APPLIED KINESIOLOGY RESEARCH AND LITERATURE COMPENDIUM

-- Edited by Scott Cuthbert, D.C.

APPLIED KINESIOLOGY RESEARCH ARTICLES IN PEER REVIEWED JOURNALS

Cuthbert SC, Barras M. Developmental delay syndromes: psychometric testing before and after chiropractic treatment of 157 children.	*J Manipulative Physiol Ther. 2009 Oct;32(8):660-9.* **OBJECTIVE:** This study presents a case series of 157 children with developmental delay syndromes, including the conditions such as dyspraxia, dyslexia, attention-deficit hyperactivity disorder, and learning disabilities who received chiropractic care. **CLINICAL FEATURES:** A consecutive sample of 157 children aged 6 to 13 years (86 boys and 71 girls) with difficulties in reading, learning, social interaction, and school performance who met these inclusion criteria were included. **INTERVENTION AND OUTCOMES:** Each patient received a multimodal chiropractic treatment protocol, **applied kinesiology chiropractic technique**. The outcome measures were a series of 8 standardized psychometric tests given to the children by a certified speech therapist pre- and posttreatment, which evaluate 20 separate areas of cognitive function, including patient- or parent-reported improvements in school performance, social interaction, and sporting activities. Individual and group data showed that at the end of treatment, the 157 children showed improvements in the 8 psychometric tests and 20 areas of cognitive function compared with their values before treatment. Their ability to concentrate, maintain focus and attention, and control impulsivity and their performance at home and school improved. **CONCLUSIONS:** This report suggests that a multimodal chiropractic method that assesses and treats motor dysfunction reduced symptoms and enhanced the cognitive performance in this group of children.
Developmental Delay Syndromes and Chiropractic: A Case Report. Blum C, Cuthbert S.	*J Ped Matern Fam Health.* Aug 2009: 3. **Objective:** Issues regarding chiropractic treatment for various types of conditions such as developmental delay syndromes, while controversial to some, have some support in the literature. At this time developmental delay syndromes such as ADHD have inconclusive etiologies. While many consider developmental delay disorders solely genetic in origin, others have supported the concept that a subset of patients may have a trauma or other physical related imbalances that could be contributory to the patient's dysfunction. **Clinical Features:** Presented is a case of fraternal twins where one twin's developmental and emotional growth was notably delayed compared to her other twin. Chiropractic cranial care was rendered, which appeared to assist a positive outcome for the treated child. **Interventions and Outcomes:** Perhaps a better way of interpreting chiropractic's ability to help patients with learning disabilities, dyslexia, dyspraxia, and ADHD, is viewing a specific subset of patients as having their conditions secondary to trauma. With developmental delay syndromes there are various related possible chiropractic interventions, such as cranial related therapies and upper cervical, cervical and even treatment for pelvic related dysfunction. **Conclusion:** Since there is some question as to the causation of the various developmental delay syndromes, this ultimately leads to some lack of clarity on treatment options, particularly for children sensitive to medication or who do not choose medication as an option. Patients are seeking alternative care, and particularly care that offers low risk and some benefit should be brought to their attention. While the studies are inconclusive, there is an emerging evidence base

	that does show chiropractic care can be involved in the treatment and care of patients with developmental delay syndromes. Greater study is needed into understanding which patients might best benefit from chiropractic care, where co-treatment is indicated, and consistent outcome assessment tools to measure changes so mechanisms of care can be evaluated.

Manual biofeedback: A novel approach to the assessment and treatment of neuromuscular dysfunction, Maffetone P.	*J Altern Med Res* 2009;1(3): 221-232. **Abstract:** This paper introduces manual biofeedback, a hands-on neuromuscular therapy that incorporates numerous clinical features of other physical assessment and treatment protocols, including EMG-type biofeedback and manual muscle testing. The clinical and scientific rationale for the use of manual biofeedback is reviewed, including the assessment and treatment of a wide range of neuromuscular dysfunction caused by brain, spinal cord and local injury. This includes the full spectrum of so-called muscle "weakness" (abnormal muscle inhibition), including those with no detectable contraction. Manual biofeedback incorporates active (versus passive) patient participation throughout the rehabilitation process that enlists many of the neurological mechanisms between the muscle and brain, and brain and muscle (including the spinal cord). Instead of using mechanical sensors common in most biofeedback computerized devices, manual biofeedback integrates the practitioner's sensory system as the primary sensor, much like traditional manual muscle testing procedures used to assess physical disability, and those employed during common neurological evaluations. Manual biofeedback is a clinical hands-on neuromuscular therapy that expands the scope and simplifies many traditional biofeedback-type therapies. It is a safe and inexpensive procedure that addresses the full range of neuromuscular problems, including common muscle imbalance, and muscle dysfunction associated with brain and spinal cord injuries.
A pilot study to determine the effects of a supine sacroiliac orthopedic blocking procedure on cervical spine extensor isometric strength, Giggey K, Tepe R.	*J Chirop Med.* Jun 2009;8(2):56-61. **Objective:** The purpose of this study was to determine if an orthopedic pelvic blocking procedure affects cervical spine extensor isometric strength. **Methods:** Twenty-two participants were sequentially assigned into treatment and control groups. Treatment consisted of a 2-minute procedure using orthopedic blocks (padded wedges with a 45° incline) that were placed bilaterally under the ilia as determined by leg length assessment. Isometric strength measurements took place in 2 sessions with a day of rest between. The treatment group received therapy at the second session immediate to postisometric measures. **Results:** Outcome measures were the pre- and posttreatment measurements of cervical isometric extension strength in pounds. The t tests showed no statistically significant difference between groups in isometric extension strength before treatment. One-way analysis of variance demonstrated a significant difference between groups after treatment ($F1,21 = 7.174$, $P = .014$). The treatment group demonstrated an average increase of 6.35 (8.18) lb in extensor strength. **Conclusions: The current study showed a statistically significant change in cervical isometric extensor strength after sacroiliac joint blocking.**
Evaluation of Applied Kinesiology meridian techniques by means of surface electromyography (sEMG): demonstration of the regulatory influence of antique acupuncture points. Moncayo R, Moncayo H.	*Chin Med.* 2009 May 29;4(1):9. **ABSTRACT: BACKGROUND:** The use of Applied Kinesiology techniques based on manual muscle tests relies on the relationship between muscles and acupuncture meridians. Applied Kinesiology detects body dysfunctions based on changes in muscle tone. Muscle tonification or inhibition within the test setting can be achieved with selected acupoints. These acupoints belong to either the same meridian or related meridians. The aim of this study is to analyze muscle sedation and tonification by means of surface electromyography. **METHODS:** Manual muscle tests were carried out using standard Applied Kinesiology (AK) techniques. The investigation included basic AK procedures such as sedation and tonification with specific acupoints. The sedation and tonification acupoints were selected from related meridians according to the Five Elements. The tonification effect of these acupoints was also tested while interfering effects were induced by manual stimulation of scars. The effects of selective neural therapy, i.e. individually tested and selected anesthetic agent, for the treatment of scars were also studied. The characteristics of muscle action were documented by surface electromyographys (sEMG). **RESULTS:** The sEMG data showed a diminution of signal intensity when sedation was used. Graded sedation resulted in a graded diminution of signal amplitude. Graded increase in signal amplitude was observed when antique acupuncture points were used for tonification. The tactile

	stretch stimulus of scars localized in meridian-independent places produced diminution of signal intensity on a reference muscle, similar to sedation. These changes, however, were not corrected by tonification acupoints. Correction of these interferences was achieved by lesion specific neural therapy with local anesthetics. **CONCLUSION:** We demonstrated the central working principles, i.e. sedation and tonification, of Applied Kinesiology through the use of specific acupoints that have an influence on manual muscle tests. Sedation decreases RMS signal in sEMG, whereas tonification increases it. Interfering stimuli from scars were corrected by selective neural therapy. **Comment:** AK MMT was conducted throughout in this study. The investigation included stimulating sedation and tonification points of the same meridian being investigated. From the conclusion: "We have been able to demonstrate one of the working principles of Applied Kinesiology in relation to tonification or sedation through the use of specific acupuncture points."

Sacroiliac Orthopedic Blocking Improves Cervical Spine Extensor Isometric Strength. Giggey K, Tepe R.	*J Chirop Ed.* 2009;21(1): 68. **Purpose:** Reviews of the effects of chiropractic manipulative therapy on head and neck conditions are equivocal. The spine is a kinematic chain subject to reflexive muscle responses induced by the stimulation of muscle and joint afferents. The purpose is to determine if an orthopedic blocking procedure may be a useful adjunctive treatment for cervical spine dysfunction. **Methods:** Following written informed consent, 22 participants with a measured leg length inequality of 5 mm or more were sequentially assigned into treatment and control groups. Treatment consisted of a 2-minute procedure using orthopedic blocks (padded wedges with a 45 degree incline), which were placed bilaterally under the ilia as determined by leg length assessment**. Isometric strength measurements took place in two sessions with a day of rest between.** The treatment group received therapy at the second session immediate to post isometric measures. **Results:** Outcome measures were the pre and post measurements of cervical isometric extension strength in pounds. T-tests showed no statistically significant difference between groups in isometric extension strength prior to treatment. **One-way ANOVA demonstrated a significant difference between groups following treatment. F (1, 21) = 7.174; p = .014. The treatment group demonstrated an average increase of 6.35 (818) lbs in extensor strength. Conclusions: The current study showed a statistically significant change in cervical isometric extensor strength following SIJ manipulation.** Orthopedic blocking may be a useful adjunctive treatment for cervical spine dysfunction. **Comment:** In AK clinical practice, the use of SOT methods of spinal manipulation – based on AK MMT diagnostic findings – consistently improves muscle strength on the MMT.
The Use of Traditional Chinese Medicine Principles In Chiropractic Technique, Brown BT, Bonello R, Pollard H.	*Chiropr J Aust* 2009;38:18-26. **Abstract:** **Objectives:** The authors of this manuscript seek to define the role, and scientific backing for the inclusion of Traditional Chinese Medicine (TCM) principles in the chiropractic techniques known as Applied Kinesiology (AK) and Neuro-Emotional Technique (NET). A discussion of the suitability of TCM principles within the chiropractic profession is also presented. **Data Sources:** A search through the electronic databases Medline, Meditext, Pubmed, OVID< CINAHL, and the Cochrane Library was performed for the period of 1900-2007 using the key words Traditional Chinese Medicine, meridian, five-element, five-phase, acupuncture, chiropractic, Applied Kinesiology, and Neuro-Emotional Technique. The results were limited to works published in English appearing in peer-reviewed journals. A hand search was then performed within the reference lists of the articles retrieved. **Study Selection:** Based on their relevance to the subject, 196 references were obtained. Data Extraction and Synthesis: Only those historical principles and current research findings that pertain specifically to the TCM concepts used in AK and NET have been included. **Conclusions:** Principles and philosophies from TCM are incorporated into the diagnostic and treatment protocols of the chiropractic techniques AK and NET. The scientific backing for this inclusion is still evolving and it is clear that further research is required to support the placement of TCM principles and practices within these chiropractic techniques. The welcoming of TCM principles into chiropractic practice may broaden the scope of the chiropractic profession and allow chiropractors to more faithfully adhere to the biopsychosocial model of health care. **Comment:** Meridian therapy was introduced into AK (and into the chiropractic profession at large) by Dr. Goodheart in 1966. Goodheart and the ICAK have provided some of the first advancements in the area of acupuncture diagnosis in the Western world. By using AK techniques, the movement of acupuncture energy in the meridians can be evaluated and corrected if out of balance. AK methodologies have also helped in the understanding of why there may be imbalance of energy in the meridian system. Other researchers in this compendium have described the value of the AK method in determining problems related to the meridian system, and this is an area where further research will necessarily continue.
Anxiety and depression	*J Altern Complement Med.* 2009 Feb;15(2):121-7.

profile of 188 consecutive new patients presenting to a neuro-emotional technique practitioner. Bablis P, Pollard H.	**Abstract:** **Objective:** The objective of this study was to describe the profile of a cohort of patients who presented to a Neuro-Emotional Technique (NET) clinic. This study investigated the change in the Distress and Risk Assessment Method (DRAM) outcome measure score after a 3-month course of NET was administered to participants. **Design and setting:** This was an uncontrolled cohort study in private practice. **Subjects:** One hundred and eighty-eight (188) consecutive new patients presented to a NET clinic. **Intervention:** The intervention was a 3-month course of NET, which incorporates elements of muscle testing, general semantics, Traditional Chinese Medicine, acupuncture, and chiropractic principles to manage patients' conditions. **Outcome measures:** Scoring on the DRAM questionnaire was the outcome measure. **Results:** Of the participants, 55.9% had musculoskeletal complaints, 34.6% had nonmusculoskeletal complaints, and 9.6% reported no presenting complaint. Strongly significant differences in the mean DRAM scores and the mean individual component scores were found between pre- and post-treatment. There was strong evidence to suggest that the Modified Somatic Perceptions Questionnaire and the Modified Zung Depression Index scores were correlated ($p < 0.001$), and that the allocation of subjects in any pretest category to categories on the basis of post-test scores changed from category to category. **Conclusions:** NET is different from traditionally described chiropractic practice, and appears, based on this one clinic, to have far more nonmusculoskeletal presentations. This profile, if consistent with other practices, has strong implications for scope of practice for this form of chiropractic practitioners. Many participant presentations were "at risk" of, or were clinically depressed, according to the DRAM. The DRAM status of the patient cohort significantly and clinically improved with the NET treatment. As this study was nonrandomized and uncontrolled, the results should be viewed with caution. We recommend that larger-scale randomized controlled trials be commenced to investigate the preliminary findings of this report.
A randomised controlled trial of the Neuro Emotional Technique (NET) for childhood Attention Deficit Hyperactivity Disorder (ADHD): a protocol. Karpouzis F, Pollard H, Bonello R.	*Trials.* 2009 Jan 27;10(1):6. **ABSTRACT:** **BACKGROUND:** An abundance of literature is dedicated to research for the treatment of Attention Deficit Hyperactivity Disorder (ADHD). Most, is in the area of pharmacological therapies with less emphasis in psychotherapy and psychosocial interventions and even less in the area of complementary and alternative medicine (CAM). The use of CAM has increased over the years, especially for developmental and behavioral disorders, such as ADHD. 60-65% of parents with children with ADHD have used CAM. Medical evidence supports a multidisciplinary approach (i.e. pharmacological and psychosocial) for the best clinical outcomes. The Neuro Emotional Technique (NET), a branch of Chiropractic, was designed to address the biopsychosocial aspects of acute and chronic conditions including non-musculoskeletal conditions. Anecdotally, it has been suggested that ADHD may be managed effectively by NET. Design/methods A placebo controlled, double blind randomised clinical trial was designed to assess the effectiveness of NET on a cohort of children with medically diagnosed ADHD. Children aged 5-12 years who met the inclusion criteria were randomised to one of three groups. The control group continued on their existing medical regimen and the intervention and placebo groups had the addition of the NET and sham NET protocols added to their regimen respectively. These two groups attended a clinical facility twice a week for the first month and then once a month for six months. The Conners' Rating Scales (CRS) were used at the start of the study to establish baseline data and then in one month and in seven months time, at the conclusion of the study. The primary outcome measures chosen were the Conners' ADHD Index and Conners' Global Index. The secondary outcome measures chosen were the DSM-IV: Inattentive, the DSM-IV:Hyperactive-Impulsive, and the DSM-IV:Total subscales from the Conners' Rating Scales, monitoring changes in inattention, hyperactivity and impulsivity. Calculations for the sample size were set with a significance level of 0.05 and the power of 80%, yielding a sample size of 93. **DISCUSSION:** The present study should provide information as to whether the addition of NET to an existing medical regimen can improve outcomes for children with ADHD.

	Comment: Within the framework of AK there are many examination and therapeutic procedures that are intimately involved with the mental-emotional side of the triad of health. As AK has grown and branched into so many areas within the healing arts, it has become apparent that many mental and emotional problems are due to physiologic dysfunction. When the body is returned to normal function, the mental or emotional problem is often eliminated or the patient is better able to cope with it. The literature on the AK and its associated MMT systems of diagnosis and treatment in relationship to children with various kinds of cognitive and behavioral disorders is growing. This paper is an important contribution to our understanding of how manual treatments may be helpful in these children.

Common errors and clinical guidelines for manual muscle testing: "the arm test" and other inaccurate procedures. Schmitt WH Jr, Cuthbert SC.	*Chiropr Osteopat.* 2008 Dec 19;16(1):16. **BACKGROUND:** The manual muscle test (MMT) has been offered as a chiropractic assessment tool that may help diagnose neuromusculoskeletal dysfunction. We contend that due to the number of manipulative practitioners using this test as part of the assessment of patients, clinical guidelines for the MMT are required to heighten the accuracy in the use of this tool. **OBJECTIVE:** To present essential operational definitions of the MMT for chiropractors and other clinicians that should improve the reliability of the MMT as a diagnostic test. Controversy about the usefulness and reliability of the MMT for chiropractic diagnosis is ongoing, and clinical guidelines about the MMT are needed to resolve confusion regarding the MMT as used in clinical practice as well as the evaluation of experimental evidence concerning its use. **DISCUSSION:** We expect that the resistance to accept the MMT as a reliable and valid diagnostic tool will continue within some portions of the manipulative professions if clinical guidelines for the use of MMT methods are not established and accepted. Unreliable assessments of this method of diagnosis will continue when non-standard MMT research papers are considered representative of the methods used by properly trained clinicians. **CONCLUSION:** Practitioners who employ the MMT should use these clinical guidelines for improving their use of the MMT in their assessments of muscle dysfunction in patients with musculoskeletal pain.
On: Hall S, Lewith G, Brien S, Little P: A review of the literature in applied and specialised kinesiology. Forsch Komplementmed 2008;15:40-46. McDowall D, Cuthbert S.	*Forsch Komplementmed.* 2008 Dec;15(6):348-50. **Abstract:** We commend the authors for attempting an in-depth literature review of such a diverse field as Specialised Kinesiology. Their recommendations for the tools that can be used in methods of analysis in future studies are well advised. The title of their paper, however, suffers from design flaws and is deceptive. This paper is primarily a review of Touch for Health Kinesiology and its family of techniques, which should be distinctly differentiated from Applied Kinesiology as defined by the International College of Applied Kinesiology. **Comment:** The ICAK replied to Hall et al's critique denying the reliability and validity of the MMT, applied kinesiology, and Touch for Health methods with a detailed rebuttal. The type of testing their literature review limited itself to was the light "two-finger pressure testing" used by some elements of the Touch for Health community. This kind of "confusion" about what AK methods are and claims to be is very common in the scientific literature.
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.).
A Multi-Modal Chiropractic Treatment Approach for Asthma: a 10-Patient Retrospective Case Series, Cuthbert SC.	*Chiropr J Aust* 2008;38:17-27. **Objective:** To describe the clinical management of 10 cases of childhood asthma using a conservative, multi-modal treatment approach based on applied kinesiology (AK) chiropractic methods. **Clinical Features:** Ten patients are presented (7 male, 3 female) between the ages of 3 and 22. Each patient had been medically diagnosed and treated for asthma, and all patients were taking one or more asthma medications. **Intervention and Outcome:** After physical, orthopaedic and AK manual muscle testing examination, the patients were admitted to a multi-modal treatment protocol including chiropractic manipulative therapy, cranial manipulative therapy, muscle therapies aimed at strengthening the muscles of respiration, and nutritional evaluation using the methods developed in applied kinesiology chiropractic. Outcome measures for the study included subjective/objective visual analogue respiratory impairment scales (VAS), improvement in exercise-induced asthma symptoms, reduction in respiratory distress with daily activity, reduction in the frequency of coughing during the day and night, and ease of breathing. These assessments were gathered from both the children and their parents or guardians. Additionally, each patient was able to go off their asthma medications over a range of 3-6 visits (covering a range of 14 days to 5 months times) without a return of their asthma symptoms. All the patients remained off their medications during a follow-up period ranging from 3 months to 4 years. **Conclusion:** A percentage of patients presenting to chiropractors have asthma. This case series report suggests that a potential benefit may exist in asthma-associated symptoms for selected cases treated with this multi-modal chiropractic protocol.
Can ankle imbalance be a risk factor for tensor fascia lata muscle weakness? Zampagni ML, Corazza I, Molgora AP, Marcacci M.	*J Electromyogr Kinesiol.* 2008 May 1. **Abstract:** Risk factors that can determine knee and ankle injuries have been investigated and causes are probably multifactorial. A possible explanation could be related by the temporary inhibition of muscular control following an alteration of proprioceptive regulation due to the ankle imbalance pathology. The purpose of our study was to validate a new experimental set up to quantify two kinesiologic procedures **(Shock Absorber Test (SAT) and Kendall and Kendall's Procedure (KKP)) to verify if a subtalus stimulus in an ankle with imbalance can induce a non-appropriate response of controlateral tensor fascia lata muscle (TFL).** Fifteen male soccer **players with ankle imbalance** (AIG) and 14 healthy (CG) were tested after (TEST) before (NO-TEST) **a manual percussion in subtalus joint (SAT).** A new tailor-made device equipped with a load cell was used to quantify TFL's strength activation in standardized positions. Two trials for each subject were performed, separated by at least one 4-min resting interval. In NO-TEST conditions both AIG and CG showed a progressive adaptation of the subject to the force imposed by operator. No reduction in mean force, mean peak force, and muscle force duration ($p>0.5$). AIG presented significant differences (mean difference 0.92+/-0.46s; $p=0.000$) in muscle force duration in TEST conditions. **Our results indicated that "wrong" proprioceptive stimuli coming from the subtalus joint in AIG might induce inhibition in terms of duration of TFL muscle altering the knee stability. This kinesiological evaluation might be useful to prevent ankle and knee injuries.** **Comment:** This fascinating study investigates two fundamental procedures developed in AK

