is an invaluable diagnostic measurement in the evaluation of patients with chronic neck pain and chronic whiplash-associated disorders. The evaluation and treatment of upper trapezius muscle dysfunction is a standard part of AK therapy.</p>
<p>Cervical mobilisation: concurrent effects on pain, sympathetic nervous system activity and motor activity. Sterling M, Jull G, Wright A.</p>	<p><i>Man Ther.</i> 2001 May;6(2):72-81.</p> <p>Abstract: Recent findings that spinal manual therapy (SMT) produces concurrent hypoalgesic and sympathoexcitatory effects have led to the proposal that SMT may exert its initial effects by activating descending inhibitory pathways from the dorsal periaqueductal gray area of the midbrain (dPAG). In addition to hypoalgesic and sympathoexcitatory effects, stimulation of the dPAG in animals has been shown to have a facilitatory effect on motor activity. This study sought to further investigate the proposal regarding SMT and the PAG by including a test of motor function in addition to the variables previously investigated. Using a condition randomised, placebo-controlled, double blind, repeated measures design, 30 subjects with mid to lower cervical spine pain of insidious onset participated in the study. The results indicated that the cervical mobilisation technique produced a hypoalgesic effect as revealed by increased pressure pain thresholds on the side of treatment (P=0.0001) and decreased resting visual analogue scale scores (P=0.049). The treatment technique also produced a sympathoexcitatory effect with an increase in skin conductance (P<0.002) and a decrease in skin temperature</p>

	<p>($P < 0.02$). There was a decrease in superficial neck flexor muscle activity ($P < 0.0002$) at the lower levels of a staged cranio-cervical flexion test. This could imply facilitation of the deep neck flexor muscles with a decreased need for co-activation of the superficial neck flexors. The combination of all findings would support the proposal that SMT may, at least initially, exert part of its influence via activation of the PAG.</p> <p>Comment: This paper describes one of the neurological hypotheses to explain the effect of chiropractic therapy upon the motor system. In the AK clinical setting, MMT of the deep cervical flexors shows increased strength after spinal manipulative therapy consistently.</p>
<p>The role of the scalenus anticus muscle in dysinsulinism and chronic non-traumatic neck pain, Rogowsky TA.</p>	<p><i>Int J AK and Kinesio Med</i>, 2001;12.</p> <p>Abstract: Investigation into why dysinsulinism often relates to symptoms of cervical spine imbalances led to the discovery that the scalenus anticus muscle was conditionally inhibited when tested as part of an applied-kinesiological exam. This conditionally inhibited muscle is implicated in many of the symptoms associated with chronic neck pain, brachial plexus syndromes, and an unstable cervical spine. Treating dysinsulinism facilitates the scalenus anticus muscle and ameliorates the cervical spine related symptoms. Using applied kinesiology, one can tailor a program that is patient-specific for better insulin tolerance.</p>
<p>Cervical muscle dysfunction in the chronic whiplash associated disorder grade II (WAD-II), Nederhand MJ, IJzerman MJ, Hermens HJ, Baten CT, Zilvold G.</p>	<p><i>Spine</i>. 2000 Aug 1;25(15):1938-43.</p> <p>STUDY DESIGN: In a cross-sectional study, surface electromyography measurements of the upper trapezius muscles were obtained during different functional tasks in patients with a chronic whiplash associated disorder Grade II and healthy control subjects. OBJECTIVES: To investigate whether muscle dysfunction of the upper trapezius muscles, as assessed by surface electromyography, can be used to distinguish patients with whiplash associated disorder Grade II from healthy control subjects. SUMMARY OF BACKGROUND INFORMATION: In the whiplash associated disorder, there is need to improve the diagnostic tools. Whiplash associated disorder Grade II is characterized by the presence of "musculoskeletal signs." Surface electromyography to assess these musculoskeletal signs objectively may be a useful tool. METHODS: Normalized smoothed rectified electromyography levels of the upper trapezius muscles of patients with whiplash associated disorder Grade II ($n = 18$) and healthy control subjects ($n = 19$) were compared during three static postures, during a unilateral dynamic manual exercise, and during relaxation after the manual exercise. Coefficients of variation were computed to identify the measurement condition that discriminated best between the two groups. RESULTS: The most pronounced differences between patients with whiplash associated disorder Grade II and healthy control subjects were found particularly in situations in which the biomechanical load was low. Patients showed higher coactivation levels during physical exercise and a decreased ability to relax muscles after physical exercise. CONCLUSIONS: Patients with whiplash associated disorder Grade II can be distinguished from healthy control subjects according to the presence of cervical muscle dysfunction, as assessed by surface electromyography of the upper trapezius muscles. Particularly the decreased ability to relax the trapezius muscles seems to be a promising feature to identify patients with whiplash associated disorder Grade II. Assessment of the muscle (dys)function by surface electromyography offers a refinement of the whiplash associated disorder classification and provides an indication to a suitable therapeutic approach.</p> <p>Comment: This is a very important paper for AK. In terms of the etiology of symptoms from chronic whiplash disorders, this study suggests that the performance of the upper trapezius muscle is an invaluable diagnostic for musculoskeletal involvement in chronic whiplash disorders than many of the other previous findings used to diagnose and treat this problem. The evaluation and treatment of the upper trapezius muscle dysfunction is a standard part of AK therapy.</p>
<p>Further clinical clarification of</p>	<p><i>Cephalalgia</i>, 1999 Apr;19(3):179-85.</p>