	over 25 years ago. This research report (conducted by physical therapists and medical doctors in Italy) specifically cites AK as the source for the information in this study. The "shock absorber test" developed in AK is a screening examination for extended foot pronation, subluxations, and other dysfunctions of the foot. When there is foot dysfunction, quite often after striking the foot with many vectors, a previously strong indicator muscle will test weak. This was demonstrated in this controlled clinical trial. In the earlier days of applied kinesiology, Goodheart reported that Edward Doss, Sr., D.C., of Stuttgart, Arkansas, told him of his frequent observation that a lateral cuboid subluxation correlated with a tensor fascia lata muscle that tested weak. Correction of the subluxation returned normal function to the muscle as observed by manual muscle testing. Goodheart concurred with the observation, and also found that adjusting the medial transverse arch (medial cuboid) often corrected adductor muscles that tested weak.

Applied Kinesiology: An Effective Complementary Treatment for Children with Down Syndrome, Cuthbert SC.	*Townsend Letter.* 2007 July;288:94-107. **Abstract:** This essay describes 15 children's case histories who have Down syndrome, and provides their clinical findings and their evaluation and treatment using applied kinesiology methods. Children with Down syndrome will be developmentally slower than their siblings and peers and have intellectual functioning in the moderately disabled range, but the range is enormous and the distance from their peers is the crucial factor where chiropractic and cranial therapeutics can make a profound difference.
Individual prognosis regarding effectiveness of a therapeutic intervention using pre-therapeutic "kinesiology muscle test". Waxenegger I, Endler PC, Wulkersdorfer B, Spranger H.	*Scientific World Journal.* 2007 Oct 22;7:1703-7. **Abstract:** Since a therapy's full positive effect and possible adverse effects are individual and not predictable for every single patient, scientists have been searching for methods to predict optimal effects of a therapy. This pilot study investigated the applicability of the "kinesiology muscle test" as a prognostic tool regarding effectiveness in a defined therapeutic procedure. Each of 11 test persons with elevated total cholesterol values received a naturopathic drug supposed to lower cholesterol level on a daily basis for eight consecutive weeks. Prior to treatment the "kinesiology muscle test" was performed, where the patients' ability to maintain a flexed position in a selected joint was evaluated. The resistance created by the patient against the tester's pressure was monitored. Being in touch with healthful or unhealthful chemical substances may, according to the kinesiology literature, increase or decrease this resistance. For testing purposes, the drug was placed onto the patients' skin. The ability of the brachioradial muscle to resist the tester's pressure was determined on a subjective scale (0-100%). The Pearson product-moment correlation coefficient between four variables (total cholesterol value before therapy, total cholesterol value after therapy, difference of total cholesterol values before and after therapy, prior to treatment kinesiology testing) was chosen. A significant correlation between the difference of total cholesterol values before-after and the prior to treatment test was found, as well as a significant correlation between the total cholesterol values after therapy and the prior to treatment kinesiology test. **Comment:** Papers like this one are common in the literature: they employ research designs that do not reflect the clinical practice and the principles of AK. Laying nutrition or other chemical substances on the skin (or in a vial held by the patient) is specifically forbidden by the ICAK as a method of testing because the lingual receptors are not engaged. In practice, AK MMT is used as an adjunct rather than alternative to other diagnostic measures (especially regarding nutritional or non-musculoskeletal conditions) and multiple AK MMTs are performed in series and parallel fashion before any diagnosis is ever made. Diagnosis regarding the benefit or harm of a nutritional or chemical element is always correlated with laboratory and other methods of analysis before a determination is made. **However, this paper does show that the MMT as used in AK has a high sensitivity, i.e. cholesterol lowering medications for patients with elevated cholesterol levels produce an increase in muscle strength.**
Foci and areas of disturbance in the trigeminal region. Implications for orthopedics, implantology, and gnathology, Garten H.	*Manuelle Medicin* 2007 May: 1433-0466. **Abstract:** Foci and areas of disturbance are defined. Both have structural impact on the cervical spine and primarily or secondarily on the craniomandibular system. Implants have become a standard in modern odontology and are ideal if the bone that carries them is free of foci. Fixed bridges of edentulous jaw areas as well as rigid junctions and block crowning of implants may cause a disturbance, which is widely ignored. It is characterized by intraosseous tension. Local and distant dysfunctions including pain syndromes may result. A great deal of foci and areas of disturbance like radical granulomas and ostitis as well as intraosseous tension cannot be detected with the usual clinical methods (X-ray, vitality test). Functional neuromuscular assessment of professional **applied kinesiology** offers a reproducible diagnostic protocol if used together with decoder dermography. The protocol is described and illustrated by case reports.

On the reliability and validity of manual muscle testing: a literature review, Cuthbert SC, Goodheart GJ Jr.	*Chiropr Osteopat.* 2007 Mar 6;15(1):4. **ABSTRACT:** A body of basic science and clinical research has been generated on the manual muscle test (MMT) since its first peer-reviewed publication in 1915. The aim of this report is to provide an historical overview, literature review, description, synthesis and critique of the reliability and validity of MMT in the evaluation of the musculoskeletal and nervous systems. **METHODS:** Online resources were searched including Pubmed and CINAHL (each from inception to June 2006). The search terms manual muscle testing or manual muscle test were used. Relevant peer-reviewed studies, commentaries, and reviews were selected. The two reviewers assessed data quality independently, with selection standards based on predefined methodologic criteria. Studies of MMT were categorized by research content type: inter- and intra-examiner reliability studies, and construct, content, concurrent and predictive validity studies. Each study was reviewed in terms of its quality and contribution to knowledge regarding MMT, and its findings presented. **RESULTS:** More than 100 studies related to MMT and the applied kinesiology chiropractic technique (AK) that employs MMT in its methodology were reviewed, including studies on the clinical efficacy of MMT in the diagnosis of patients with symptomatology. With regard to analysis there is evidence for good reliability and validity in the use of MMT for patients with neuromusculoskeletal dysfunction. The observational cohort studies demonstrated good external and internal validity, and the 12 randomized controlled trials (RCTs) that were reviewed show that MMT findings were not dependent upon examiner bias. **CONCLUSION:** The MMT employed by chiropractors, physical therapists, and neurologists was shown to be a clinically useful tool, but its ultimate scientific validation and application requires testing that employs sophisticated research models in the areas of neurophysiology, biomechanics, RCTs, and statistical analysis. **Comment:** This is a landmark study presenting the basic science and clinical research evidence for the reliability and validity of the manual muscle test and applied kinesiology chiropractic technique. The literature review presents the results of more than 100 peer-reviewed studies related to the manual muscle test (MMT) and the applied kinesiology chiropractic technique (AK). **Muscle testing, which is the backbone of AK, now has support for its use in the field of chiropractic to diagnose and treat neuromusculoskeletal dysfunction.**
Sunflower therapy for children with specific learning difficulties (dyslexia): a randomised, controlled trial. Bull L.	*Complement Ther Clin Pract.* 2007 Feb;13(1):15-24. Epub 2006 Dec 15. The aim of the study was to determine the clinical and perceived effectiveness of the Sunflower therapy in the treatment of childhood dyslexia. The Sunflower therapy includes **applied kinesiology**, physical manipulation, massage, homeopathy, herbal remedies and neuro-linguistic programming. A multi-centred, randomised controlled trial was undertaken with 70 dyslexic children aged 6-13 years. The research study aimed to test the research hypothesis that dyslexic children 'feel better' and 'perform better' as a result of treatment by the Sunflower therapy. Children in the treatment group and the control group were assessed using a battery of standardised cognitive, Literacy and self-esteem tests before and after the intervention. Parents of children in the treatment group gave feedback on their experience of the Sunflower therapy. Test scores were compared using the Mann Whitney, and Wilcoxon statistical tests. While both groups of children improved in some of their test scores over time, there were no statistically significant improvements in cognitive or Literacy test performance associated with the treatment. However, there were statistically significant improvements in academic self-esteem, and reading self-esteem, for the treatment group. The majority of parents (57.13%) felt that the Sunflower therapy was effective in the treatment of learning difficulties. Further research is required to verify these findings, and should include a control group receiving a dummy treatment to exclude placebo effects.

The Effects of Chiropractic Care on Individuals Suffering from Learning Disabilities and Dyslexia: A Review of the Literature, Pauli Y.	*J Vertebral Subluxation Res* 2007, Jan 15:1-12. **Objective**: To present current mainstream and alternative theories about learning disabilities, with a special emphasis on dyslexia, as well as to systematically review the chiropractic and related literature about the effects of chiropractic care in people suffering from learning disabilities and dyslexia, and to compare chiropractic causal theories to accepted medical models. **Methods**: Computerized and hand searching of the various databases Mantis, ICL, CRAC **as well as the Proceedings of the International College of Applied Kinesiology were conducted with the following index terms: "dyslexia", "learning", "learning disabilities", "learning disorders", "applied kinesiology", and "neurologic disorganization".** The retrieved literature was selected or rejected according to predetermined inclusion and exclusion criteria and was subsequently classified according to level of evidence and critically reviewed on predefined methodologic criteria. We also compared the various causal chiropractic theories to accepted mainstream science causal theories of learning disability and dyslexia. **Results**: Eight studies met our criteria. Four of them belonged to the lowest class of evidence, for a total of 25 anecdotal reports. The remaining four were before/after studies. None of the studies met all of our predefined methodologic criteria. Points of interests and methodologic weaknesses are discussed. **Conclusion**: All studies reviewed suggested a positive effect of chiropractic care in individuals suffering from learning disabilities and dyslexia. However, the various methodological weaknesses of those studies preclude any definitive conclusions and all the results are therefore to be considered preliminary. Within those limitations, there seem to exist a potential role for chiropractic care in improving various cognitive modalities known to be essential in learning. The model of vertebral subluxation and its effects on cognitive function may serve as a link between the field of chiropractic care and the neuroscience of those disorders. **Comment:** This paper offers an excellent review of AK concepts regarding the treatment of children with learning disabilities and dyslexia. This is an extensive review and a description of the evidence-base in the literature regarding outcomes for these children who have been treated with AK.

A musculoskeletal model of low grade connective tissue inflammation in patients with thyroid associated ophthalmopathy (TAO): the WOMED concept of lateral tension and its general implications in disease. Moncayo R, Moncayo H.	*BMC Musculoskelet Disord.* 2007 Feb 23;8:17. **BACKGROUND:** Low level connective tissue inflammation has been proposed to play a role in thyroid associated ophthalmopathy (TAO). The aim of this study was to investigate this postulate by a musculoskeletal approach together with biochemical parameters. **METHODS:** 13 patients with TAO and 16 controls were examined. Erythrocyte levels of Zn, Cu, Ca2+, Mg, and Fe were determined. The musculoskeletal evaluation included observational data on body posture with emphasis on the orbit-head region. The angular foot position in the frontal plane was quantified following gait observation. The axial orientation of the legs and feet was evaluated in an unloaded supine position. Functional propioceptive tests based on stretch stimuli were done by using foot inversion and foot rotation. **RESULTS:** Alterations in the control group included neck tilt in 3 cases, asymmetrical foot angle during gait in 2, and a reaction to foot inversion in 5 cases. TAO patients presented facial asymmetry with displaced eye fissure inclination (mean 9.1 degrees) as well as tilted head-on-neck position (mean 5.7 degrees). A further asymmetry feature was external rotation of the legs and feet (mean 27 degrees). Both foot inversion as well as foot rotation induced a condition of neuromuscular deficit. This condition could be regulated by gentle acupressure either on the lateral abdomen or the lateral ankle at the acupuncture points gall bladder 26 or bladder 62, respectively. In 5 patients, foot rotation produced a phenomenon of moving toes in the contra lateral foot. In addition foot rotation was accompanied by an audible tendon snapping. Lower erythrocyte Zn levels and altered correlations between Ca2+, Mg, and Fe were found in TAO. **CONCLUSION:** This whole body observational study has revealed axial deviations and body asymmetry as well as the phenomenon of moving toes in TAO. The most common finding was an arch-like displacement of the body, i.e. eccentric position, with foot inversion and head tilt to the contra lateral side and tendon snapping. We propose that eccentric muscle action over time can be the basis for a low grade inflammatory condition. The general implications of this model and its relations to Zn and Se will be discussed. **Comment:** The Moncayos are endocrinologists also trained in AK as well as acupuncture who have displayed a keen interest in thyroid disorders. This “open access” paper is available in full and free of charge on-line and it describes the postural, endocrinological, acupuncture, and nutritional aspects of thyroid associated disorders. The interactions of organic disorders with neuromusculoskeletal dysfunction is displayed with remarkable clarity in this paper, and it’s recommended to everyone interested in AK methods.
Cranial Therapeutic Care: Is There any Evidence? Blum CL, Cuthbert S.	*Chiropractic & Osteopathy* 2006, 14:10. **Background:** In the commentary by Hartman, (Cranial osteopathy: its fate seems clear, Chiropractic & Osteopathy 2006, 14:10.) he has attempted to elicit a response by making far overreaching statements, which are ironic since Hartman thinly veils himself in a gossamer cloak of science, research, and evidenced-based healthcare. Hartman has picked an isolated diagnostic procedure or treatment, cerebrospinal fluid (CSF) pulsation palpation, questioned its reliability and validity, and then used this fractional aspect of a method of care to condemn all of cranial therapy. What can be said by Hartman and fairly so, is that from his review of selected studies regarding CSF palpation as discussed in cranial therapeutic care, further study to investigate its validity and reliability is warranted and this component of cranial diagnosis should not be used at this time as a sole criteria for cranial diagnosis or treatment. **Discussion** Much of Hartman’s position is refuted by, at the very least, reviewing the difference between the gross mechanical aspects of cranial care, which has documentation, and the subtle mechanical aspects, which remain controversial. A comprehensive evidenced based rationale of cranial therapeutics is presented along with three tables listing pertinent studies relating to cranial bone dynamics and the efficacy of cranial manipulative therapy. **Conclusion** While the onus to do the research is upon those who are proponents of a method of care, there is also an onus upon those who call for its virtual abolition to be familiar with all the published research on the topic and how evidenced based clinical practice is formulated.

Lower limb manual muscle testing in the early stages of Charcot-Marie-Tooth disease type 1A, Vinci P, Serrao M, Pierelli F, Sandrini G, Santilli V.	*Funct Neurol.* 2006 Jul-Sep;21(3):159-63. **Abstract:** Charcot-Marie-Tooth disease (CMT) is a genetically and clinically heterogeneous disorder that affects approximately one in 2,500 individuals. CMT 1A, which is due to a duplication in the area containing the PMP-22 gene on chromosome 17, is the most frequent CMT subtype. **To date, there is no consensus among authors about which muscles are weakened in the early stages of CMT, even though this knowledge would be crucial for deciding the most appropriate interventions to restore balance between muscles and prevent the development of deformities.** The aim of this study was to evaluate the strength of several lower limb muscles in the early stages of CMT 1A. In a series of 45 patients (age 10-72 years; 21 males, 24 females) affected by CMT 1A, we evaluated 83 non-operated lower limbs that corresponded to the two milder stages of a five-level functional classification. The strength of two foot muscles, seven leg muscles, two thigh muscles, and three pelvic girdle muscles was graded using the manual muscle testing techniques of Daniels and Worthingham; the power of the triceps surae was graded, in the prone position, using a 4-level scale of ability to raise the heel from the floor. Muscle strength was determined on the basis of interobserver agreement estimated by kappa statistics between two observers. The flexor hallucis brevis and lumbricals were very weak in all the limbs; the leg muscles were strong in more than 90% of limbs, except the peronei (strong in 83.13%); all the triceps surae were strong in the prone test, but 16.87% were weak in the standing test; all the proximal muscles were strong. In the large majority of patients in the early stages of CMT 1A, the intrinsic foot muscles are very weak and the leg and proximal muscles are strong.

Proposed mechanisms and treatment strategies for motion sickness disorder: A case series, Cuthbert S.	*Journal Chiro Med*, Spring 2006;5(1):22-31. **Objective:** To present an overview of symptomatic motion sickness disorder, with allopathic and chiropractic approaches for treatment. A convenience sample of three representative cases is presented involving patients with motion sickness, ranging in age from 9 to 66. All three patients had suffered from this condition throughout their lives. **Clinical Features:** A discussion of the hypothesis of sensory conflict as a causative factor in cases of motion sickness will be given. Specific diagnostic tests and clinical rationales in relation to the diagnosis and chiropractic treatment of patients with motion sickness will be presented. **Intervention and Outcome:** Following spinal and cranial manipulative treatment the three patients were able to travel long distances without nausea, sickness, or dizziness. The evaluation of these patients' responses to treatment was determined by the doctor's observation, the patients' subjective description of symptoms while riding in a motor vehicle, the Visual Analog Scale for Neck and Associated Pain, and applied kinesiology chiropractic physical assessment tools. **Conclusion:** Further studies into chiropractic manipulative treatments for sensory conflict and proprioceptive dysfunctions associated with the problem of motion sickness are indicated. The hypothesis of sensory conflict as the cause of motion sickness should be explored more fully by other chiropractic physicians and researchers.
The Ileocecal Valve Point and Muscle Testing: A Possible Mechanism of Action, Pollard HP, Bablis P, Bonello R.	*Chiropr Aust* 2006;36(4):122-126 and 159-160. **Abstract:** This paper presents a literature review of recent evidence showing that stimulation of the skin changes muscle strength and function. In AK, therapy localization is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system. A number of papers in this Compendium have presented the neuro-physiological basis for this finding. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and they are part of the mechanism for what is found clinically with TL testing. In AK, positive TL always calls for further investigation to the area concerned.
Can the Ileocecal Valve Point Predict Low Back Pain Using Manual Muscle Testing? Pollard HP, Bablis P, Bonello R.	*Chiropr Aust* 2006;36:58-62 **Background:** According to some technique groups in chiropractic the ileocecal valve may malfunction and be associated with a large array of health problems that can lead to common chronic health issues prevalent in our society. Many tests commonly used in chiropractic are presumed to identify painful and/or dysfunctional anatomical structures, yet many have undemonstrated reliability. Despite this lack of evidence, they form the basis of many clinical decisions. One cornerstone procedure that is frequently used by chiropractors involves the use of manual muscle testing for diagnostic purposes not considered orthopaedic in nature. A point of the body referred to as the ileocecal valve point is said to indicate the presence of low back pain. This procedure is widely used in Applied Kinesiology (AK) and Neuro-Emotional Technique (NET) chiropractic practice. **Objective:** To determine if correlation of tenderness of the "ileocecal valve point" can predict low back pain in sufferers with and without low back pain. It was the further aim to determine the sensitivity and specificity of the procedure. **Methods:** One hundred (100) subjects with and without low back pain were recruited. Subjects first completed information about their pain status, then the practitioner performed the muscle testing procedure in a separate room. The practitioner provided either a *yes* or *no* response to a research assistant as to whether he had determined if the subject had back pain based on the muscle test procedure. **Results:** Of 67 subjects who reported low back pain, 58 (86.6%) reported a positive test of both low back pain and ICV point test. Of 33 subjects, 32 (97%) with no back pain positively reported no response to ICV point test. Nine (9) subjects (13.4%) reported false negative ICV tests and low back pain, and 1 subject (3%) reported a false positive response for ICV test and no low back pain. **Conclusion:** The majority of subjects with low back pain reported positive ileocecal valve testing, and all but one of the subjects without low back pain reported negative ileocecal valve

	testing. The application of ileocecal valve testing as a diagnostic measure of low back pain was found to have excellent measures of sensitivity, specificity and diagnostic competency. This study confirms that the use of this test within the limitations of this study is reliably associated with the presence of low back pain. Further testing is required to investigate all aspects of the diagnostic milieu commonly used by proponents of this form of diagnostic testing. **Comment:** In AK, the ileocecal valve dysfunction is not related automatically to low back pain though this is a frequent consequence of the problem. Another interesting research question that might have been posed to the subjects of this study would have been whether they had experiencing any digestive difficulties and its relationship to positive MMT outcomes. The finding of excellent sensitivity and specificity in this research report is noteworthy.

Electromyogram and force patterns in variably timed manual muscle testing of the middle deltoid muscle, Conable K, Corneal J, Hambrick T, Marquina N, Zhang J.	*J Manipulative Physiol Ther.* 2006 May;29(4):305-14. **OBJECTIVE:** The objective of the study was to compare force curves and surface electromyogram from examiners and subjects during manual muscle testing with 3 examiner-identified variants of manual muscle testing (MMT)-examiner-started (ESMMT), patient-started (PSMMT), and undifferentiated/near-simultaneous (NSMMT). **METHODS:** Forty-two volunteer applied kinesiologist doctors tested 36 volunteer students, doctors, and spouses at a professional conference. Start-time difference between examiner and subject muscle contraction, peak force, time of peak force and duration of force was measured. Force and surface electromyogram from examiner and subject were recorded simultaneously during MMT of the middle deltoid muscle for each style of testing used in practice. **RESULTS:** The congruence between examiner label and timing was as follows: ESMMT, 39%; PSMMT 61%; and NSMMT 28% within 50 milliseconds of simultaneous. Mean subject/examiner start-time difference differed significantly between PSMMT (-0.116 seconds) and both ESMMT (-0.018 seconds) and NSMMT (-0.0053 seconds). No clear cutoff between styles was evident. Peak force ranged from 0.548 to 23.615 lb (mean, 8.806 lb; SD, 4.543 lb), and all styles were significantly different. Duration of force ranged from 0.325 to 3.490 seconds (mean, 1.338 seconds; SD, 0.576 seconds), with NSMMT significantly shorter than ESMMT or PSMMT. The shape of force curves did not differ between styles of muscle testing, but differed between facilitated vs. inhibited tests. **CONCLUSIONS:** In this group of doctors, neither start-time difference nor the shape of force curves distinguished styles of MMT. Differences in peak force and test duration may account for differences in outcomes when examiners purposely vary their muscle testing style.
Applied Kinesiology in Chiropractic, Zhang J, Hambrick T, Conable K.	*Journal of Chiropractic Education* 2006;20(1):112 **Abstract:** The purpose of the study is to investigate important factors that affect the practice of applied kinesiology (AK) in chiropractic care. The research questions in this survey included AK practitioners' attitude toward research, how they used the doctor-initiated, patient-initiated and simultaneous muscle testing in patient care, and satisfaction with AK practice. This study was conducted through the use of a questionnaire containing 36 questions ranging from demographic factors to factors affecting the practice of AK in chiropractic in the USA. Six hundred and eighty nine surveys were sent to the membership of the ICAK-USA (593 doctors, 96 chiropractic students). One hundred forty-seven surveys were returned to the ICAK-USA Central office. Frequency analysis, mean values, standard deviation and correlations were used for the statistical analysis. A total of 147 AK doctors (120 male, 26 female, one did not report gender) completed the questionnaire. Their ages ranged from 24 to 78 years with an average of 44.6±11.6. Years in practicing AK ranged from 1 year to 43 years with an average of 14.3±10.2 years. Doctors expressed strong satisfaction in practicing AK with an average of 6.67±0.59 (minimum of 4 and maximum 7). This was the highest rating among all the questions as 90 doctors selected 7 in the question. Using doctor-initiated testing (4.30±2.33) was rated higher than patient-initiated testing (3.92±2.08). Using simultaneous AK testing was rated between doctor and patient-initiated testing (3.99±2.30). More doctors differentiate muscle testing styles (61.9%) than do not (32%). Most AK doctors did not use needle acupuncture in their practice, but many of them use non-invasive acupuncture treatment. It was concluded that most AK practitioners very satisfied with the AK technique in their practice. They realized the importance of research in the AK practice. There were no major differences in responses to the survey categorized by preference for doctor-initiated, patient-initiated and simultaneous muscle testing.
Intra-rater and inter-rater reliability of the 10-point Manual Muscle Test (MMT) of strength in children with juvenile idiopathic	*Phys Occup Ther Pediatr.* 2006;26(3):5-17. **OBJECTIVE:** Children with juvenile idiopathic inflammatory myopathies (JIIM) present with muscle inflammation and decreased strength that may affect their functional abilities. The purpose of this study was to determine the intra-rater and inter-rater reliability of the 0 to 10-point manual muscle testing method for children with JIIM. **METHODS:** For the intra-rater and

inflammatory myopathies (JIIM), Jain M, Smith M, Cintas H, Koziol D, Wesley R, Harris-Love M, Lovell D, Rider LG, Hicks J.	inter-rater reliability studies, 10 and 9 children with JIIM participated, respectively. For intra-rater reliability, one pediatric therapist completed two assessments in one day with a one-hour break. For inter-rater reliability, four therapists assessed the same child within a single morning. **RESULTS:** Spearman correlations for intra-rater reliability ranged from 0.70 to 1.00. Kendall's W coefficient for inter-rater reliability of groups of muscles (total, proximal, distal, and peripheral) ranged from 0.51 to 0.76. **CONCLUSIONS: The total, proximal, and peripheral Manual Muscle Test (MMT) score, using the 0-10 point scale, has acceptable reliability in JIIM patients.**
Chiropractic Testing for Equilibrium and Balance Disorders, Cuthbert S.	*DC Tracts* May 2006. **Abstract:** For about 76 million Americans, proprioceptive disorders cause more than a passing problem. More than 5 million of them visit their doctors each year because occasional or chronic feelings of wooziness, spinning, lack of balance, and fainting are seriously interfering with their ability to work or to enjoy their leisure. In fact, dizziness and other equilibrium disorders is one of the most common symptoms reported to physicians. The effective diagnosis and treatment of these disorders depends upon precise determination of the tissues involved producing the proprioceptive disorder, and their correction using manipulative methods. A comprehensive evaluation of the patient with equilibrium disorders using the standard techniques from AK is presented which provides additional data that informs the clinical decision-making process and directs therapy.
Symptomatic Arnold-Chiari malformation and cranial nerve dysfunction: a case study of applied kinesiology cranial evaluation and treatment, Cuthbert S, Blum C.	*J Manipulative Physiol Ther.* 2005 May;28(4):e1-6. (www.journals.elsevierhealth.com/periodicals/ymmt) **Objective:** To present an overview of possible effects of Arnold-Chiari malformation (ACM) and to offer chiropractic approaches and theories for treatment of a patient with severe visual dysfunction complicated by ACM. **Clinical Features**: A young woman had complex optic nerve neuritis exacerbated by an ACM (Type I) of the brain. **Intervention and Outcome**: Applied kinesiology chiropractic treatment of the spine and cranium was used for treatment of loss of vision and nystagmus. After treatment, the patient's ability to see, read, and perform smooth eye tracking showed significant and lasting improvement. **Conclusion**: Further studies into applied kinesiology and cranial treatments for visual dysfunctions associated with ACM may be helpful to evaluate whether this single case study can be representative of a group of patients who might benefit from this care.
Interexaminer reliability of the deltoid and psoas muscle test, Pollard H, Lakay B, Tucker F, Watson B, Bablis P.	*J Manipulative Physiol Ther*, Jan 2005:28(1):52-6 **Objective:** To determine if 2 practitioners of differing skill levels could reliably agree on the presence of a weak or strong deltoid or psoas muscle. **Study Design:** Interexaminer reliability study of 2 common muscle tests. **Main Outcome Measures:** Cohen κ (unweighted) scores, observer agreement, and 95% confidence intervals (CIs). **Results:** The results showed that an experienced and a novice practitioner have good agreement when using repeated muscle test procedures on the deltoid (κ 0.62) and the psoas (κ 0.67). **Conclusions:** The manual muscle test procedures using the anterior deltoid or psoas showed good interexaminer reliability when used by an experienced and a novice user. These techniques may be used between practitioners in multidoctor assessment/management programs.
Investigation of methods and styles of manual muscle testing by AK practitioners, Conable KM, Corneal J, Hambrick T, Marquina N, Zhang J.	*J Chiropractic Med,* 2005 March;4(1):1-10 **Objective:** Establishing objective descriptive data regarding manual muscle testing (MMT) as used in Applied Kinesiology, including "patient-started" versus "examiner-started" variations, is necessary before research pertaining to the reliability and clinical significance of this procedure is done. This study measured surface electromyography (sEMG) output from experienced MMT practitioners and their tested subjects during the performance of sequential MMT on the same

	muscle during 3 styles of MMT: normally-done, examiner-started and patient-started. Methods: 21 examiners experienced in MMT and 24 subjects with varying degrees of exposure to MMT were engaged in the study. sEMG was simultaneously recorded from examiner and subject during testing of the middle deltoid muscle. The examiner first tested the middle deltoid muscle of the subject in his/her normal fashion 3 times and identified the MMT style as "examiner-started" or "patient-started." He/she was then asked to perform the other method of MMT. If the examiner said he/she did not know or did not differentiate which form of testing was initially done, he/she then performed one series each of examiner- and patient-started MMT. **Results:** Nine (approximately 43%) of testers identified their "normally done" muscle test as examiner-started, 4 (19%) as patient-started, and 8 (38%) as simultaneous or undifferentiated. In 64.5% of the MMT described as examiner started, sEMG showed that the examiner's contraction started before the patient's. In tests identified as patient-started, 54% were indeed patient started. Undifferentiated tests were 45% patient-started, 45% examiner-started, and 10% exactly simultaneous. Near simultaneous contractions were observed in 55% of all tracings evaluated and 70% of undifferentiated tests. **Conclusions:** While many MMT practitioners consider that they are performing either an examiner- or patient-started muscle test, a significant number do not make this distinction routinely. The majority of testers in this study did near-simultaneous testing regardless of label. Examiner and subject start times alone, as measured by sEMG, did not clearly differentiate between theorized forms of manual muscle testing.
Chiropractic care for a patient with spasmodic dysphonia associated with cervical spine trauma, Waddell RK.	***Journal Chiro Med,*** Winter 2005;4(1):19-24. **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 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. **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.
Kinesiology. Simeón F, Monge JC. [Article in Spanish]	*Rev Enferm.* 2005 Dec;28(12):19-22. **Abstract:** Kinesiology is a holistic and complete methodology. Having great applications in sub-clinical situations and to get rid of stress, kinesiology has proven to be of great help in pathological cases, given its possibility to activate innate health mechanisms and through its capacity to reduce stress. Kinesiology is very effective, since it is applied by means of the interested person's own muscles and at the same moment when information professionals work with is received. Besides being excellent therapy, its corrective techniques, by themselves, can improve the energetic and psychic state of a patient, thereby optimizing the resources people have in any situation.

Evaluation of Chapman's neurolymphatic reflexes via applied kinesiology: a case report of low back pain and congenital intestinal abnormality, Caso ML.	*J Manipulative Physiol Ther.* 2004 Jan;27(1):66. (www.journals.elsevierhealth.com/periodicals/ymmt) **Objective**: To describe the applied kinesiologic evaluation of Chapman's neurolymphatic (NL) reflexes in the management of a person with an unusual congenital bowel abnormality and its role in the manifestation of low back pain. The theoretical foundations of these reflexes will be elaborated on and practical applications discussed. **Clinical Features**: A 29-year-old man had chronic low back pain. Radiographs of the patient's lumbar spine and pelvis were normal. Magnetic resonance imaging (MRI) demonstrated a mild protrusion of the fifth lumbar disk. Oral anti-inflammatory agents, cortisone injections, and chiropractic manipulative therapy provided little relief. Though generally in robust health, the patient was aware of a congenital intestinal abnormality diagnosed when he was a child; it was thought to be of no consequence with regard to his current back condition. **Intervention and outcome**: The patient's history, combined with applied kinesiology examination, indicated a need to direct treatment to the large bowel. The essential diagnostic indicators were the analysis of the Chapman's neurolymphatic reflexes themselves, coupled with an evaluation of the traditional acupuncture meridians. The primary prescribed therapy was the stimulation of these reflexes by the patient at home. This intervention resulted in the resolution of the patient's musculoskeletal symptomatology, as well as improved bowel function. **Conclusion**: The rather remarkable outcome from the application of this relatively simple, yet valuable, diagnostic and therapeutic procedure represents a thought-provoking impetus for future study and clinical application.
Understanding how to unwind the complex web of chronic fatigue immune dysfunction syndrome, Maykel WM.	*DC Tracts* 2004;16(2). **Abstract:** Chronic fatigue immune dysfunction syndrome (CFIDS) represents an autoimmune illness where immune defenses and repair have been depleted. Intercellular acidosis, impaired electron transport and depletion of biochemical cofactors usually coexist. A comprehensive multi-system approach to reduce both the immune and toxicant loads, while reversing macronutrient and cofactor depletion as well as enhancing adaptive skills and immune competence, is imperative. Applied kinesiology testing leverages treatment individualization, resulting in a patient-centered, comprehensive approach that is both cost and outcome effective.
New diagnostic and therapeutic approach to thyroid-associated orbitopathy based on applied kinesiology and homeopathic therapy, Moncayo, R., Moncayo, H., Ulmer, H., Kainz, H.	*J Altern Complement Med,* 2004 Aug;10(4):643-50. **Objectives:** To investigate pathogenetic mechanisms related to the lacrimal and lymphatic glands in patients with thyroid-associated orbitopathy (TAO), and the potential of applied kinesiology diagnosis and homeopathic therapeutic measures. **Design:** Prospective. **Settings/location:** Thyroid outpatient unit and a specialized center for complementary medicine (WOMED, Innsbruck; R.M. and H.M.). **Subjects:** Thirty-two (32) patients with TAO, 23 with a long-standing disease, and 9 showing discrete initial changes. All patients were euthyroid at the time of the investigation. **Interventions:** Clinical investigation was done, using applied kinesiology methods. Departing from normal reacting muscles, both target organs as well as therapeutic measures were tested. Affected organs will produce a therapy localization (TL) that turns a normal muscle tone weak. Using the same approach, specific counteracting therapies (i.e., tonsillitis nosode and lymph mobilizing agents) were tested. **Outcome measures:** Change of lid swelling, of ocular movement discomfort, ocular lock, tonsil reactivity and Traditional Chinese Medicine criteria including tenderness of San Yin Jiao (SP6) and tongue diagnosis were recorded in a graded fashion. **Results:** Positive TL reactions were found in the submandibular tonsillar structures, the tonsilla pharyngea, the San Yin Jiao point, the lacrimal gland, and with the functional ocular lock test. Both Lymphdiaral® (Pascoe, Giessen, Germany) and the homeopathic preparation chronic tonsillitis nosode at a C3 potency (Spagyra,® Grödig, Austria) counteracted these changes. Both agents were used therapeutically over 3–6 months, after which all relevant parameters showed improvement. **Conclusions:** Our study demonstrates the involvement of lymphatic structures and flow in the pathogenesis of TAO. The tenderness of the