<p>the muscle dysfunction in cervical headache, Jull G, Barrett C, Magee R, Ho P.</p>	<p>Abstract: The Headache Classification Committee of the International Headache Society listed impairments in cervical muscle function as criteria for headaches of cervical spine origin. Fifteen subjects with cervical headache and 15 controls were tested for the frequency of abnormal responses to passive stretching and abnormal muscle contraction. A new test of cranio-cervical flexion was used to assess the contraction of the deep neck flexors. Results indicated a trend towards a higher frequency of abnormal response to passive stretching of the muscles examined in the cervical headache group but only the upper trapezius proved significantly different to the control group. Deep neck flexor muscle contraction was significantly inferior in the cervical headache group. From the perspective of physical characterization of cervical headache, it appears that response from passive stretch of muscle may not be a strong criterion for cervical headache but deep neck flexor performance may have potential to identify musculoskeletal involvement in headache. The finding may also provide positive directions for conservative treatment of cervical headache. Comment: This is a very important paper for AK. In terms of the etiology of headache, The Headache Classification Committee of the International Headache Society suggests in this study that the performance of the deep neck flexors has greater diagnostic value for musculoskeletal involvement in headache than any other finding.</p>
<p>Manual Muscle Testing combined with Specific Head Positioning, and other Articular Challenges, as an Assessment of Vertebral Subluxation of the Upper Cervical Spine: A Descriptive Paper, Dobson GJ.</p>	<p><i>J Vertebral Subluxation Res</i>, 1999;3(2):1-7.</p> <p>Abstract: This article presents the Dobson Muscle Testing (DMT) procedure. Those aspects of the procedure as it relates to other indicators of vertebral subluxation and other methodologies are described. The procedure detects aberrant cervical joint dynamics (movement) through muscle challenges used in combination with various head positions, designed to functionally engage specific articular levels, (positioning) and other articular challenges. In the cervical spine joints and soft tissue there are a large number of mechanoreceptors. Thus, it is postulated that in the presence of vertebral subluxation, when aberrant joint mechanics affect these mechanoreceptors, the application of the head positioning challenges produces a barrage of noxious or inappropriate impulses through the cerebellovestibular regulatory circuits. This is believed to result in poor quality motor responses, which may be detected with the DMT procedure through manual muscle testing. The DMT procedure is described as a complement to other forms of vertebral subluxation assessment. To date, clinical observations suggest a positive correlation to Blair upper cervical radiographic analysis in addition to other indicators including muscle and motion palpation and leg length analysis. Further study is planned to test the validity of these observations through controlled studies.</p>
<p>Upper trapezius muscle activity during the brachial plexus tension test in asymptomatic subjects, Balster SM, Jull GA.</p>	<p><i>Man Ther.</i> 1997 Aug;2(3):144-149.</p> <p>Abstract: The brachial plexus tension test (BPTT) is used clinically to test the dynamics of the neural tissues of the upper quadrant. The upper trapezius muscle and the nerves of the brachial plexus share common anatomical locations and are jointly affected by BPTT movements. This study investigated the relationship between the BPTT, upper trapezius muscle activity and range of neural tissue extensibility in asymptomatic subjects. Normal male subjects with greater and lesser neural tissue extensibility were tested. Results revealed that those with lesser neural extensibility exhibited significantly greater upper trapezius muscle activity during discrete BPTT stages. There was no difference between groups in the levels of pain perceived with the test. These results suggest that asymptomatic neural tissues are protected from stretch by muscle activity not solely mediated by pain but also possibly mediated by stretch receptors in neural structures. Comment: The diagnosis and treatment of injuries to neuromuscular spindle cells, located throughout the muscle, is a high priority in AK therapy.</p>
<p>Postural stability, neck proprioception and tension</p>	<p><i>Acta Otolaryngol Suppl.</i> 1997;529:95-7.</p>