	San Yin Jiao point correlates to the abovementioned changes and should be included in the clinical evaluation of these patients.
The Somatovisceral Reflex: How Important for the "Type O" Condition? Pollard, H.	*Chiropr J Aust* 2004; 34: 93-102. **Objective:** To review the neurophysiology of somatovisceral reflexes and discuss the factors that influence the reflexes in the context of management of systemic or organic disease (as distinct from musculoskeletal injury). **Data Sources:** MEDLINE search using key words: chiropractic, osteopathy, neurophysiology, review, spinal reflex, supraspinal reflex, manipulation. **Data Selection:** The search resulted in more than 200 papers that fit the key words. Papers were selected on the basis that they contained relevant information on somatovisceral, viscerosomatic or supraspinal reflexes or treatment approaches relevant to the management of visceral disorders by spinal manipulative therapy. **Data Extraction:** Ninety-four selected papers contained information that related to somatovisceral and viscerosomatic reflexes or on supraspinal influences on these reflexes. **Data Synthesis:** A review of the proposed mechanisms of the effect of spinal manipulative therapy on visceral neurophysiology was conducted. The reflexes affect the resting status of the somatic structures via mechanical and neurological (somato-somatic reflex) mechanisms that can cause a change to the afferent arm of the somato-visceral reflex. Such changes can occur by the direct action of a somatovisceral effect at the segmental level, but the effect is minimised by the action of the supraspinal pathways in the integration of the reflexes. It is hypothesised that SMT may affect the supraspinal inhibitory and excitatory pathways to the preganglionic neurones, although this has not been demonstrated. There is scanty evidence of SMT affecting visceral disease through manipulation of the spine. **Conclusions:** Spinal manipulative therapy can affect the resting status of somatic structures via mechanical and neurological (somato-somatic reflex) mechanisms, and this change can cause a change to the afferent arm of the somato-visceral reflex. It is likely that supraspinal influences play a major role in this effect, however the exact nature of this effect has not been demonstrated with respect to manipulation of the spine. Much research is required to establish a causative relationship between the treatment of somatic structures of the spine and normalisation of pathological visceral tissues via somatovisceral or supraspinal reflexes.
Manual strength testing in 14 upper limb muscles: a study of inter-rater reliability, Jepsen, J., Laursen, L., Larsen, A., Hagert, CG. -- Department of Occupational Medicine, Central Hospital, DK-6700 Esbjerg, Denmark. jrj@ribeamt.dk	*Acta Orthop Scand.* 2004 Aug;75(4):442-8. **BACKGROUND:** Manual muscle testing has been termed a "lost art" and is often considered to be of minor value. The aim of this investigation was to study the inter-rater reliability of manual examination of the maximal voluntary strength in a sample of upper limb muscles. **PATIENTS AND METHODS:** The material consisted of a series of 41 consecutive patients (82 limbs) who had been referred to a clinic of occupational medicine for various reasons. Two examiners who were blinded as to patient-related information classified 14 muscles in terms of normal or reduced strength. In order to optimize the evaluation, the individual strength was assessed simultaneously on the right and left sides with the limbs in standardized positions that were specific for each muscle. Information on upper limb complaints (pain, weakness and/or numbness/tingling) collected by two other examiners resulted in 38 limbs being classified as symptomatic and 44 as asymptomatic. For each muscle the inter-rater reliability of the assessment of strength into normal or reduced was estimated by kappa-statistics. In addition, the odds ratio for the relation to symptoms of the definition in agreement of strength was calculated. **RESULTS:** The median kappa-value for strength in the muscles examined was 0.54 (0.25-0.72). With a median odds ratio of 4.0 (2.5-7.7), reduced strength was significantly associated with the presence of symptoms. **INTERPRETATION:** This study suggests that manual muscle testing in upper limb disorders has diagnostic potential. **Comment:** In this study, Jepsen et al chose to study only individual muscle strength as opposed to the assessment of strength of groups of muscles, because the latter would not identify a differential involvement of muscles, and the diagnostic potential would consequently be reduced. Reduced grip strength, for example, can accompany a number of orthopedic conditions as well as systemic disorders, but it is of limited significance for differential diagnosis. In contrast,

	provided that strength in representative individual muscles can be reliable assessed, the identification or exclusion of selectively reduced strength in representative muscles would improve the diagnostic and treatment options, with some focal conditions being more likely and others less likely. Jepsen also chose the MMT over quantitative dynamometric measurement because the MMT enables the examiner to guide the tested part into the exact test position and to give a precise amount of pressure to determine the strength. This study also demonstrated a comparable or better reliability than other diagnostic tests in common use for upper limb dysfunction, including the brachial plexus tension and shoulder abduction relief tests, passive cervical spine motion, trigger point palpation, and tendon reflexes, as well as the Babinskui sign for the lower limb.
Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test, Falla DL, Jull GA, Hodges PW.	*Spine.* 2004 Oct 1;29(19):2108-14. **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.
Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients. Jull G, Kristjansson E, Dall'Alba P.	*Man Ther.* 2004 May;9(2):89-94. **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.
The supine hip extensor manual muscle test: a reliability and validity study, Perry J, Weiss WB, Burnfield JM, Gronley JK. -- Pathokinesiology Laboratory, Rancho Los Amigos National Rehabilitation Center, Downey, CA 90242, USA. pklab@larei.org	*Arch Phys Med Rehabil.* 2004 Aug;85(8):1345-50. **OBJECTIVES:** To define the relative hip extensor muscle strengths values identified by the 4 grades obtained with a supine manual muscle test (MMT) and to compare these values with those indicated by the traditional prone test. **DESIGN:** Comparison of 4 manual supine strength grades with isometric hip extension joint torque; kappa statistic-determined interrater reliability, and analyses of variance identified between grade differences in torque. **SETTING:** Pathokinesiology laboratory. **PARTICIPANTS:** Adult volunteers recruited from local community and outpatient clinics. Reliability testing: 16 adults with postpolio (31 limbs). Validity testing (2 groups): 18 subjects without pathology (18 limbs), and 26 people with clinical signs of hip extensor weakness (51 limbs). **INTERVENTIONS:** Not applicable. **MAIN OUTCOME MEASURES:** Supine hip extensor manual muscle grade and isometric hip extension torque. **RESULTS:** Reliability testing showed excellent agreement (82%). Subjects with pathology had significant differences in mean torque (P<.01) for the assigned grade 5 (176 Nm), grade 4 (103 Nm), grade 3 (67 Nm), and grade 2 (19 Nm). Healthy adults showed significant differences between grade 5 (212 Nm) and grade 4 (120 Nm) in mean torque (P<.05). **CONCLUSIONS:** The supine MMT is a reliable and valid method with which to assess hip extension strength.
Lovett Brothers: The Relationship Between The Cervical And Lumbar Vertebra, Blum CL.	*The Journal of Vertebral Subluxation Research,* Apr 2004; 6(1): 1-3. **Introduction**: For years, chiropractors have used the term "Lovett Brothers" to describe the relationship between specific vertebra in the lumbar and cervical spine. **Purpose**: This paper seeks to investigate the rational behind this "Lovett Brother" relationship and present possible theories for its existence. These theories vary from fascial and myological interrelationships, referred pain patterns, and facilitating tonic neck reflexes involving intersegmental spinal pathways. **Discussion**: While there have been no definitive studies evaluating the use of "Lovett Brothers" as a diagnostic and treatment modality there have been some reported case studies which support its use. **Conclusion**: Future research is necessary to further understand this phenomenon that is already readily accepted in the chiropractic profession.
Fix foot problems without orthotics, McDowall D.	*Int J AK and Kinesio Med,* 2004;18. **Abstract:** A new approach to supporting the functional movement of the foot without the use of orthotics is discussed. A short review of myo-tendinous attachments of the foot is presented with associated treatments. Epidemiologic studies provide strong support for the clinical advantages of orthoses, yet explanations of foot orthotic mechanisms remain elusive. Researchers await a more complete theoretical understanding of the mechanisms of foot orthotics. Some studies are considering the 3-dimensional effects of subtalar joint motion on the entire kinetic chain. Chiropractors and other manipulators have developed techniques to treat a variety of foot conditions. Some even propose using this area of skill as a bridge to working with physical therapists. Probably the most frequently a chiropractor looks at the feet is indirectly when checking for a leg length discrepancy. At this time the most common observation is usually of foot rotation. Walther describes a variety of approaches to resolving foot problems (5). I will not discuss existing techniques in this paper. The graphics of Netter illustrate the attachments of the lower leg muscles at both their origin on the femur, tibia, and fibula and their insertion on the foot. My observations are an application of Goodheart's work regarding origin-insertion technique recorded in his 1964 manual. I have applied these observations in regard to micro avulsion of the periosteal attachments of the tendons being the initial injury of most foot

	problems. These foot problems are easily fixed leaving the use of orthotics to chronic pathologies of the foot.
Chiropractic Techniques – American Chiropractic Association	Christensen MG. American Chiropractic Association (home page on the Internet). According to the American Chiropractic Association, Applied Kinesiology is one of the 15 most frequently used chiropractic techniques in the United States, with 43.2% of chiropractors employing this method. "This is an approach to chiropractic treatment in which several specific procedures may be combined. Diversified/manipulative adjusting techniques may be used with nutritional interventions, together with light massage of various points referred to as neurolymphatic and neurovascular points. Clinical decision-making is often based on testing and evaluation muscle strength."
Migraines – the Applied Kinesiology and Chiropractic perspective, Hambrick TM.	*Journal of Bodywork and Movement Therapies,* 2003;7(1):37-41. **Abstract:** A case presentation involving migraine headache is presented. The case is notable in that it contains most of the classical multifactorial elements typically found in instances of migraine headaches. Purely from a structurally based chiropractic perspective, correction of the cervical and thoracic subluxations resulting from the postural distortion is imperative. Further, a comprehensive evaluation of the patient with the standard techniques of Applied Kinesiology is presented which provides additional data that informs the clinical decision-making process and directs therapy. A food allergy was found using AK MMT methods, and this factor was part of the etiology of this patient's migraines.
Insult, Interference and Infertility: An Overview of Chiropractic Research, Behrendt, M.	*Journal of Vertebral Subluxation Research,* May 2003:1 www.jvsr.com **Objective:** Infertility is distinct from sterility, implying potential, and therefore raises questions as to what insult or interference influences this sluggish outcome. Interference in physiological function, as viewed by the application of chiropractic principles, suggests a neurological etiology and is approached through the mechanism of detection of vertebral subluxation and subsequent appropriate and specific adjustments to promote potential and function. Parental health and wellness prior to conception influences reproductive success and sustainability, begging efficient, effective consideration and interpretation of overall state and any distortion. A discussion of diverse articles is presented, describing the response to chiropractic care among subluxated infertile women. **Clinical Features:** Fourteen retrospective articles are referenced, their diversity includes: all 15 subjects are female, ages 22-65; prior pregnancy history revealed 11 none, 2 successful unassisted, 1 assisted, 1 history of miscarriage. 9 had previous treatment for infertility, 4 were undergoing infertility treatment when starting chiropractic care. Presenting concerns included: severe low back pain, neck pain, colitis, diabetes, and female dysfunction such as absent or irregular menstrual cycle, blocked fallopian tubes, endometriosis, infertility, perimenopause and the fertility window within a religious based lifestyle, and a poor responder undergoing multiple cycles of IVF. **Chiropractic Care and Outcome:** Outcomes of chiropractic care include but are not limited to benefits regarding neuromuscular concerns, as both historical and modern research describe associations with possible increased physiological functions, in this instance reproductive function. Chiropractic care and outcome are discussed, based on protocols of a variety of arts, including **Applied Kinesiology (A.K.),** Diversified, Directional Non-Force Technique (D.N.F.T.), Gonstead, Network Spinal Analysis (N.S.A.), Torque Release Technique

	(T.R.T.), Sacro Occipital Technique (S.O.T.) and Stucky-Thompson Terminal Point Technique. Care is described over a time frame of 1 to 20 months. **Conclusion:** The application of chiropractic care and subsequent successful outcomes on reproductive integrity, regardless of factors including age, history and medical intervention, are described through a diversity of chiropractic arts. Future studies that may evaluate more formally and on a larger scale, the effectiveness, safety and cost benefits of chiropractic care on both well-being and physiological function are suggested, as well as pursuit of appropriate funding.
Comparison of four tests of quadriceps strength in L3 or L4 radiculopathies, Rainville J, Jouve C, Finno M, Limke J. -- The Spine Center, New England Baptist Hospital, Boston, MA 02120, USA. jrainvil@caregroup.harvard.edu	*Spine.* 2003 Nov 1;28(21):2466-71. **STUDY DESIGN:** This prospective cohort study evaluated four office tests of quadriceps strength in symptomatic adults with radiographic evidence of L3 or L4 nerve root compression. **OBJECTIVE:** The study observed the performance of each test for its ability to detect quadriceps weakness when compared to the asymptomatic side. To determine the potential influence of radicular pain on the performance of the four tests, a control group of patients over the age of 40 with clinical and radiographic L5 or S1 radiculopathies underwent identical testing of quadriceps strength. **SUMMARY OF BACKGROUND DATA:** The L3 and L4 nerve roots innervate the quadriceps; therefore, quadriceps weakness may be a consequence of L3 or L4 radiculopathies. There are no standardized or validated methods to evaluate quadriceps strength in the clinical office setting. This may lead to inconsistent detection by clinicians of quadriceps weakness in cases of L3 or L4 radiculopathy. **METHODS:** Thirty-three consecutive patients with L3 or L4 radiculopathies and 19 with L5 or S1 radiculopathies were studied. The four tests of quadriceps strength included: 1) single leg sit-to-stand test; 2) step-up test; 3) knee-flexed manual muscle testing; and 4) knee-extended manual muscle testing. Results from a second examiner repeating the four tests were used to calculate interrater reliability. **RESULTS:** In L3 and L4 radiculopathies, unilateral quadriceps weakness was detected by the single leg sit-to-stand test in 61%, **by knee-flexed manual muscle testing in 42%**, by step-up test in 27% and by knee-extended manual muscle testing in 9% of patients. The sit-to-stand test detected weakness in all but one case when weakness was detected by another test. All patients with L5 or S1 radiculopathies could perform the sit-to-stand test. Kappa coefficient was high for sit-to-stand test (0.85), step-up (0.83), and knee-flexed manual muscle testing (0.66), and low for knee-extended manual muscle testing (0.08). **CONCLUSION:** In L3 and L4 radiculopathies, unilateral quadriceps weakness was best detected by a single leg sit-to-stand test. Patients of similar age with radicular pain caused by L5 or S1 radiculopathies could perform this test. As the interrater reliability of the single leg sit-to-stand test is high, clinicians should consider utilizing this test for assessing quadriceps strength in cases of L3 and L4 radiculopathies.
Evidence of Altered Lumbopelvic Muscle Recruitment in the Presence of Sacroiliac Joint Pain, Hungerford B, Gilleard W, Hodges P.	*Spine* 2003; 28(14):1593-1600. **Study Design.** Cross-sectional study of electromyographic onsets of trunk and hip muscles in subjects with a clinical diagnosis of sacroiliac joint pain and matched control subjects. **Objectives**. To determine whether muscle activation of the supporting leg was different between control subjects and subjects with sacroiliac joint pain during hip flexion in standing. **Background**. Activation of the trunk and gluteal muscles stabilize the pelvis for load transference; however, the temporal pattern of muscle activation and the effect of pelvic pain on temporal parameters has not been investigated. **Methods**. Fourteen men with a clinical diagnosis of sacroiliac joint pain and healthy age-matched control subjects were studied. Surface electromyographic activity was recorded from seven trunk and hip muscles of the supporting leg during hip flexion in standing. Onset of muscle activity relative to initiation of the task was compared between groups and between limbs. **Results**. The onset of obliquus internus abdominis (OI) and multifidus occurred before initiation of weight transfer in the control subjects. The onset of obliquus internus abdominis, multifidus, and gluteus maximus was delayed on the symptomatic side in subjects with sacroiliac joint pain compared with control subjects, and the onset of biceps femoris electromyographic activity was earlier. In addition, electromyographic onsets were different between the symptomatic and asymptomatic sides in subjects with

	sacroiliac joint pain. **Conclusions**. The delayed onset of obliquus internus abdominis, multifidus, and gluteus maximus electromyographic activity of the supporting leg during hip flexion, in subjects with sacroiliac joint pain, suggests an alteration in the strategy for lumbopelvic stabilization that may disrupt load transference through the pelvis.
AK classic case management: enuresis, Goodheart GJ.	*Int J AK and Kinesio Med*, 2003;16: 22-23. Many doctors and many parents are deeply concerned with the problems that enuresis produces in the children under their care. Attempts have been made to ascribe this troublesome condition to psychic or emotional causes. Efforts have been made to use conditioned reflexes and elaborate moisture sensing devices to alleviate the problem of bed-wetting. Spontaneous cessation of the symptoms sometimes occurs as the child grows older. Fluid restriction and interruption of the child's sleep by the parent to allow the child to void any accumulation of fluids is good management of the situation. This is a physical, functional, structural problem associated with disturbances of the segments, not at the kidney and bladder areas of the spine, but at C3, which is associated with the innervation of the phrenic and intercostals nerves. The respiratory center is located in the lower brain stem and consists of two division, an inspiratory and an expiratory center. This respiratory center is powerfully affected by changes in the CO2 content of the blood, in that, as the CO2 level rises, the respiratory center is stimulated. It vents off or washes out the accumulating CO2 by increasing the depth or frequency of respiration or both. This increase in the depth or the frequency of the respiration must be accomplished by an increased excursion of the diaphragm, and this action must be accomplished by the phrenic nerve, which is basically derived from the segments at cervicals 3, 4, and 5, principally at cervical 3. The depth of sleep varies with children and adults on two distinct curves. In most adults, sleep deepens rapidly to the end of the first hour, then sharply shallows out, and then gradually shallows its curve until the person awakens. In the child the sleep curve is different. There are two periods of deepest sleep in children. The initial period occurs in the first one or two hours. There is a second deep sleep curve at the eighth and ninth hour, following which the curve sharply shallows, as does the adults' curve, as the child nears awakening. It is these different patterns of sleep that are sometimes responsible for the oft told admonition "not to worry", that the child will outgrow the condition. This is occasionally true but is only sheer chance and unpredictable to say the least. As the child sleeps, either at the first deep period or at the second deep period, and as the sleep deepens, there is an occasional sighing respiration as the CO2 is vented off by action of the respiratory center. If the nerve control to the diaphragm is normal, there is no interruption of sleep nor is there any involuntary voiding or urine.
Applied Kinesiology and Down syndrome: a study of 15 cases, Cuthbert S.	*Int J AK and Kinesio Med*, 2003;16:16-21. This essay describes these children's histories, their clinical findings, and their evaluation and treatment using applied kinesiology methods. Down syndrome is the most common readily identifiable cause of intellectual disability, accounting for almost one-third of all cases. It occurs equally in all races with an overall incidence of approximately one in 800 births. Children with Down syndrome will be developmentally slower than their siblings and peers and have intellectual functioning in the moderately disabled range, but the range is enormous and the distance from their peers is the crucial factor where our chiropractic therapeutics can make a profound difference. The ability we possess to repair the neurological disorganization in these children can be affected rapidly with the proper treatment to the cranial-sacral mechanism. Parents are frequently amazed at the speed with which this happens. Once the cranial mechanism is repaired and it begins to move freely, the child becomes a new creature with his/her potentialities greatly improved for normal function. The cranial mechanism must be included in the practice of chiropractic care for the physically and mentally challenged because it is in fact the headquarters for all the functions that operate within the child. This is the part of the body with the greatest disturbances in these cases and should not be ignored.
Pediatric case history: cost	*Int J AK and Kinesio Med*, 2003;16:34.

effective treatment of block naso-lacrimal canal utilizing applied kinesiology tenets, Maykel W.	**Abstract:** To present a case discussing the successful treatment of a blocked tear duct in a 14-month-old boy. Through the use of surrogate testing – a technique unique to applied kinesiology – cranial and spinal lesions were specifically identified for correction. This approach provides a safe, cost effective approach and should therefore be considered as a standard first line of treatment for this condition. Further studies should be designed to elucidate this.
A 39-year-old female cyclist suffering from total exhaustion caused by over-training and false nutrition, Weiss G.	*Int J AK and Kinesio Med,* 2003;15:39. **Abstract:** To present a case involving a 39-year-old competitive female cyclist having menstrual troubles. Nutritional counseling (based on traditional Chinese medicine concepts) was offered and followed. Her menstruation improved and her energy level and cycling performance improved. Treatment to the sacrococcygeal area improved her symptom picture. After cranial correction and nutritional support she improved further and she remained stable.
Acupuncture in applied kinesiology: a review, Garten H.	*Int J AK and Kinesio Med,* 2002;14. **Abstract:** Acupuncture is a healing art, which is embedded in eastern culture and Traditional Chinese Medicine (TCM).Applied kinesiology (AK) as a Western development has an analytical, logical basis, which is backed up by neurological and other models, and apparently supplies a logical "easy" tool for the use of acupuncture. Difficult and "mystic" tasks like pulse diagnosis and the selection of points seem to be facilitated by the "objective" tool of muscle testing. Yet for the purpose of a "constitutional diagnosis" the diagnosis of pulse points, alarm points, and muscle strength as per AK is not equivalent to a traditional Chinese diagnosis. The AK-specific therapy based on AK-specific pulse diagnosis can furnish only part of the possible acupuncture effects. For constitutional acupuncture treatments a TCM diagnosis has to be established and the treatment has to be done accordingly. The selection of points can be improved by therapy localization and challenge as per AK. Therapy of dysfunctional muscles is a major issue in AK. The AK-specific use of acupuncture of tapping points according to the AK-specific acupuncture diagnosis is by no means a sufficient way of imitating the effects of a needle therapy with the correct manipulation of the needle at the site of the disturbed structure of the muscle (trigger points, tendon avulsions, etc). Musculoskeletal therapy is most effective using concepts derived from manual therapy and myofascial therapy. The practitioner must follow anatomical and palpatory information and use the adequate stimulus as defined by the reflexotherapeutic aspects of acupuncture. Somatotopic reflexotherapy can be used (ear, scalp, hand, and others). Muscle function and the selection of points can be monitored by manual muscle testing.
Applied kinesiology for treatment of women with mastalgia, Gregory, W.M., Mills, S.P., Hamed, H.H., Fentiman, I.S.	*Breast,* 2001 Feb;10(1):15-9. (www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14965552&query_hl=1) To determine whether an applied kinesiology technique was of benefit to women with breast pain, an open pilot study was conducted in which 88 newly presenting women with self-rated moderate or severe mastalgia were treated by applied kinesiology. This involved a hands-on technique consisting of rubbing a series of 'lymphatic reflex points' while touching painful areas of the breasts. The women were predominantly pre-menopausal, and patients with both cyclical and non-cyclical pain were included in the study. Patients' self-rated pain scores, both before and immediately after applied kinesiology were compared, together with a further score 2 months later. Immediately after treatment there was considerable reduction in breast pain in 60% of patients with complete resolution in 18%. At the visit after 2 months, there was a reduction in severity, duration and frequency of pain of 50% or more in about 60% of cases (P<0.0001). This preliminary study suggests that applied kinesiology may be an effective treatment for mastalgia, without side-effects and merits testing against standard drug therapies.

Plantar fascitis, Hambrick T.	*Journal of Bodywork and Movement Therapies*, 2001 Jan:49-55 **Abstract:** A case presentation involving plantar fascitis is presented. The structural causes of plantar fascitis are reviewed. The specific muscular factors found on AK examination that produce the dropped longitudinal arch of the foot, the separation of the distal tibia and fibula, and the posterior calcaneus are presented. The inflammatory component of this problem is reviewed, and treatment for disturbances in fatty acid metabolism and adrenal function suggested. The importance of evaluating patient's with plantar fascitis in the weight bearing position and during gait is stressed, and evaluation of muscular function during gait is offered. In AK, the effect of specific acupuncture point stimulation upon the function of the ambulatory muscles is presented. Treatment of each of these factors in this patient proved successful in resolving her problem with plantar fascitis.
Clinical evaluator reliability for quantitative and manual muscle testing measures of strength in children, Escolar DM, Henricson EK, Mayhew J, Florence J, Leshner R, Patel KM, Clemens PR.	*Muscle Nerve.* 2001 Jun;24(6):787-93. **Abstract:** Measurements of muscle strength in clinical trials of Duchenne muscular dystrophy have relied heavily on manual muscle testing (MMT). The high level of intra- and interrater variability of MMT compromises clinical study results. We compared the reliability of 12 clinical evaluators in performing MMT and quantitative muscle testing (QMT) on 12 children with muscular dystrophy. QMT was reliable, with an interclass correlation coefficient (ICC) of >0.9 for biceps and grip strength, and >0.8 for quadriceps strength. Training of both subjects and evaluators was easily accomplished. MMT was not as reliable, and required repeated training of evaluators to bring all groups to an ICC >0.75 for shoulder abduction, elbow and hip flexion, knee extension, and ankle dorsiflexion. We conclude that QMT shows greater reliability and is easier to implement than MMT. Consequently, QMT will be a superior measure of strength for use in pediatric, neuromuscular, multicenter clinical trials. **Comment:** The I.C.A.K. has always insisted that muscle testing is an art form that is easy to learn but difficult to master. It is the key to diagnostic success in AK. The doctor unable to distinguish the change in muscle strength caused by challenge to the patient's body is reduced in proportion to his ability to diagnose a patient's status. Accurate, consistent, and reproducible MMT is the most important physical talent an AK practitioner will ever develop. This study showed that with training, even previously untrained manual muscle testers could be brought up to a statistically reliable interclass coefficient. Diagnosis via manual muscle testing requires in depth training and consistent application to achieve mastery.
The Clinical Utility of Force/Displacement Analysis of Muscle Testing in Applied Kinesiology, Caruso, W., Leisman, G.	*International Journal of Neuroscience*. 2001; 106:147-157. This study provided a physical record of the phenomena in an AK muscle test. The record allowed the observer to distinguish between conditionally inhibited and conditionally facilitated muscles. This study demonstrates that the difference between these states of muscle function is quantifiable. The authors suggest however that unlike the X-ray of the radiologist and the histological specimen of the clinical pathologist, the objective outcome of an AK muscle test will not be the source of the AK practitioner's judgment; that is, he will continue to rely on his trained perception of the event that produces the record. But the record (conditionally inhibited or conditionally facilitated) will stand after the fact as a piece of objective evidence that others may examine in order to confirm the practitioner's judgment.
The role of the scalenus anticus muscle in dysinsulinism and chronic non-traumatic neck pain, Rogowskey TA.	*Int J AK and Kinesio Med*, 2001;12. **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.
An applied kinesiology evaluation of facial neuralgia: a case history of Bell's Palsy, Cuthbert S.	*Int J AK and Kinesio Med,* 2001;10:42-45. **Abstract:** This case deals with the chiropractic evaluation and treatment of a businesswoman who was referred to my care by her husband. As part of a thorough, whole body evaluation and treatment using applied kinesiology's diagnostic methods, an interesting case of Bell's palsy was treated in this patient, with very satisfying results. Numerous causative problems involving the seventh cranial nerve were found in the evaluation of this patient, and when these causative factors were eliminated, the associated symptomatology disappeared. The anatomy and cranial architecture involved in this case are described. The patient has had no major complaints for over 7 months after the correction of her condition.
Job analysis of chiropractic: a project report, survey analysis, and summary of the practice of chiropractic within the United States, Christensen, MG, Delle Morgan, DR.	National Board of Chiropractic Examiners, Greeley, CO. In a survey by the National Board of Chiropractic Examiners in 2000, 43.2% of respondents stated that they used applied kinesiology in their practices, up from 37.2% of respondents who reported they used AK in 1991.
A Force/Displacement Analysis of Muscle Testing, Caruso, B., Leisman, G.	*Perceptual and Motor Skills.* 2000; 91:683-692. Using a force transducer developed by Dr. Caruso, this study demonstrated the difference between muscles that the examiners perceived to be "weak" or inhibited, and those perceived to be "strong" or facilitated. This study also demonstrated that the muscle tests of examiners with over five years of clinical experience using AK procedures had reliability and reproducibility when their outcomes were compared. Also, the perception of inhibition or facilitation made by the examiner was corroborated by test pressure analysis using the instrumentation developed.
Changes in strength over time among polio survivors, Klein MG, Whyte J, Keenan MA, Esquenazi A, Polansky M.	*Arch Phys Med Rehabil,* 2000 Aug;81(8):1059-64. **Abstract:** OBJECTIVE: To study changes in the strength of different muscle groups in polio survivors over a period of approximately 9 months. DESIGN: Longitudinal study. SETTING: Moss Rehabilitation Research Institute. PARTICIPANTS: One hundred twenty subjects (57 men, 63 women) were studied on three occasions, each 3 to 5 months apart. Subjects were recruited through the Einstein-Moss Post-Polio Management Program. newspaper advertisements, and polio support groups. MAIN OUTCOME MEASURES: Isometric strength of 30 muscle groups (16 in upper extremities, 14 in lower extremities) was measured, using a hand-held dynamometer. RESULTS: Data were analyzed in two separate groups: upper-extremity muscles and lower-extremity muscles. Results for the upper-extremity muscles revealed evidence of a significant deterioration in strength. The amount of deterioration differed among muscles and increased with age. There was also evidence of deterioration in strength in the flexor muscles in the ankle, hip, and knee. However, the rate of deterioration in these muscles was not strongly related to age, time since polio, gender, symptom status, or history of residual weakness. CONCLUSIONS: Strength is deteriorating among polio survivors at a rate higher than that associated with normal aging. This deterioration is not occurring in the extensor, or so-called "weight-bearing" muscles, but is occurring in many of the upper-extremity muscle groups and in the flexor muscles in the lower extremities. **Comment:** This paper demonstrates what has been long hypothesized (and demonstrated clinically) in chiropractic and AK to be the case, i.e. that neurological function deteriorates in disease states, and that the muscular system reflects this change in state, thus serving as a "somatic window" or "representational system" of neurological function.
Applied Kinesiology and the	*Int J AK and Kinesio Med,* 2000;8.

Immune System, Astill-Smith CR.	**Abstract:** Applied kinesiology offers a valuable diagnostic tool for assessing the immune system. Through a series of specific challenges, using chemical or homeopathic biological response modifiers (biomarkers), the practitioner can assess for likely causation and most suitable remedial intervention in both acute and chronic inflammatory disorders.
Mechanical force spinal manipulation increases trunk muscle strength assessed by electromyography: a comparative clinical trial, Keller TS, Colloca CJ.	*J Manipulative Physiol Ther.* 2000 Nov-Dec;23(9):585-95. **OBJECTIVE:** The objective of this study was to determine whether mechanical force, manually-assisted (MFMA) spinal manipulative therapy (SMT) affects paraspinal muscle strength as assessed through use of surface electromyography (sEMG). **DESIGN:** Prospective clinical trial comparing sEMG output in 1 active treatment group and 2 control groups. **SETTING:** Outpatient chiropractic clinic, Phoenix, AZ. **SUBJECTS:** Forty subjects with low back pain (LBP) participated in the study. Twenty patients with LBP (9 females and 11 males with a mean age of 35 years and 51 years, respectively) and 20 age- and sex-matched sham-SMT/control LBP subjects (10 females and 10 males with a mean age of 40 years and 52 years, respectively) were assessed. **METHODS:** Twenty consecutive patients with LBP (SMT treatment group) performed maximum voluntary contraction (MVC) isometric trunk extensions while lying prone on a treatment table. Surface, linear-enveloped sEMG was recorded from the erector spinae musculature at L3 and L5 during a trunk extension procedure. Patients were then assessed through use of the Activator Methods Chiropractic Technique protocol, during which time they were treated through use of MFMA SMT. The MFMA SMT treatment was followed by a dynamic stiffness and algometry assessment, after which a second or post-MVC isometric trunk extension and sEMG assessment were performed. Another 20 consecutive subjects with LBP were assigned to one of two other groups, a sham-SMT group and a control group. The sham-SMT group underwent the same experimental protocol with the exception that the subjects received a sham-MFMA SMT and dynamic stiffness assessment. The control group subjects received no SMT treatment, stiffness assessment, or algometry assessment intervention. Within-group analysis of MVC sEMG output (pre-SMT vs post-SMT sEMG output) and across-group analysis of MVC sEMG output ratio (post-SMT sEMG/pre-SMT sEMG output) during MVC was performed through use of a paired observations t test (POTT) and a robust analysis of variance (RANOVA), respectively. **MAIN OUTCOME MEASURES:** Surface, linear-enveloped EMG recordings during isometric MVC trunk extension were used as the primary outcome measure. **RESULTS: Nineteen of the 20 patients in the SMT treatment group showed a positive increase in sEMG output during MVC (range, -9.7% to 66.8%) after the active MFMA SMT treatment and stiffness assessment. The SMT treatment group showed a significant (POTT, $P < 0.001$) increase in erector spinae muscle sEMG output (21% increase in comparison with pre-SMT levels) during MVC isometric trunk extension trials.** There were no significant changes in pre-SMT vs post-SMT MVC sEMG output for the sham-SMT (5.8% increase) and control (3.9% increase) groups. Moreover, the sEMG output ratio of the SMT treatment group was significantly greater (robust analysis of variance, $P = 0.05$) than either that of the sham-SMT group or that of the control group. **CONCLUSIONS: The results of this preliminary clinical trial demonstrated that MFMA SMT results in a significant increase in sEMG erector spinae isometric MVC muscle output.** These findings indicate that altered muscle function may be a potential short-term therapeutic effect of MFMA SMT, and they form a basis for a randomized, controlled clinical trial to further investigate acute and long-term changes in low back function.
Applied Kinesiology as Functional Neurology, Garten H.	*Manuelle Medicin* 2000;38(3):1433-0466.
Muscular strength and chiropractic: theoretical mechanisms and health	*J Verebralt Subluxation Res*, 3(4), 1999-2000. **Abstract:** To date, a number of studies have investigated the relationships between chiropractic

implications, Smith DL, Cox, RH.	care and muscular strength. Chiropractic practice philosophy states that correction of vertebral subluxation promotes health through enhancing neurological integrity. Accordingly, chiropractic adjustments aimed at reducing vertebral subluxation should also reduce neurological interference at the involved levels. A reduction of interference to the nervous system would thereby allow muscles to more fully express their functional potential, including an improvement in strength. In the present study, a focused discussion is presented relating vertebral subluxation to muscular strength. Consideration is also given to cardiovascular regulation as a result of improving neuromuscular function. This is followed by an overview of the principal factors affecting muscular strength. Finally, the relevant chiropractic literature pertaining to strength, with potential mechanisms of action, is discussed. A paradigm shift from a disease treatment model to a health enhancement model of chiropractic is afforded by presenting these concepts and conclusion in the current presentation. **Comment:** The review article demonstrates that 1) the benefits of improved neurological flow of information can improve the functional capabilities of both the muscular and cardiovascular systems, 2) the musculoskeletal/physiological pathways that may account for the efficacy of the adjustment in eliminating fixated joints and improving muscular strength are provided, and 3) clinical MMT, and other forms of testing, should be considered an important way to ascertain and track the patient's neuromuscular status, and that return of muscle strength is a good indicator of the success of that approach.
Expanding the Neurological Examination Using Functional Neurologic Assessment Part I: Methodological Considerations, Motyka, T., Yanuck, S.	*International Journal of Neuroscience*. 1999; 97:61-76. The authors discuss AK as a clinical measure of neurologic function. A review of the literature reveals methodological problems with previous studies of AK as a form of neurologic assessment. The authors discuss the problems with research designs that do not reflect the clinical practice of AK which are common in the literature. They outline principles of AK and recommend that future research reflect more accurately the clinical practice of functional neurologic assessment and AK.
Expanding the Neurological Examination Using Functional Neurologic Assessment Part II: Neurologic Basis of Applied Kinesiology, Schmitt, W., Yanuck, S.	*International Journal of Neuroscience*. 1999; 97:77-108. This paper proposes a neurologic model for many AK procedures. Manual assessment of muscular function is used to identify changes associated with facilitation and inhibition, in response to the introduction of sensory receptor-based stimuli. Muscle testing responses to sensory stimulation of known value are compared with usually predictable patterns based on known neuroanatomy and neurophysiology, guiding the clinician to an understanding of the functional status of the patient's nervous system. The proper understanding of the neurophysiologic basis of muscle testing procedures will assist in the design of further investigations into AK. Accordingly, the neurophysiologic basis and proposed mechanisms of these methods are reviewed.
Muscle Test Comparisons of Congruent and Incongruent Self-Referential Statements, Monti, D., Sinnott, J., Marchese, M., Kunkel, E., Greeson, J.	*Perceptual and Motor Skills*. 1999, 88:1019-1028. **Abstract:** This study investigated differences in manual muscle test outcomes after exposure to congruent and incongruent semantic stimuli. Muscle testing with a computerized dynamometer was performed on the deltoid muscle group of 89 healthy college students after repetitions of congruent (true) and incongruent (false) self-referential statements. The order in which statements were repeated was controlled by a counterbalanced design. The combined data showed that approximately 17% more total force over a 59% longer period of time could be endured when subjects repeated semantically congruent statements ($p<.001$). Order effects were not significant. Over all, significant differences were found in muscle test responses between congruent and incongruent semantic stimuli.
Applied Kinesiology Helping Children with Learning	*Int J AK and Kinesio Med,* 1999;4. **Abstract:** This was a study of a group of 10 children all experiencing learning difficulties and

Disabilities, Mathews MO, Thomas E, Court L.	how they responded to Applied Kinesiology (AK) treatment. Treatment involved a patient/therapist contact time of 3 to 4 hours spread over 9 to 12 sessions over a period of 6-12 months. The children were tested before and after treatment by an Educational Psychologist using standardised tests of intelligence to monitor changes in their learning skills. Parents and teachers were asked to complete questionnaires before and after treatment regarding other aspects of the children's educational performance. A health profile was also kept based on parental observation. Results were compared with a control group of 10 children matched for age, IQ and social background who had not received any AK treatment over a similar period.
Applied Kinesiology and Homeopathy: A Muscle/Organ/Remedy Correlation, Francis TD.	*Int J AK and Kinesio Med*, 1999;3. **Abstract:** Applied kinesiology utilizes manual muscle testing to correct body dysfunction via structural, biochemical and emotional procedures. A basic premise is that there exists a muscle/organ-gland association. Homeopathy utilizes diluted and potentized substances from the plant, animal and mineral kingdoms that in a healthy person would produce similar symptoms as a person who is suffering with illness. There exists a muscle/organ-gland/homeopathic remedy correlation that may be verified utilizing manual muscle testing.
Evaluating and Treating Functional Hypothyroidism Utilizing Applied Kinesiology, Farkas J.	*Int J AK and Kinesio Med*, 1999;3. Abstract: Although only a very small percentage of patients (approx. 3%) demonstrate thyroid hormone levels which deviate downward from the norm, much clinical evidence suggests that subtler forms of thyroid hypofunction are endemic. This paper reviews thyroid physiology, as well as standard methods for evaluating thyroid function. In addition, an argument will be made for the inclusion of functional thyroid evaluation, as well as the use of non-standard therapies, including those indicated by testing with applied kinesiology.
Point-Counterpoint: Is O-Ring testing a reliable method? Van Benschoten MM.	*Am J Acupunct.* 1999;27(3-4):243-247. **Abstract:** This article presents an impressive literature review regarding the O-Ring method. 59 citations are offered from the peer-review literature investigating the O-Ring test. The potential of utilizing manual muscle testing to receive relevant feedback directly from physiological processes in the subject's body rather than relying primarily on the patient's and doctor's information was first developed by Goodheart and elaborated by Walther.
The Systems, Holograms and Theory of Micro-Acupuncture, Dale RA.	*Am J Acupunct*, 1999;27(3-4):207-242. **Abstract:** Although acupuncture has been practiced for more than 5,000 years, micro-acupuncture is a recent concept. In the mid-1950s, Nogier discovered that the ear may be utilized as a diagnostic and therapeutic system for the entire body. He explored the toplogy of acupoints on the ear, observing that it is reiterative of the anatomy. Micro-acupuncture extends these principles to other parts of the body, for example the foot, hand, nose, and even the orbit of the eye. The development, systems, theory, clinical uses and holograms of micro-acupuncture are reviewed. It is suggested that the holographic paradigm may even have implications for the evolution of a new scientific, social and personal consciousness. **Comment:** Dale reviews several "hologram systems" used specifically in AK, including the Teeth System of M.L. Rees and the Temporal Sphenoidal (TS) Line, each of which have been correlated by Goodheart with muscle and meridian correspondents. The AK applications of meridian system principles are cited frequently and very positively by Dale in his frequent articles in the *American Journal of Acupuncture*.
Correlation of Applied Kinesiology Muscle Testing Findings with Serum Immunoglobulin Levels for	*International Journal of Neuroscience*. 1998; 96:237-244. **Abstract:** The pilot study attempted to determine whether subjective muscle testing employed by Applied Kinesiology practitioners, prospectively determine those individuals with specific hyperallergenic responses. Seventeen subjects were found positive on Applied Kinesiology