neck, Koskimies K, Sutinen P, Aalto H, Starck J, Toppila E, Hirvonen T, Kaksonen R, Ishizaki H, Alaranta H, Pyykko I.

Abstract: We examined whether tension neck (TN) may due to inadequate proprioceptive and vestibular activation of the cervico-colic reflex (CCR). CCR and vestibulospinal responses (VSRs) were recorded from 106 forest workers by stimulating the neck, lumbar or calf proprioceptors by vibration. The VSRs were recorded with posturography. TN occurred in 27 out of 106 subjects. The subjects with TN (48.5 years) were older than those without TN (43.1). The mean body sway during quiet stance was the same in both groups during the neck stimulation. In subjects with tension neck stimulation of neck or lumbar proprioceptors caused excessive, unpredictable body excursion in the lateral and anteroposterior direction that continued after stimulation. Results from stimulation of lower limb proprioceptors did not significantly differ between the 2 groups. In logistic regression analysis a model to predict TN consisting of perstimulatory postural stability (odds ratio 1.4) and poststimulatory postural stability (odds ratio 1.8) turned out to be statistically significant. **The anatomical findings of CCR in the medulla oblongata suggest that neck muscle afferents control the posture and muscle activity of the neck. The erroneous facilitation of proprioception in TN subjects indicate that TN may be raised by inadequate facilitation of CCR.**

Neck flexor muscle strength, efficiency, and relaxation times in normal subjects and subjects with unilateral neck pain and headache. Barton PM, Hayes KC.

Arch Phys Med Rehabil. 1996 Jul;77(7):680-7.

OBJECTIVE: To determine the test-retest reliability of a new method for measuring muscular strength, efficiency, and relaxation times of the neck flexor musculature of healthy adults, and to compare these neck flexor muscle properties in subjects who have unilateral neck pain and headache with those in controls. **DESIGN:** Subjects lay supine and isometrically flexed their necks against a force transducer attached to the back of a webbing and velcro helmet. Electromyograms (EMGs) were recorded from surface electrodes on the sternocleidomastoid (SCM) muscles. Two consecutive sessions of five contractions of varying levels of effort from minimal through moderate and maximal effort were analyzed. **SETTING:** Ambulatory referral center. **PARTICIPANTS:** Volunteer control subjects (n = 10, 3 men and 7 women) were recruited from hospital and university personnel. Volunteer neck pain subjects (n = 10, 3 men and 7 women) were recruited from a physiatric chronic pain practice and a hospital outpatient physical therapy practice. **RESULTS:** In the controls, the intraclass correlation coefficients (ICCs) for the first two maximum neck flexion contractions were; peak force ICC = .81; peak force/body weight ICC = .75; average force ICC = .75; force relaxation time ICC = .73; SCM EMG relaxation times: right ICC = .60 and left ICC = .67. Comparing sessions 1 and 2 the intraclass correlations for SCM efficiencies were right ICC = .58 and left ICC = .97. **The peak force in controls (mean = 45.3 +/- 17.6N) was reduced by 50% in the neck pain subjects (mean = 22.4 +/- 13.1N) (p = .004).** Similarly, peak force/body weight in the neck pain subjects (X = 0.3 +/- 0.2N/kg) was 46% of control (mean = 0.7 +/- 0.2N/kg) (p = .001), and average force in the neck pain subjects (X = 12.1 +/- 7.5N) was 43% of controls (mean = 28.5 +/- 11.0N) (p = .001). In two neck pain subjects. SCM, EMG and force relaxation times were abnormally long in both the affected and the unaffected SCM muscles, exceeding the control values by greater than 3 standard deviations. The difference between the right SCM efficiency of the control subjects (mean = 0.3 +/- 0.2N/ microV) and the affected SCM efficiency of the neck pain subjects (mean = 0.1 +/- 0.1 N/microV) approached the p < .05 criterion for significance (p = .055). **CONCLUSION:** The technique was found to be highly reliable for the measurement of neck flexor peak force, peak force/body weight, average force, and force relaxation time, and moderately reliable for the quantitation of SCM EMG relaxation times and SCM efficiency. **All force values were significantly lower in the neck pain population compared with the controls. In the neck pain population, force and SCM EMG relaxation times, as well as efficiencies, suggested abnormalities.** Neck pain subjects showed no significant differences in SCM EMG relaxation time or SCM efficiency between affected and unaffected SCM muscles.

Cervicogenic headache: the influence of mental load on pain level and EMG of

Headache. 1996 Jun;36(6):372-8.

Abstract: The relationship between pain and EMG levels was studied in 17 cervicogenic