Food Allergies, Schmitt, W., Leisman, G.	(A.K.) muscle testing screening procedures indicating food hypersensitivity (allergy) reactions. Each subject showed muscle weakening (inhibition) reactions to oral provocative testing of one or two foods for a total of 21 positive food reactions. Tests for a hypersensitivity reaction of the serum were performed using both a radio-allergosorbent test (RAST) and immune complex test for IgE and IgG against all 21 of the foods that tested positive with A.K. muscle screening procedures. These serum tests confirmed 19 of the 21 food allergies (90.5%) suspected based on the applied kinesiology screening procedures. This pilot study offers a basis to examine further a means by which to predict the clinical utility of a given substance for a given patient, based on the patterns of neuromuscular response elicited from the patient, representing a conceptual expansion of the standard neurological examination process. **Comment:** This study showed a high degree of correlation between AK procedures used to identify food allergies and serum levels of immunoglobulins for those foods. AK methods in this study consisted of stimulation of taste bud receptors with various foods, and observation of changes in manual muscle testing that resulted. The patient was judged to be allergic to foods that created a disruption of muscle function. Blood drawn subsequently showed that patients had antibodies to the foods which were found to be allergenic through AK assessment.
The effects of a pelvic blocking procedure upon muscle strength: a pilot study, Unger, J.	*Chiropractic Technique*, Nov 1998;10(4) Using a hand-held force transducer, the unit was interposed between the examiner's hand and the subject's appendage being tested. The unit used in this study was interfaced with a computer program that gives statistical analysis for repeated testing reliability. This study found a significant increase in strength in the pectoralis (sternal and clavicular divisions tested separately), anterior deltoid, latissimus dorsi, psoas, tensor fascia lata, adductor, and gluteus medius muscles following the correction of a category II pelvic fault.
Jugular Compression in the Diagnosis and Treatment of Cranio-sacral Lesions, Shafer J.	*Int J AK and Kinesio Med,* 1998;2. **Abstract:** Manual compression of the jugular veins (Queckenstedt's Maneuver) is regularly used during routine lumbar puncture procedures. In healthy persons, a rise in CSF pressure is expected at the site of puncture during compression of the veins. The author has observed consistent clinical significance in the use of the maneuver for cranio-sacral and dural membrane evaluation and treatment. In patients with a normal metabolic rate and exhibiting normal cranio-sacral, stomatognathic and dural membrane mechanics, compression of the jugular veins causes no change in pre-compression muscle strength. When dysfunction is present, immediate and significant changes in pre-compression muscle strength has been observed. It is hypothesized that the use of the technique during routine applied kinesiology examination is an invaluable aid to cranio-sacral therapy.
George Goodheart, Jr., D.C., and a history of applied kinesiology. Green BN, Gin RH.	*J Manipulative Physiol Ther,* 1997;20(5):331-337. **Abstract:** Applied Kinesiology (AK), founded by Michigan chiropractor George J. Goodheart, is a popular diagnostic and therapeutic system used by many health care practitioners. Many of the components in this method were discovered by serendipity and observation. In 1964, Goodheart claimed to have corrected a patient's chronic winged scapula by pressing on nodules found near the origin and insertion of the involved serratus anterior muscle. This finding led to the origin and insertion treatment, the first method developed in AK. Successive diagnostic and therapeutic procedures were developed for neurolymphatic reflexes, neurovascular reflexes and cerebrospinal fluid flow from ideas originally described by Frank Chapman, D.O., Terrence J. Bennett, D.C., and William G. Sutherland, D.O., respectively. Later, influenced by the writings of Felix Mann, M.D., Goodheart incorporated acupuncture meridian therapy into the AK system. Additionally, the vertebral challenge method and therapy localization technique, both based on phenomena proposed by L.L. Truscott, D.C., were added to the AK system. Scholarship has also evolved regarding AK and research on the topic is in its infancy. This paper documents some of the history of AK.

Interexaminer Agreement for Applied Kinesiology Manual Muscle Testing, Lawson, A., Calderon, L.	*Perceptual and Motor Skills.* 1997; 84:539-546. This study demonstrated significant interexaminer reliability for individual tests of the pectoralis major and piriformis muscles, but not for the tensor fascia lata or hamstring, which are essentially tests of groups of muscles at once. The primary importance of this study is that it demonstrates the reliability and reproducibility of muscle testing as a clinical tool, while also highlighting the need for clinicians to be aware of potential inaccuracies involved with the testing of some muscle groups.
Internal consistency of manual muscle testing scores, Bohannon RW.	*Percept Mot Skills,* 1997 Oct;85(2):736-8. **Abstract:** The internal consistencies of manual muscle test scores of the actions of three upper and three lower extremity muscles were examined among 37 home care patients. The correlations between scores of specific pairs of actions ranged from .01 to .88. Cronbach alphas ranged from .59 to .88. Manual scores of limb muscle strength, therefore, appear to possess suitable internal consistency. **Comment:** Accurate, precise, repeatable, artful muscle testing is easy to learn, but difficult to master. It is the key to success in both the use of AK and to its value as a method of diagnosis using manual muscle testing itself. Consistently accurate MMT is the most important physical talent an AK practitioner will ever develop.
The ability of male and female clinicians to effectively test knee extension strength using manual muscle testing, Mulroy SJ, Lassen KD, Chambers SH, Perry J.	*J Orthop Sports Phys Ther.* 1997 Oct;26(4):192-9. **Abstract:** It has been suggested that the accuracy of manual muscle testing is dependent on examiner strength. Our purpose was to relate male and female clinicians' upper extremity strength to their ability to challenge the quadriceps and detect weakness in patients using manual muscle testing. Quadriceps muscles of seven men and 12 women with postpoliomyelitis were tested manually by a male and female clinician while forces were recorded with a hand-held dynamometer. Patients' maximal isometric knee extension force was recorded with a Lido dynamometer and clinicians' maximal vertical push force was recorded with the hand-held dynamometer. Manual muscle testing forces, patient maximum quadriceps forces, and examiner push forces were compared with repeated measures analysis of variance. Female examiners' maximal vertical push force (235.7 +/- 54.3 N) was not significantly different from either female or male patients' maximal quadriceps force (166.8 +/- 66.7 N and 341.6 +/- 123.7 N) but was only 60% and 40% of the isometric knee extension forces generated by a group of normal women and men. Male examiners were significantly stronger (357.0 +/- 93.4 N) than the female but not the male patients and produced 90% and 60% of the normal isometric quadriceps forces for women and men. Examiners gave appropriate grades in 30 of 38 tests. Examiner strength limits detection of moderate quadriceps weakness with manual resistance. Most of the muscle test grades, however, were appropriate, given the examiner's upper extremity strength. Clinicians using manual muscle testing should determine their maximal vertical push force and the extent of weakness they can detect.
Grade 4 in manual muscle testing: the problem with submaximal strength assessment, Dvir Z.	*Clin Rehabil.* 1997 Feb;11(1):36-41. **OBJECTIVE:** To compare the static moment of force required for a muscle group to support a limb segment against gravity with the maximal dynamic moment it can generate. **DESIGN:** Based on anthropometric measures of both sexes and theoretical calculations, the estimated anti-gravity static muscular moments (MGM) at the shoulder, elbow, hip and knee joints were compared with published data relating to the isokinetic strength (MIM) of the same muscle groups. RESULTS: The ratio of static to dynamic moment, MGM/MIM, was drastically higher in muscles operating on the proximal compared with the more distal joints. In women, the values of this ratio in the shoulder, hip, elbow and knee muscles were 7-27%, 5-65%, 7% and 5-10% respectively. The corresponding figures in men were 7-21%, 4-44%, 8-10% and 5-8%. The ratios relating to the abductors, flexors and extensors of the hip joint were substantially higher in

	women than in men. **CONCLUSIONS:** Since MGM and MIM correspond to grades 3 and 5 in manual muscle testing, **the findings of this theoretical analysis indicate that elbow and knee muscles assessed as having grade 4 may generate as low as 10% of their maximal strength. With regard to shoulder and hip muscles the corresponding values are typically around 20% and 30-40%.** Coupled with the very limited human precision in sensing of force, these findings indicate that where quantitative targets in muscle strength conditioning are set or when an accurate measure of impairment is being sought, grade 4 cannot and should not serve as a valid criterion.
A preliminary inquiry into manual muscle testing response in phobic and control subjects exposed to threatening stimuli, Peterson KB.	*J Manipulative Physiol Ther.* 1996 Jun;19(5):310-6. **Objective:** To determine phobic and non-phobic subject response to a provocative threat stimulus and to determine variables that confound the response. **Design:** Randomized blind examiner test-retest of randomized phobic and control subjects with qualitative, semistructured, information postintervention interview. **Setting:** Private chiropractic clinic. Subjects: Thirteen phobic individuals, as determined by the Diagnostic and Statistical Manual of Mental Disorders, Third Edition – Revised (DSM-III-R), and 14 control volunteer subjects. **Intervention:** Manual muscle testing was performed while each subject viewed a threat stimulus (i.e., a cue word on a printed card). The results were recorded as "weak" or "strong." **Results:** The analysis of the data demonstrates poor inter- (K = -0.19) and intraexaminer reliability (K = -0.14- +0.29). The test for independence for valid muscle testing was strong for both examiners (p = .462, p = 1.00) When confounding variables were corrected for, the validity of muscle testing increased to 91%. **Conclusion:** This preliminary inquiry demonstrates the need for musculoskeletal, attentional and presensitized subject variables to be controlled to ascertain if muscle testing can be reliably used as a tool to identify emotional arousal.
Ear infection: a retrospective study examining improvement from chiropractic care and analyzing for influencing factors, Froehle RM.	*J Manipulative Physiol Ther.* 1996 Mar-Apr;19(3):169-77. **OBJECTIVE:** The aims of this study were to determine (a) if the patients improved while under chiropractic care; (b) how many treatments were needed to reach improvement; and (c) which factors were associated with early improvement. **DESIGN:** Cohort, nonrandomized retrospective study. **SETTING:** Private chiropractic practice in a Minneapolis suburb. **PARTICIPANTS:** Forty-six children aged 5 yr and under. **INTERVENTION:** All treatments were done by a single chiropractor, who adjusted the subluxations found and paid particular attention to the cervical vertebrae and occiput. **Sacral Occipital Technique-style pelvic blocking and the doctor's own modified Applied Kinesiology was used**. Typical treatment regimen was three treatments per week for 1 wk, then two treatments per week for 1 wk, then one treatment per week. However, treatment regimen was terminated when there was improvement. **OUTCOME MEASURE:** Improvement was based on parental decision (they stated that the child had no fever, no signs of ear pain, and was totally asymptomatic), and/or the child seemed to be asymptomatic to the treating DC and/or the parent stated that the child's MD judged the child to be improved. A data abstraction form was used to determine number of treatments used and presence of factors possibly associated with early improvement. **RESULTS:** 93% of all episodes improved, 75% in 10 days or fewer and 43% with only one or two treatments. Young age, no history on antibiotic use, initial episode (vs. recurrent) and designation of an episode as discomfort rather than ear infection were factors associated with improvement with the fewest treatments. **CONCLUSION:** Although there were several limitations to this study (mostly because of its retrospection but also, significantly, because very little data was found regarding the natural course of ear infections), this study's data indicate that limitation of medical intervention and the addition of chiropractic care may decrease the symptoms of ear infection in young children.
Electromyographic Effects of Fatigue and Task Repetition on the Validity of Estimates of Strong and Weak Muscles	*Perceptual and Motor Skills.* 1995; 80:963-977. **Abstract:** The study investigated the effects of fatigue and task repetition on the relationship between integrated electromyogram and force output during subjective clinical testing of upper

in Applied Kinesiology Muscle Testing Procedures, Leisman, G., et al.	extremity muscles. Muscles were studied under two conditions differing in nature and duration of constant force production (SHORT-F) and (LONG-F). The findings included a significant relationship between force output and integrated EMG, a significant increase in efficiency of muscle activity with task repetition, and significant difference between Force/integrated EMG ratios for muscles labeled "Strong" and "Weak" in the LONG-F condition. This supports Smith's 1974 notion that practice results in increased muscular efficiency. With fatigue, integrated EMG activity increased strongly and functional (force) output of the muscle remained stable or decreased. Fatigue results in a less efficient muscle process. Muscles subjectively testing "Weak" or "Strong" yield effects significantly different from fatigue.
Manual muscle strength testing: intraobserver and interobserver reliabilities for the intrinsic muscles of the hand. Brandsma JW, Schreuders TA, Birke JA, Piefer A, Oostendorp R.	*J Hand Ther.* 1995 Jul-Sep;8(3):185-90. **Abstract: The reliability of manual muscle strength testing of the intrinsic muscles of the hand is reported. The muscle strengths of 28 patients who had neuropathies of the ulnar nerve or the ulnar and median nerves were graded by two physiotherapists to determine intraobserver and interobserver reliabilities.** Muscle strength was graded using the numeric scale developed by the Medical Research Council (grades 0 to 5). Reliabilities were established for nine muscles or muscle groups. **Intraobserver reliabilities ranged from 0.71 to 0.96 and interobserver reliabilities from 0.72 to 0.93.** It is difficult to isolate, and hence grade, most of the intrinsic muscles of the hand. Therefore, it is suggested that specific movements be tested and graded when assessing and evaluating muscle or nerve function. **Comment:** In AK, the MMT for hand function is a very useful to help determine if therapy for dysfunctions in the hand have been effective (improving muscle strength). This study shows that for the muscles of the hand, there is good-to-excellent intra- and inter-observer reliability for the MMT.
Isokinetic Muscle Testing: Is It Clinically Useful?, Almekinders LC, Oman J.	*J Am Acad Orthop Surg*, 1994 Jul;2(4):221-225. **Abstract**: The use of computer-driven muscle-testing devices has become increasingly popular during the past two decades. This expensive equipment allows evaluation of muscles and muscle groups in an isokinetic manner. Isokinetic muscle testing is performed with a constant speed of angular motion but variable resistance. Isokinetic dynamometers have been shown to produce relatively reliable data when testing simple, uniaxial joints, such as the knee, as well as when testing the spine in flexion and extension. Isokinetic strength data are generally not helpful in the diagnosis of orthopedic abnormalities. Isokinetic testing can be helpful during the rehabilitation of orthopedic patients, since it allows easy monitoring of progress. It also enables the patient to work on muscle rehabilitation in a controlled manner at higher speeds than are possible with more conventional exercise equipment. An isokinetic rehabilitation program can be easily tailored with concentric and eccentric components that closely resemble muscle actions during occupational and sports activities.
Muscle Testing Response to Vertebral Challenge and Spinal Manipulation: A Randomized Controlled Trial of Construct Validity, Haas, M., Peterson, D., Hoyer, D., Ross, G.	*Journal of Manipulative and Physiologic Therapeutics*. 1994; 17(3):141-148. **Objective:** To evaluate the relationship of muscle strength response to a provocative vertebral challenge and to spinal manipulation. **Design:** Prospective double-blind randomized controlled trial: crossover and between subjects designs. **Setting:** Laboratory: Center for Technique Research. **Participants:** Sixty-eight naïve volunteers from the student body, staff and faculty of the college. **Interventions**: Provocative vertebral challenge: standardized 4-5 kg force applied with a pressure algometer to the lateral aspects of the T3-T12 spinous processes. **Intervention:** manual high velocity low amplitude adjustment or switched-off activator sham. **Main Outcome Measures:** Piriformis muscle response was defined in two ways: reactivity (a decrease in muscle resistance, yes or no, following a vertebral challenge); responsiveness (the cessation of reactivity following spinal manipulation). Relative response attributable to the maneuver (RRAM): the percent of an outcome attributable to the challenge or adjustment itself. **Results:** Average RRAM = 16% reactivity to vertebral challenge; average RRAM = 0% responsiveness to spinal

	manipulation. Six to 10% of muscle tests were positive regardless of examiner, previous finding or intervention. **Conclusions:** For the population under investigation, muscle response appeared to be a random phenomenon unrelated to manipulable subluxation. In and of itself, muscle testing appears to be of questionable use for spinal screening and post-adjustive evaluation. Further research is indicated in more symptomatic populations, different regions of the spine, and using different indicator muscles. **Comment:** As described by the I.C.A.K., vertebrae without subluxation, fixation, or other mechanical problems should be negative to challenge. Only 40% of the 68 subjects tested had pain, and only 50% of them had stiffness in the thoracic region. It should be obvious that challenging a normally functioning vertebra should cause a negative result, thereby making positive tests of the thoracic spinal column from T3 to T12 statistically insignificant. General lateral to medial spinous process pressure applied to a vertebra that may be subluxated does not always produce a muscle response. The specific vector of challenge must match the specific subluxation of the vertebra if the rebound phenomenon described in AK diagnosis of vertebral subluxations is to be evaluated. A more specific research design would be to diagnose vertebral subluxations by another method (palpation, radiography, thermography), and then to employ the AK method of vertebral challenge to these specific vertebrae to evaluate the intra- and inter-examiner reliability of this method.
Comparison of a hand-held and fixed dynamometer in measuring strength of patients with neuromuscular disease, Brinkmann JR.	*J Orthop Sports Phys Ther.* 1994 Feb;19(2):100-4. **Abstract:** While numerous studies report acceptable reliability of hand-held dynamometers, very little information is available on factors affecting measurements and comparisons with other force measurement systems. A hand-held dynamometer was compared to a fixed dynamometer to determine if the two systems of force measurement yielded comparable results. Twenty-one patients with neuromuscular disease were measured for maximal isometric strength of 12 muscle groups with both force measurement systems using standardized positioning and stabilization procedures. Only one of the 12 muscle groups tested demonstrated significantly different force measurements between the two systems. Good association was found between both systems in force measurements, with Pearson correlation coefficients ranging from .76 to .90. We conclude that a hand-held dynamometer and a fixed dynamometer yield comparable results in patients with neuromuscular disease, provided that testing is limited to muscle groups producing relatively low forces.
The demystification of Chinese pulse diagnosis: An overview of the validations, holograms, and systematics for learning the principles and techniques, Dale RA.	*Am J Acupunct* 1993;21(1):63-80. **Abstract:** Chinese pulse diagnosis is demystified in this review of the scientific validations, and of the holographic relationships between the pulse, the anatomy and the principal energetic exchanges of the body. A systematics is presented for learning to “read” the quantitative and qualitative differentiations at the six classical positions of the radial artery. Novices at pulse diagnosis are provided a methodology that permits basic readings of various patterns of energetic imbalances to be acquired at the outset. Treatment suggestions for each pathological pattern are provided for correcting these imbalances, and for immediately reevaluating the pulse. **Comment:** The AK applications of meridian system principles are cited frequently and very positively by Dale in his frequent articles in the *American Journal of Acupuncture*. In this paper, Dale says of Goodheart: “George Goodheart is a chiropractic physician in Detroit who has developed a holistic systematics of diagnosis and treatment, which incorporates acupuncture. Goodheart defines switching as a neurological disorganization that can interfere with the immunological system. Paul Nogier, who discovered auriculo-acupuncture refers to the same dysfunction as the oscillation of the corpus callosum, the structure which makes left and right brain assignments in response to different stimuli.”
Educational Kinesiology with learning disabled children: an	*Percept Mot Skills.* 1994 Feb;78(1):105-6.