<p>shoulder-neck and facial muscles. Bansevicius D, Sjaastad O.</p>	<p>headache patients and 17 group-matched healthy controls. All subjects performed a 1-hour, complex, two-choice, reaction time test. Every 10 minutes before, during, and also for 20 minutes after the test, they reported pain levels (using visual analogue scales) in the forehead, both temples, neck, and shoulders. Electromyographic activity, using superficial electrodes, was also recorded from the frontal, temporal, neck (splenius), and trapezius muscles. Maximal voluntary contractions were performed in all the muscles. Increased pain levels before, during, and after the test were found on the symptomatic side in the temple, shoulder area, and neck in the patient group compared with nonsymptomatic side and controls (neck only compared with controls). Electromyographic amplitudes from the trapezius muscle on the symptomatic side were significantly higher before and during the test, compared with the nonsymptomatic side, but most markedly during the test. Pretest EMG amplitudes from the frontal muscle on the symptomatic side in patients were also significantly higher than those in controls, but the difference vanished during the test. There are indications that the temporal pain, ie, the headache, is a referred pain. These observations may point to a "muscular" involvement in the pathogenesis of cervicogenic headache, either primarily or, which seems more plausible, secondarily.</p>
<p>Changes in neck electromyography associated with meningeal noxious stimulation, Hu JW, Vernon H, Tattourian I.</p>	<p><i>J Manipulative Physiol Ther.</i> 1995 Nov-Dec;18(9):577-81.</p> <p>OBJECTIVE: To determine if the activity of jaw and neck muscles in a rat model is influenced by the application of small-fiber irritant mustard oil to meningeal/dural vascular tissues. DESIGN: Controlled animal experiment. SETTING: University neurophysiology laboratory. INTERVENTIONS: Applications of mineral oil (vehicle control) and mustard oil to exposed meningeal/dural vascular tissues. MAIN OUTCOME MEASURE: Electromyographic (EMG) recordings from deep suboccipital muscles, bilaterally, and the left trapezius and left masseter muscles. RESULTS: Mineral oil evoked no EMG responses in any muscles. The incidences of mustard oil-evoked EMG increases were 100%, 100%, 89% and 78% for left deep neck, right deep neck, left trapezius and left masseter muscles, respectively. The durations of EMG responses were (mean +/- SD) 19.2 +/- 6.6 min, 17.3 +/- 7.5 min, 14.5 +/- 6.8 min and 12.7 +/- 8.5 min, respectively. CONCLUSIONS: These results document that meningeal/dural vascular irritation leads to sustained and reversible activation of neck and jaw muscles that may be related to the clinical occurrence of muscular tension and pain associated with certain types of headaches, particularly migraine.</p>
<p>Cervical musculoskeletal dysfunction in post-concussional headache, Treleaven J, Jull G, Atkinson L.</p>	<p><i>Cephalalgia,</i> 1994 Aug;14(4):273-9; discussion 257.</p> <p>Abstract: Persistent headache is a common symptom following a minor head injury or concussion, possibly related to simultaneous injury of structures of the cervical spine. This study measured aspects of cervical musculoskeletal function in a group of patients (12) with post-concussional headache (PCH) and in a normal control group. The PCH group was distinguished from the control group by the presence of painful upper cervical segmental joint dysfunction, less endurance in the neck flexor muscles and a higher incidence of moderately tight neck musculature. Active range of cervical motion and postural attitude were not significantly different between groups. As upper cervical joint dysfunction is a feature of cervicogenic causes of headache, the results of this study support the inclusion of a precise physical examination of the cervical region in differential diagnosis of patients suffering persistent headache following concussion.</p> <p>Comment: The need for specific and reliable clinical tests for cervical muscular function is highlighted in this paper. Tests that are cost-effective and reliable provide the practitioner with a powerful tool for initial examination, and for repeated tests to measure the effectiveness of treatment. The complexity of injury in PCH is such that a system of diagnosis and treatment has been developed in AK that encompasses a wide range of modalities.</p>
<p>Electromyographic analysis of neck muscle fatigue in patients</p>	<p><i>Spine.</i> 1994 Mar 1;19(5):502-6.</p>

with osteoarthritis of the cervical spine. Gogia PP, Sabbahi MA.

Abstract: Median frequency parameters of myoelectric signals were studied in 25 patients with osteoarthritis of the cervical spine and in 25 normal subjects. The median frequency parameters included initial median frequency and slope of the median frequency during 20%, 50%, 80%, and 100% of maximum voluntary contractions (MVC). The subjects performed sustained, isometric constant-force contractions of forward and backward bend of the cervical spine. The median frequency signals were obtained from the anterior (sternocleidomastoid) and posterior (upper trapezius) neck muscles. The results showed that at moderate and high forces (i.e., 50%, 80%, and 100% MVC) the anterior neck muscles in patients with osteoarthritis of the cervical spine fatigued faster than those of normal subjects. The posterior neck muscles in patients fatigued faster compared to normal subjects at high force levels (i.e., 80% and 100% MVC). This indicates a higher fatigue of the anterior and posterior neck muscles associated with arthritic changes of the cervical spine. Rehabilitation programs must consider these muscular changes to obtain optimal outcomes.

Comment: To test the construct validity of the AK hypothesis that muscle weakness instead of muscle spasm was the cause of spinal pain and dysfunction, researchers have attempted to quantify the muscle weakness that occurs with specific clinical conditions such as neck pain related to osteoarthritis. This paper very elegantly demonstrates one of the prime contentions of AK.

Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance, Watson DH, Trott PH

Cephalalgia, 1993 Aug;13(4):272-84; discussion 232.