efficacy study, Cammisa KM.	**Abstract:** Educational Kinesiology is a treatment using specific movements to access different parts of the brain in maximizing learning potential. It has been recommended for use with learning disabled children; however, studies validating its effects are limited. The school records of 25 students each with a diagnosis of specific learning disability were examined for pre- and posttest scores on academic and perceptual motor skill measures following an Educational Kinesiology program. Analysis indicated significant improvement in perceptual motor skills following the Educational Kinesiology program. The change in academic skills was not significant. Educational Kinesiology is recommended as a treatment to improve perceptual motor function of learning disabled children. Other variables affecting this study as well as clinical and research implications are discussed. **Comment:** In AK, a diagnostic and treatment system called "cross-crawl patterning" was developed from the work of Doman and Delacato. This treatment is thought to assist in the re-patterning of certain central nervous system functions that are impaired in some patients. This paper examines the effect of this treatment method on children with academic and motor control problems.
A pilot study on the value of applied kinesiology in helping children with learning difficulties, Mathews MO, Thomas E.	*Br Osteopathic J*, 1993;XII.
Relationship between two measures of upper extremity strength: manual muscle test compared to hand-held myometry, Schwartz S, Cohen ME, Herbison GJ, Shah A.	*Arch Phys Med Rehabil.* 1992 Nov;73(11):1063-8. **Abstract:** One hundred and twenty-two individuals with spinal cord injuries at levels C4-6, Frankel classifications A through D, were evaluated to determine the relationship between the manual muscle test (MMT) and hand-held myometry as accurate methods for measuring muscular strength. More specifically, this study attempted to define a range of myometry scores that could be correlated with discrete MMT grades. It also investigated which of the two modalities (MMT or hand-held myometry) is the best reflection of improvement in muscle strength over time. Sequential motor strength examinations using both modalities were performed at 72 hours, one week, and two weeks post SCI and then one, two, three, four, six, 12, 18, and 24 months post injury. The data analyses included calculations of Spearman ranked correlations, analyses of variance, and linear regressions. Results showed that 22 of 24 correlations between MMT and myometry were significant at p values less than .001. The range of myometry measurements for a particular MMT grade appears to be most specific for MMT scores less than 4 (i.e., poor-plus to good), and less specific for MMT scores greater than or equal to 4. The results of this study also indicate that myometry measurements detect increases in strength over time, which are not reflected by changes in MMT scores.
Somatic dyspnea and the orthopedics of respiration, Masarsky CS, Weber M.	*Chiro Tech* 1991;3(1):26-29. **Abstract:** Several brief cases are presented in which the symptom of dyspnea was alleviated or abolished following the correction of vertebral subluxation complex or other somatic dysfunctions. In discussing such cases, the term "somatic dyspnea" is suggested to denote air hunger or shortness of breath related to somatic dysfunction. Somatic dyspnea is a condition which may accompany other causes of dyspnea (lung pathology, psychogenic or "functional" causes, etc.), or it can exist alone. In our chiropractic practice, most somatic dyspnea is seen as a secondary condition in patients presenting primarily with orthopedic complaints. When the symptom is secondary, the patient will often not mention it until an examination procedure reproduces it or treatment causes it to improve or disappear. The response to manipulative therapy is sometimes so dramatic and rapid that a strong linkage between the dyspnea and the primary presenting complaint is suggested. **Comment:** The treatments used in this study come primarily from AK. The "challenge" method is employed for discovery of articular problems; neurolymphatic and neurovascular reflexes (as

	described by Goodheart) are employed for the diaphragm muscle; evaluation of the meridian system (as modified by Goodheart and others) is used; cranial manipulation (AK methods) were used; and evaluation and treatment of inhibited muscles involved in respiration described. Masarsky and Weber have also published a paper that showing that AK examination and treatment procedures in the treatment of a patient with chronic obstructive pulmonary disease were also beneficial. Masarsky and Masarsky have explicated in great detail the contention in AK that somato-visceral and viscero-somatic methodologies should be a part of the chiropractic approach to patients in their excellent book *Somato-visceral aspects of chiropractic: an evidence-based approach.*
Objective Measurement of Proprioceptive Technique Consequences on Muscular Maximal Voluntary Contraction During Manual Muscle Testing, Perot, C., Meldener, R., Gouble, F. -- Departement de genie biologique, URA CNRS 858, Universite de technologie, Compiegne.	*Agressologie*. 1991; 32(10):471-474. This study measured the electrical activity in muscles. It established that there was a significant difference in electrical activity in the muscle, and that this corresponded with the difference found between "strong" versus "weak" muscle testing outcomes by AK practitioners. It further established that these outcomes were not attributable to increased or decreased testing force from the doctor during the tests. In addition, the study showed that manual treatment methods used by AK practitioners to reduce the level of tone of spindle cells in the muscle are in fact capable of creating a reduction in tone of the muscle, as had been observed clinically. Response of Tibialis anterior muscle to a "proprioceptive technique" used in applied kinesiology was investigated during manual muscle testing using a graphical registration of both mechanical and electromyographic parameters. Experiments were conducted blind on ten subjects. Each subject was tested ten times, five as reference, five after proprioceptive technique application reputed to be inhibitory. Results indicated that when examiner-subject coordination was good an inhibition was easily registered. Therefore reliability of the proposed procedure is mostly dependent upon satisfactory subject-examiner coordination that is also necessary in standard clinical manual muscle testing.
Failure of the musculo-skeletal system may produce major weight shifts in forward and backward bending, Goodheart, G.	*Proc Inter Conf Spinal Manip*, Washington, DC;May 1990:399-402 Forty patients were evaluated for pre- and post-treatment weight balance. Of the 40 patients, only one had minimal changes in weight upon two scales beneath the feet when both flexing and extending the spine. The treatment protocol employed (applied kinesiology methods) proved to balance the aberrant patterns of weight distribution during flexion and extension of the spine.
Reliability of Manual Muscle Testing with a Computerized Dynamometer, Hsieh, C.Y., Phillips, R.B.	*Journal of Manipulative and Physiological Therapeutics*. 1990; 13:72-82. **Abstract:** The purpose of this study was to investigate the reliability of manual dynamometry. Three testers participated and performed the doctor-and-patient-initiated testing methods as described in the applied kinesiology literature. Three muscles from each subject were tested. Fifteen normal volunteer adults had their muscles tested by the doctor-initiated method and another and another 15 had their muscles tested by the patient-initiated method. Each tester took two observations per muscle. The testing procedures were repeated 7 days later. The results showed that the intratester reliability coefficients were 0.55, 0.75 and 0.76 for testers 1, 2 and 3, respectively, when the doctor-initiated method was used; 0.96, 0.99 and 0.97 when the patient-initiated method was used. The intertester reliability coefficients were 0.77 and 0.59 on day 1 and day 2, respectively, for the doctor-initiated method; 0.95 and 0.96 for the patient-initiated method. It is concluded that manual dynamometry is an acceptable procedure for the patient-initiated method and is not acceptable for the doctor-initiated method. **Comment:** Numerous hand-held dynamometers have been developed to quantify the manual muscle test. These are units that are interposed between the examiner's hand and the subject's limb being tested. There is a constant effort to upgrade the hand-held units. These units can measure many aspects of the manual muscle test, but none of them has all of the measuring capacities that are in each of them separately. To date none of these units have been capable of

	measuring the manual muscle test as used in applied kinesiology with consistent reliability. This study does show a correlation, but it does not validate the complete system of manual muscle testing as used in AK. It appears that the major difference between testing against fixed transducers – whether isometric or concentric – is that the muscle is required to simply produce power; in manual muscle testing, the muscle is required to adapt to the changing pressure of the examiner's force. This requires effective functioning in the gamma system adjusting the neuromuscular spindle cell, and proper interpretation of its afferent supply and response by the nervous system.
A Review of the Research Papers Published by the International College of Applied Kinesiology from 1981 to 1987, Klinkoski, B., LeBoeuf, C.	*J Manipulative Physiol Ther,* 1990;13:190-194 **Abstract:** Applied Kinesiology (AK) is a diagnostic and therapeutic approach used by a large number of chiropractors. AK seminars are conducted worldwide; during these seminars mention is frequently made of the presence of supportive research. A review was undertaken of the type and scientific quality of 50 papers which had been published between 1981 and 1987 by the International College of Applied Kinesiology, 20 of which were classified as research papers. These were subjected to further scrutiny relating to criteria considered crucial in research methodology, namely, a clear identification of sample size, inclusion criteria, blind and naïve subjects and statistical analysis. Although some papers satisfied several of these criteria, none satisfied all seven of them. As none of the papers included adequate statistical analyses, no valid conclusions could be drawn concerning their report of findings. **Comment:** It may be that the "controlled clinical trial" cannot be realized in practice; a "dream of reason" leading its ghostly existence on the pages of research journals and largely disregarded in practice. The positive patient outcomes as a result of applied kinesiology chiropractic that are described in the papers reviewed in this article may have greater weight than data from designed research protocols involving human subjects. In "controlled clinical trials" it is not possible to control all of the variables in individual patients in the study, and therefore it may only be naively assumed that every detail of an idealized research methodology have been met. However, in the evolving health care system, self-assessed, or subjective measures of a patient's response to treatment are gaining credibility. The unreliability of physical, mechanistic measurements in defining outcomes has led to a shift toward using patient-reported perceptions as outcome measures. For example, patient-reported symptoms of disability have been found to be more predictive of outcomes such as returning to work than diagnostic tests or signs such as x-rays or orthopedic examinations of physical abnormalities. Applied kinesiology's emphasis on health rather than disease, and treatment of the whole person rather than the symptoms, makes it difficult to fully describe or detect the effects of AK therapies in patients' function through currently existing physiologic measures or "controlled clinical trials."
Somatosensory Evoked Potential Changes During Muscle Testing, Leisman, G., Shambaugh, P., Ferentz, A.	*International Journal of Neuroscience.* 1989; 45:143-151. This study measured the way the central nervous system is functioning when muscles test strong versus when they test weak. Clear, consistent and predictable differences were identified in the central nervous system between weak and strong muscle test outcomes. This supports the idea that manual muscle testing outcome changes reflect changes in the central nervous system.
Cybernetic Model of Psychophysiologic Pathways: II. Consciousness of Effort and Kinesthesia, Leisman, G.	*Journal of Manipulative and Physiological Therapeutics*. 1989; 12(3):174-191. **Abstract:** This paper describes a series of experiments directed toward the following questions: a) do signals from musculotendinous receptors reach consciousness?, and b) does feed-forward information of muscular force and expected extent of voluntary movement exist? To answer these questions, data from voluntary compression of springs and strain-gauge have been analyzed in healthy young subjects. By successive elimination of information from other sources, it was possible to verify that receptors in muscles and tendons do signal movement magnitude and muscular tension to the cerebral cortex, and that this information does reach consciousness. There also exists a feed-forward mechanism signaling parameters of voluntary contraction.

	However, it is unclear whether peripheral, subcortical or intracortical loops are directly involved.
Cybernetic Model of Psychophysiologic Pathways: III. Impairment of Consciousness of Effort and Kinesthesia, Leisman, G.	*Journal of Manipulative and Physiological Therapeutics*. 1989; 12(4):257-265. **Abstract:** It is unclear whether peripheral, subcortical or intracortical loops are directly involved between receptors in muscles and tendons and the cerebral cortex in signaling movement magnitude and muscular tension information. Previous experiments have indicated that this information does reach consciousness. Data from voluntary compression of springs and strain-gauge were analyzed in patients with unilateral lesions of the cerebral hemispheres. It was found that the perception of signals of muscular tension is abolished by lesions of the contralateral cortex near the central sulcus. It was concluded that the possibility exists of separate cortical projection areas for kinesthetic signals from muscles and from joints.
Chiropractic Management of Chronic Obstructive Pulmonary Disease, Masarsky CS, Weber M.	*J Manipulative Physiol Ther.* 1988;11(6):505-510. **Abstract:** A patient with a history of chronic obstructive pulmonary disease going back more than 20 years was treated with a combination of chiropractic manipulation, nutritional advice, therapeutic exercises, and intersegmental traction. Improvements were noted in forced vital capacity, forced expiratory volume in one second, coughing, fatigue, and ease of breathing (sign significant at 0.005 level). Improvement was also noted in laryngospasm. Studies are made and speculation as to the mechanisms of the treatment effect is provided. **Comment:** The treatments used in this study are primarily AK. The "challenge" method is employed for discovery of articular problems; neurolymphatic and neurovascular reflexes (as described by Goodheart) are employed for the diaphragm muscle; cranial manipulation (AK methods) were used; cross-crawl patterning was given to the patient; and evaluation and treatment of inhibited muscles involved in respiration described. Masarsky and Weber have also published a paper that employed AK examination and treatment procedures in the treatment of a series of 6 patients with "somatic dyspnea." Masarsky and Masarsky have also explicated in great detail contention in AK that somato-visceral and viscero-somatic methodologies should be a part of the chiropractic approach to patients in their excellent book *Somato-visceral aspects of chiropractic: an evidence-based approach.*
Applied kinesiology unreliable for assessing nutrient status. Kenney JJ, Clemens R, Forsythe KD.	*J Am Diet Assoc.* 1988 Jun;88(6):698-704. **Abstract:** Applied kinesiology is a technique used to assess nutritional status on the basis of the response of muscles to mechanical stress. In this study, 11 subjects were evaluated independently by three experienced applied kinesiologists for four nutrients (thiamin, zinc, vitamin A, and ascorbic acid). The results obtained by those applied kinesiologists were compared with (a) one another, (b) standard laboratory tests for nutrient status, and (c) computerized isometric muscle testing. Statistical analysis yielded no significant interjudge reliability, no significant correlation between the testers and standard biochemical tests for nutrient status, and no significant correlation between mechanical and manual determinations of relative muscle strength. In addition, the subjects were exposed in a double-blind fashion to supplements of thiamin, zinc, vitamin A, and ascorbic acid and two placebos (pectin and sucrose) and then re-tested. According to applied kinesiology theory, "weak" (indicating deficiency) muscles are strengthened when the subject is exposed to an appropriate nutritional supplement. Statistical analysis revealed no significant differences in the response to placebo, nutrients previously determined (by muscle testing) to be deficient, and nutrients previously determined (by muscle testing) to be adequate. Even though the number of subjects (11) and nutrients (4) tested was limited, the results of this study indicated that the use of applied kinesiology to evaluate nutrient status is no more useful than random guessing. **Comment:** This study by Kenney et al, of the Pritikin Longevity Center, is useful in evaluating the claims of lay people in the nutritional field. However, the claim that this study investigated AK methods of nutritional supplementation is in error, and the study concerns nothing that the ICAK supports or teaches. Papers like Kenney et al's are common in the literature: they employ

	research designs that do not reflect the clinical practice and the principles of AK. In practice, AK MMT is used as an adjunct rather than alternative to other diagnostic measures (especially regarding nutritional or non-musculoskeletal conditions) and multiple AK MMTs are performed in series and parallel fashion before any diagnosis is ever made. This is not reflected in Kenney's study.
Effect of educational kinesiology on static balance of learning disabled students, Morris GS, Sifft JM, Khalsa GK.	*Percept Mot Skills* 1988 Aug, **67(1)**:51-4. **Abstract:** Educational Kinesiology is a movement-based program designed to enhance academic performance and may also influence performance of motor skills. The purpose of this study was to determine whether the Educational Kinesiology techniques of repatterning and/or integration movements affected static balance of 60 learning disabled students, ranging in age from 7 to 11 yr. Subjects were matched on age and sex and assigned to one of three groups: control, movement, or repatterned. Children in the repatterned group received a 10-min. individual session of combined arm and leg movements coordinated with eye-placements prior to the start of the 6-wk. program. Both treatment groups then participated in a movement program for 5 min. twice a day, 5 days a week for 6 wk. The control group received no exposure to these special techniques. Static balance was pretested and posttested in each group using the Modified Stork Stand test. A one-way analysis of variance indicated a significant difference between groups. A Scheffé post hoc test showed that the repatterned group improved more than the movement group, who in turn improved more than the control group. **Comment:** In AK, a diagnostic and treatment system called "cross-crawl patterning" was developed from the work of Doman and Delacato. This treatment is thought to assist in the re-patterning of certain central nervous system functions that are impaired in some patients. This paper examines the effect of this treatment method on children with academic and motor control problems.
Intrarater reliability of manual muscle testing and hand-held dynametric muscle testing, Wadsworth CT, Krishnan R, Sear M, Harrold J, Nielsen DH.	*Phys Ther,* 1987 Sep;67(9):1342-7. **Abstract:** Physical therapists require an accurate, reliable method for measuring muscle strength. They often use manual muscle testing or hand-held dynametric muscle testing (DMT), but few studies document the reliability of MMT or compare the reliability of the two types of testing. We designed this study to determine the intrarater reliability of MMT and DMT. A physical therapist performed manual and dynametric strength tests of the same five muscle groups on 11 patients and then repeated the tests two days later. The correlation coefficients were high and significantly different from zero for four muscle groups tested dynametrically and for two muscle groups tested manually. The test-retest reliability coefficients for two muscle groups tested manually could not be calculated because the values between subjects were identical. We concluded that both MMT and DMT are reliable testing methods, given the conditions described in this study. Both testing methods have specific applications and limitations, which we discuss.
Clinical Reliability of Manual Muscle Testing, Frese, E., Brown, M., Norton, B.J. .	*Phys Ther*. 1987; 67:1072-1076 **Abstract:** The purposes of this study were to develop a protocol to examine the reliability of manual muscle testing in a clinical setting and to use that protocol to assess the interrater reliability of manually testing the strength of the middle trapezius and gluteus medius muscles. One hundred ten patients with various diagnoses participated as subjects, and 11 physical therapists participated as examiners in this study. The results showed that interrater reliability for right and left middle trapezius and gluteus medius muscles were low. The percentage of therapists obtaining a rating of the same grade or within one third of a grade ranged from 50% to 60% for the four muscles. This study indicates that using manual muscle testing to make accurate clinical assessments of patient status is of questionable value. **Comment:** This study demonstrates that manual muscle testing as a diagnostic tool is only as good as the operator conducting the test. The study notes that the 11 physical therapists who were the examiners were recent graduates of a physical therapy program, with only an average of 2.3