Abstract: In this study, 60 female subjects, aged between 25 and 40 years, were divided into two equal groups on the basis of absence or presence of headache. A passive accessory intervertebral mobility (PAIVM) examination was performed to confirm an upper cervical articular cause of the subjects' headache and a questionnaire was used to establish a profile of the headache population. Measurements of cranio-cervical posture and isometric strength and endurance of the upper cervical flexor muscles were compared between the two groups of subjects. **The headache group was found to be significantly different from the non-headache group in respect to forward head posture (FHP) ($t = -5.98, p < 0.0005$), less isometric strength ($t = 3.43, p < 0.001$) and less endurance ($t = 8.71, p < 0.0005$) of the upper cervical flexors. A statistically significant relationship was also established between natural head posture and isometric endurance of the upper cervical flexor musculature which demonstrated that FHP corresponded with a low endurance capacity ($\chi^2 = 13.2; p < 0.01$).** The outcome of this study highlights the need to screen for cervical etiology in patients who are suspected of suffering from common migraine.

Comment: This study found that forward head posture is correlated with decreased isometric strength and endurance of the neck flexor muscles.

Cervicogenic dysfunction in muscle contraction headache and migraine: a descriptive study, Vernon H, Steiman I, Hagino C.

J Manipulative Physiol Ther. 1992 Sep;15(7):418-29.

OBJECTIVE: The prevalence and nature of findings of cervicogenic dysfunction is explored in subjects with muscle contraction/tension-type (MCH) headache and common migraine without aura (CM). **DESIGN:** Descriptive survey. **SETTING:** Chiropractic outpatient research clinic. **PATIENTS:** Forty-seven (47) subjects, aged 18-55 with two categories of benign headache, were studied: MCH (tension-type) $n = 19$ (6 males, 13 females) and CM (without aura), $n = 28$ (3 males, 25 females). Subjects were recruited as part of an intervention trial and, thus, form a consecutive sample of patients. The present findings were elicited as part of the initial assessment. **INTERVENTION:** No therapeutic intervention is reported. **MAIN OUTCOME MEASURES:** Standardized headache history; plain film and dynamic spinal X rays; motion palpation; and pressure algometry. **RESULTS:** For CM, the most prevalent headache locations were frontal (81%) and occipital (78%). Neck pain and upper back pain accompanied headache in 90% and 41% of subjects, respectively. For MCH, the most prevalent headache locations were occipital (87%) and frontal (81%). Neck and upper back pain accompanied headache in 100% and 27%, respectively, of all subjects. For the total group, 77% of all subjects and 89% of females exhibited a marked reduction, absence or reversal of the

	<p>normal cervical lordosis. Ninety-seven percent of all subjects exhibited, on dynamic X-ray studies, at least one significant abnormality of segmental mobility from C1 to C7, while 43% exhibited abnormalities at four or more segments. Segmental motion at C0-C1 was reduced in 90% of subjects in flexion and 70% of subjects in extension. On motion palpation, 84% of CM and MCH subjects were found to have at least two major fixations from C0 to C2. On pressure algometry, 92% of CM and 85% of MCH had at least one verifiable tender point (TP) in the upper cervical region. The most common locations for TPs were mid-cervical (C2-C3), lateral occipital and suboccipital. CONCLUSIONS: Both MCH and CM subjects demonstrate high occurrences of: a) occipital and neck pain during headaches; b) tender points in the upper cervical region; c) greatly reduced or absent cervical curve; and d) X-ray evidence of joint dysfunction in the upper and lower cervical spine. These findings support the premise that the neck plays an important, but largely ignored role in the manifestation of adult benign headaches. A case-control study should be conducted to confirm the greater prevalence of cervicogenic dysfunction in headache as compared to nonheadache subjects.</p>
<p>Evaluation of neck muscle strength with a modified sphygmomanometer dynamometer: reliability and validity, Vernon HT, Aker P, Aramenko M, Battershill D, Alepin A, Penner T.</p> <p>-- Canadian Memorial Chiropractic College, Toronto, Ontario.</p>	<p><i>J Manipulative Physiol Ther.</i> 1992 Jul-Aug;15(6):343-9.</p> <p>OBJECTIVE: Determine test-retest reliability, normative data and clinical validity of isometric muscle strength testing in the neck with a modified sphygmomanometer dynamometer (MSD). DESIGN: Analytic survey. Paired trials of various muscle strength tests were conducted on convenience samples of normal subjects and consecutive samples of symptomatic subjects. SETTING: Outpatient chiropractic research clinic. PATIENTS/SUBJECTS: For study 2, 40 normal male subjects, average age 25 +/- 2 yr, were studied for reliability and normative data. For study 3, 24 symptomatic patients, 12 males and 12 females, average age 39 +/- 7 yr, were studied, 8 with "whiplash"-type injuries (average duration 22.5 wk) and 16 with nontraumatic chronic neck pain (average duration 110 wk). INTERVENTION: No therapeutic intervention is reported. MAIN OUTCOME MEASURE: Pressure levels generated by subjects against a modified sphygmomanometer-type dynamometer as measured in kilopascals. RESULTS: Study 1. Repeated paired trials of a standardized weight column (20 lbs) produced a coefficient of variation of 0.84% and virtually no difference between the means of the first vs. second trials. Study 2. High test-retest correlation coefficients were found for all ranges of motion (.79-.97). Right-to-left asymmetry in rotation and lateral flexion was within 6-8%. The flexion/extension ratio was .57:1, indicating that in normal subjects, flexion was approximately 40% lower than extension. Lower cutoffs were established as the mean--1 SD as follows (in kPa): flexion--3300, extension--5800, rotation--5200 and lateral flexion--6200. Coefficients of variation ranged from 25 to 29%. Study 3. Differences between paired trials were analyzed by intraclass coefficients, which were very high (.95-.99), and by percentages, which ranged from 4 to 10.4%, with an average of 7%, indicating a high degree of test-retest consistency. The mean values for all symptomatic subjects for flexion, extension, right rotation and right lateral bending were all well below the normal cutoff values as found in study 2. The flexion/extension ratio for whiplash subjects was 0.25:1.00, which is half of that of normal subjects. CONCLUSIONS: The MSD has been found to be a reliable instrument for the evaluation of isometric muscle strength in the neck in normal and symptomatic subjects. Normative values for absolute test levels, bilateral symmetry and flexion/extension ratios have been determined. A symptomatic group demonstrated significant deviations from these norms in the form of reduced strength levels and reduced flexion/extension ratios, while still maintaining very high levels of test-retest consistency and bilateral symmetry. The MSD appears very promising in the evaluation of neck-injured patients.</p>
<p>Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain, Silverman JL, Rodriguez AA,</p>	<p><i>Arch Phys Med Rehabil.</i> 1991 Aug;72(9):679-81.</p> <p>Abstract: Although weakness of anterior cervical muscles is postulated to contribute to persistent neck pain in patients with mechanical neck pain, quantitation of weakness has never been reported. We compared anterior cervical muscle strength in 30 subjects with</p>

<p>Agre JC.</p>	<p>mechanical neck pain and in 30 asymptomatic control subjects. Testing was performed with the subject supine, chin retracted, and neck flexed. Assessment was made using a hand-held dynamometer with head held at the midline and with rotation left and right within a pain-free range. Analysis with Wilcoxon scores showed that patients with neck pain had significantly less (p less than .05) strength (N.Kg-1) in all three positions than controls (1.16 +/- 0.49 vs. 1.71 +/- 0.42, sagittally; 1.01 +/- 0.52 vs. 1.47 +/- 0.41, rotation left; .99 +/- 0.46 vs. 1.43 +/- 0.43 rotation right; neck pain vs. control, respectively.) This weakness and its role in persistent neck pain should be recognized. The efficiency and effect of cervical muscle strengthening in treatment of chronic neck pain should be further defined. Comment: This paper gives evidence for one of the fundamental tenets of AK and is very important. AK theorizes that physical imbalances are associated with secondary muscle dysfunction – specifically a muscle inhibition -- usually preceding an overfacilitation of an opposing muscle. Applying the proper therapy results in improvement in the inhibited muscle.</p>
<p>Chronic cervical dysfunction: correlation of myoelectric findings with clinical progress. Beal MC, Vorro J, Johnston WL.</p>	<p><i>J Am Osteopath Assoc.</i> 1989 Jul;89(7):891-900. Abstract: In this pilot study, four patients with motion impairment and chronic cervical pain after cervical spine injury received osteopathic manipulative treatment for spinal dysfunction for periods in excess of 3 months. Records were compared for changes in the patient's subjective complaints, in the physician's findings, and in the standardized measurement of electrical activity of the cervical spine musculature. All three measures demonstrated parallel improvement in the health status of these patients. Attention to functional aspects of a neuromusculoskeletal problem appears to provide reliable indicators for directing treatment of somatic dysfunction and registering both subjective and objective change. Comment: This paper gives evidence that functional strength testing is a valid tool for assessing improvement after manipulative therapy.</p>
<p>Clinical biomechanical correlates for cervical function: Part II. A myoelectric study, Vorro J, Johnston W.</p>	<p><i>J Am Osteopath Assoc</i> 1987;87:353-367 Abstract: Part 1 of this study compared cervical motion ranges for two groups of human subjects classified as symmetric or asymmetric on the basis of a single clinical test for cervical sidebending. Data from the asymmetric group revealed limited mobility in all primary rotations and in secondary deviations. Part 2 reports on the concurrent, bilateral measurement of electromyographic activity for 12 selected muscle sites during the movements executed. Data revealed that muscles in the asymmetric group were slower to initiate action and were reduced in time and strength of contraction. Because muscles provide the motive forces for the reduction in range previously reported, these myoelectric data expand understanding of the disturbance in physiologic function that is indicated when a clinical test for response to motion in a spinal region is positive for asymmetry.</p>
<p>Electromyographic analysis following chiropractic manipulation of the cervical spine: a model to study manipulation-induced peripheral muscle changes, Rebechini-Zasadny H, Tasharski C, Heinze, W.</p>	<p><i>J Manipulative Physiol Ther</i> 1981;4(2):61-63. Abstract: An electromyographic analysis following chiropractic manipulation of the cervical spine was conducted on twelve subjects for the purpose of constructing a model for the study of the physiological effects of spinal manipulation. These effects may be reflected in electromyographically-measured peripheral muscle changes. Twelve out of 12 subjects showed increased muscle activity following manipulation of the cervical spine when compared to the control subjects, and nine out of 12 subjects showed increased muscle strength when compared to subjects who had received only passive cervical spine movements. It was concluded that this model may serve as an effective tool for further research into the efficacy of chiropractic spinal manipulative therapy. Comment: This paper gives evidence that functional strength testing is a valid tool for assessing improvement after manipulative therapy.</p>
<p>On Weakness of the Posterior</p>	<p><i>Medical Press and Circular</i> 1920, N.S. cviv:461-463.</p>

Cervical Muscles as a cause of Headache, Cyriax E.

Abstract: Although weakness of the erector muscles of the trunk **has for centuries been recognized as one of the everyday causes of backache**, yet weakness of the posterior muscles of the neck as a possible cause of headache has received little or no attention. The presentation of manual muscle tests that evaluate specific extensor muscles of the neck are photographed and described in this paper, and the author states that these tests had been taught by Kellgren since 1893! Weakness of the suboccipital muscles and neck extensor muscles were specifically associated with suboccipital neuralgia and headaches in this paper.