	years of clinical experience. Two different types of manual muscle testing procedures were also employed during this study, thereby increasing the variability of outcomes. The methods of manual muscle testing used in this study were not those taught by the I.C.A.K., and the numerous variables in a manual muscle test (patient positioning, accuracy of timing during the test, and consistency of the type of testing done on the patients by the examiners) were not accounted for, any one of which may influence the perception of strength or weakness on testing.
Physical balancing: Acupuncture and Applied Kinesiology, Larson D.	*Am J Acupunct.* 1985;13(2):159-162. **Abstract:** This paper is an introduction to applied kinesiology (muscle testing) and its relation to acupuncture. Comparisons are made with pulse diagnosis and muscle testing. The Five-Element treatment plan is described. **Comment:** This paper is part of a continuing series of papers regarding the interrelationships found between the muscular system – readily accessible through the manual muscle test – and the meridian system of Traditional Chinese Medicine (TCM). Acupuncture is a healing art which is embedded in eastern culture and TCM. Applied kinesiology (AK) as a Western development is supported by neurological models, and potentially supplies a logical "easy-to-use" tool for the use of acupuncture. The MMT has been a key tool for the entry of many clinicians into the ideas and methods of TCM. The more recent discoveries in the West like Applied Kinesiology may add to the tools for diagnosis and treatment using TCM principles.
Diagnosis of thyroid dysfunction: applied kinesiology compared to clinical observations and laboratory tests, Jacobs G, Franks T, Gilman G.	*J Manipulative Physiol Ther,* 1984;7(2):99-104. **Abstract:** Sixty-five patients presenting to three clinics were independently evaluated for thyroid dysfunction by applied kinesiology (AK), a clinical protocol, and laboratory testing. Each was rated on a scale of 1 (unquestionably hypothyroid) to 7 (unquestionably hyperthyroid). AK ratings correlated with laboratory ratings ($r_s = .32$, $p < 0.002$) and with laboratory ratings ($r_s = .32$, $p < 0.005$). Correlation between clinical and laboratory diagnosis was .47, $p < 0.000$. Three AK therapy localizations had a significant correlation with the laboratory diagnosis ($p < .05$). Two of these (right neurovascular-left brain and left neurolymphatic-right brain) were points associated with thyroid function. The third, ventral hand on the glabella with the other on the external occipital protuberance, is associated with pituitary function. AK enhanced but did not replace clinical/laboratory diagnosis of thyroid dysfunction. Preliminary evidence indicates that there may be a significant correlation between certain AK tests and an elevated LDH in the serum.
Effects of Manipulation on Gait Muscle Activity: Preliminary Electromyographic Research, Hibbard D.	*ACA J Chiropr* Oct 1983;17(10):49-52. **Abstract:** Electromyographic analysis of lower limb muscle activity during gait was performed on 27 subjects to record any changes in muscle electrical activity following lower extremity manipulation. The 10 control subjects receiving passive treatment showed a small, but statistically significant, decrease in electrical activity post treatment. The 17 test subjects, receiving manipulation to reduce malposition, showed a highly statistically significant change in electrical activity post treatment. A statistically signifiocant relationship was also found between the type of joint malposition present and the direction of muscle activity change following manipulation. **Comment:** In this important study muscles of the lower extremity were systematically tested using the methods of Kendall and Kendall (the method used in AK MMT) until one muscle was found which was found weak compared to the same muscle on the other leg. Articulations upon which this inhibited muscle directly acts were examined for malposition using joint "challenge" as taught in AK methods, as well as static palpation. EMG analysis on the muscle was then carried out. Numerous other papers in this compendium have showed as significant a difference in the electrical activity of peripheral muscles following manipulation to spine and extremities. These data offer further support for the hypothesis held in AK that spinal and extra-spinal manipulative procedures lead to an increase in central motor excitability rather than overall

	inhibition.
The Efficacy of Manual Assessment of Muscle Strength Using a New Device, Marino, M., Nicholas, J.A., Gleim, G., Rosenthal, P., Nicholas, S.J. -- Institute of Sports Medicine and Athletic Trauma of Lenon Hill Hospital, New York	*American Journal of Sports Medicine*. 1982; 10:360-364. **Abstract:** The purpose of this study was to compare the manual assessment of muscle strength with a small, hand-held (by the examiner) force-measuring device developed by the Institute of Sports Medicine and Athletic Trauma (ISMAT). One hundred twenty-eight patients presented with a known lower extremity orthopedic pathology. All patients were clinically evaluated for hip abductor and hip flexor weakness in standard positions using the "break test" technique. All 128 patients were then evaluated with the ISMAT Manual Muscle Tester, a small-hand held device with recorded the peak force (kg) required to break a muscle contraction. Three bilateral measures of hip abduction and hip flexion were recorded, averaged, and compared to the subjective clinical evaluation using a Chi-square analysis. Bilateral values which were within 5% of each other were not considered significant and therefore not included in the calculations. The average hip abduction and hip flexion scores measured by the ISMAT tester were consistent with the examiner's perception of muscle weakness (P less than 0.001). The results demonstrate consistent detection of muscle weakness by the ISMAT Manual Muscle Tester over a broad range of testing conditions.
Muscle Strength Testing as a Diagnostic Screen for Supplemental Nutrition Therapy: A Blind Study, Triano, J.	*Journal of Manipulative and Physiological Therapeutics*. 1982; 5:179. **Abstract:** A controlled study of the reliability of clinical muscle testing as an index of nutritional assessment is presented. Both participating clinicians and patients were unaware of the nature of the substances being tested for their effect on the latissimus dorsi muscle. Previously identified "weak" muscles were used to observe for a "strengthening" effect as a result of topical and sublingual exposure to specific nutritional supplements. **Comment:** This study reports that there is no one-to-one association between certain muscle weaknesses and a specific nutrient that always strengthens the muscle. This assertion has never been made by the I.C.A.K. The most serious problem with this study is that its negative conclusions are much broader than its data supports, because they lack the statistical power to justify such a broadly negative (or positive) conclusion. Furthermore, research on AK nutritional testing requires a much more complex design. There are many factors that can cause a muscle to test weak that need to be taken into consideration.
Applied kinesiology: an experimental evaluation by double blind methodology, Jacobs, G.	*J Manipulative Physiol Ther*, 1981;4:141-145 **Abstract:** The object was to develop a double blind experiment for testing the premise of a muscle testing procedure referred to as Applied Kinesiology (A.K.). In a non-blind test there was a significant difference (P<.05) in muscle response to lump sugar versus the same amount in a 10 ml solution of distilled H_20. It was not possible to demonstrate significant differences in response to sweet and non-sweet sugar solutions of various concentrations, to fresh sesame oil and heated, or to fresh corn oil and aged corn oil when stimuli were applied in a double blind experiment. It was concluded on the basis of the parameters of this study that the AK response generally expected did not occur. **Comment:** This study demonstrated a random muscle weakening on gustatory stimulation with refined sugar. The "AK response generally expected" was that muscles would weaken upon gustatory stimulation with refined sugar. This is an example of experimental bias against sugar. In some patients sugar will cause improved muscle function depending on the patient's physiological status at the time. None of the literature from the I.C.A.K. suggests that all individuals weaken on oral stimulation with refined sugars. This double-blind study did demonstrate, however, an 81.9% agreement between two testers, indicating good inter-examiner reliability.
Effects of an Applied Kinesiology Technique on	*Physical Therapy*. 1981; 61:1011-1016. **Abstract:** The effect of either the muscle spindle cell receptor technique of applied kinesiology

Quadriceps Femoris Muscle Isometric Strength, Grossi, J.A.	or a placebo technique on isometric strength of the right quadriceps femoris muscle group was studied among 20 normal human subjects. Peak, perpendicular maximal values of isometric quadriceps femoris muscle force was measured by a force transducer. Three training sessions consisting of three trials of peak maximal contractions of the isometric quadriceps femoris muscle were performed by all subjects. After the three training sessions, matched pairs of subjects were formed from a rank order list of each subject's mean values of isometric quadriceps femoris muscle strength on the third session. One subject of a matched pair was then randomly assigned to either an experimental (applied kinesiology) or control (placebo) group for the testing session. No significant differences in mean values of isometric quadriceps femoris muscle strength between the matched pairs for control and experimental subjects were noted. Within the context of a normal population, the applied kinesiology technique does not appear to augment isometric quadriceps femoris muscle strength. **Comment:** This study investigates something that is not a part of applied kinesiology and concludes that the treatment protocol used is ineffective. This study was conducted on normally functioning subjects, and attempted to increase a muscle's strength by neuromuscular spindle technique. Applied kinesiology manipulation of the neuromuscular spindle cell is designed to treat an abnormally functioning muscle that is hypertonic or tests weak on manual muscle testing due to the dysfunctioning muscle spindle cell. One must first identify that the muscle is dysfunctional and then that it is due to the neuromuscular spindle cell. Under those conditions treatment to the neuromuscular spindle cell is appropriate. The application of neuromuscular spindle cell technique in AK is toward a dysfunctional spindle cell that is diagnosed by positive therapy localization, palpable, swollen, or fibrotic area, and tenderness to digital pressure. The therapeutic pressure applied to the suspected neuromuscular spindle cell area is from 1-7 kg; however, a harder pressure may occasionally be needed. This is significantly greater than the .9 to 2.7 kg pressure indicated in Grossi's procedure in this paper. The measurement of muscle strength in Grossi's study was against a fixed force transducer with the muscle contraction isometric. It has been established in AK that a muscle's ability to produce force in an isometric contraction is different than the adaptation necessary when the test begins with an isometric contraction and then force is produced against the muscle to cause it to go into eccentric contraction. The MMT appears to evaluate the nervous system's ability to adapt the muscle to changing requirements of producing force. It makes little sense to try to make a normal muscle more normal by this technique, as was attempted in this study.
New simple early diagnostic methods using Omura's "Bi-Digital O-Ring Dysfunction Localization Method" and acupuncture organ representation points, and their applications to the "drug & food compatibility test" for individual organs and to auricular diagnosis of internal organs--part I, Omura Y	*Acupunct Electrother Res.* 1981;6(4):239-54. **Abstract:** By critically evaluating exceptions which may lead to false diagnoses, as well as by improving the currently-used **applied kinesiology diagnostic method** (="Dysfunction Localization Method"), the author was able to develop the "Thumb-Index Finger Bi-Digital O-Ring Diagnostic Method," **using the Applied Kinesiology Dysfunction Localization Principle.** By combining the author's "Bi-Digital O-Ring Dysfunction Localization Method" with clinically useful organ representation points in acupuncture medicine (where the presence of tenderness at the organ representation point is used for diagnosis as well as for the location of treatment), it has become possible to make early diagnoses of most of the internal organs, with an average diagnostic accuracy of over 85%, without knowing the patient's history or using any instruments. The method can detect dysfunctioning or diseased organs even before tenderness appears at the organ representation point, with an applied force of less than 1 gm/mm2 on the skin surface, while the detection of tenderness at the organ representation point often requires a minimum applied force of 80-100 gm/mm2. The method was applied to the "Drug and Food Compatibility Test" to determine the probable effects of a given food or drug on individual internal organs without going through time-consuming, expensive laboratory tests. It was also applied to auricular organ representation points and their evaluation, and has succeeded in increasing their diagnostic sensitivity. The method was also used for the evaluation of magnetic fields. Usually the North pole increased muscle strength and the South pole weakened it at most parts of the

	body. This simple, improved, economical diagnostic method may have invaluable implications in clinical diagnosis, treatment and drug research. **Comment:** In the late 1970s, medical doctor and electrical engineer Yoshiaki Omura developed the O-ring test which he derived from applied kinesiology methods. Using the AK method of therapy localization to areas of organic dysfunction, Omura showed that measurable decreases in grip strength occurred. In addition to journal articles regarding the O-ring method in English, Omura published two books in Spanish and one in Japanese. [**Electro Acupunctura y Acupunctura Manual: Bases Biofisicas y Bioquimicas. (Electro Acupuncture & Manual Acupuncture: Biophysical and Biochemical Bases). EDAD S.A., Maracaibo, Venezuela, 1984.]** [**Practice of Bi-Digital O-Ring Test. Ido-No-Nihon-Sha, Tokyo Japan, 1986. (In Japanese).**] The "Bi-Digital O-Ring Test" refers to an opponens pollicus and flexor digiti minimi general manual muscle test, while the patient or assistant TLs a particular organ, acupuncture point or substance to be tested. Omura's difference with AK in the area of acupuncture is primarily in Omura's exclusive use of finger muscles without testing any other muscles in the body potential effect from meridian imbalances. This may prove to be a significant limitation from the research presented in this compendium.
The effect of oral administration of refined sugar on muscle strength, Rybeck D, Swenson R.	*J Manipulative Physiol Ther,* 1980;3:155-161. **Abstract:** The discipline of Applied Kinesiology has described a weakening of major muscle groups in certain experimental subjects upon refined sugar being placed in the mouth. Manual muscle testing, particularly of the latissimus dorsi muscle, has been associated clinically with sugar metabolism. The weakening phenomenon was investigated using an isometric, mechanically measured, test of the latissimus dorsi and a manual test of the same muscle in 73 subjects. Tests were conducted blind prior to and following sugar being placed in the mouths of the experimental group and nothing being given to the controls. The mechanical test showed no statistically significant change upon sugar administration while the manual test revealed a statistically significant difference ($p = 0.0062$) between the control and the experimental groups. Alternative explanations for the "weakening" phenomenon observed in the experimental group with manual muscle testing are discussed as are possible explanations for the apparent inability of the mechanical test to distinguish the control from the experimental group. **Comment:** As noted previously, it is not expected that everyone will weaken when sugar is placed in the mouth. On a clinical basis it is observed that patients who have sugar handling stress more frequently weaken when sugar is placed in the mouth than does the random population. The failure of the manual muscle test to correlate with the mechanical transducer finding is supported by studies by Blaich and Mendenhall showing the difference between manual muscle testing and the Cybex II instrument testing.
Applied Kinesiology (AK), Perle, S.	*Chiro Technique,* 7(3);Aug 1995:103-107. **Abstract:** Applied Kinesiology (AK) intends to be a comprehensive interdisciplinary approach to health care. It postulates that human disease can be seen as an alteration in the function in structural, chemical, and/or mental aspects of the body. Unique to AK is the use of manual muscle testing procedures to aid in the diagnosis of the structural, chemical and/or mental aspects of a disease process. After treatment, AK again uses manual muscle testing procedures to determine the effectiveness of the treatment. Therefore, manual muscle testing is used both to diagnose specific dysfunction and to assess outcomes.
Strength modulation of the biceps brachii muscles immediately following a single manipulation of the C4/C5 intervertebral motor unit in healthy subjects;	*Am J Chiro Med* 1990;3:14-18. **Abstract:** This paper provides evidence that functional strength testing has the potential of being a valid clinical tool for assessing improvements in function after chiropractic manipulative therapy.

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Strength modulation of the erector muscles immediately following manipulation of the thoracolumbar spine. Bonci A, Ratliff C, Adams E, Mirtz T.	*Chiropractic* 1990;6:29-33. **Abstract:** This paper provides evidence that functional strength testing has the potential of being a valid clinical tool for assessing improvements in function after chiropractic manipulative therapy. In AK, the lower trapezius muscles that overlie the erector muslces are strengthened by successful manipulation of the thoracolumbar spine.
Neuromuscular relaxation and CCMDP. Rolfing and applied kinesiology (article in Italian), Santoro, F., Maiorana, C., Geirola, R.	*Dent Cadmos.* 1989 Nov 15;57(17):76-80.
Applied kinesiology and dentistry, Goodheart, G.J.	*Basal Facts,* 9(2);1987:69-73 **Abstract:** This paper presents the applied kinesiology approach for treating structurally based disorders of the temporomandibular joint through an integrated approach to patient care. This approach may require close cooperation between dental orthopedic and chiropractic professionals in evaluating and treating patients. Dental occlusion is suggested to be part of a larger pattern of function that includes the spine, pelvis, cranium, and neuromuscular systems that span them. The jaws, cranium, spine and pelvis are considered as interdependent parts of the whole body system. The AK protocol for evaluation of these factors is presented, and specific techniques for the diagnosis and treatment the musculature of the stomatognathic system are offered.
Applied Kinesiology: Muscle Response In Diagnosis, Therapy And Preventive Medicine, Meal G.	*Eur J Chiro,* Jun 1986;34(2):107
Quantification of the Inhibition of Muscular Strength Following the Application of a Chiropractic Maneuver, Perot, D., Goubel, F., Meldener, R.	*Journale de Biophysique et de Biomecanique*. 1986; 32(10):471-474.
Applied kinesiology and colon health, White, P.	*Basal Facts,* 1985;7(2):143-50. **Abstract:** A review of the physiology of the gastro-intestinal tract is given, as well as the anatomical and bio-chemical factors that may disturb normal function in the colon. A protocol of AK evaluation is offered for the examination of the gastro-intestinal tract. The ileocecal valve's importance for normal colon health is described, and dietary and nutritional advice is given for disturbances in the colon.
Uses of applied kinesiology for dentists, Walther, D.S.	*Basal Facts,* 1985;7(2):133-41. **Abstract:** This paper also describes the applied kinesiology approach for treating structurally based disorders of the temporomandibular joint through an integrated approach to patient care. This approach may require close cooperation between dental orthopedic and chiropractic professionals in evaluating and treating patients. Dental occlusion is suggested to be part of a

	larger pattern of function that includes the spine, pelvis, cranium, and neuromuscular systems that span them. The jaws, cranium, spine and pelvis are considered as interdependent parts of the whole body system. The AK protocol for evaluation of these factors is presented, and specific techniques for the diagnosis and treatment of the musculature of the stomatognathic system are offered.
Applied dental kinesiology: temporomandibular joint dysfunction, Glassley DP	*Basal Facts*, 1983;5(2):65-6
Electromyographic Analysis Following Chiropractic Manipulation of the Cervical Spine: A Model to Study Manipulation-Induced Peripheral Muscle Changes, Rebechini-Zasadny H, Tasharski CC, Heinze WJ.	*J Manipulative Physiol Ther*, 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 electromyograhpically-measured peripheral muscle changes. Twelve out of 12 subjects showed increased muscle activity following manipulation to 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:** These data offer further support for the hypothesis, long held in AK, that SMT procedures lead to an increase in central motor excitability rather than overall inhibition.
Applied kinesiology--double-blind pilot study. Friedman MH, Weisberg J.	*J Prosthet Dent.* 1981 Mar;45(3):321-3. **Comment:** This study does not adhere to proper muscle testing principles. Possibly the most important item in obtaining good results is the examiner's knowledge of how the subject may change the parameters of the test to appear strong when, in fact, the muscle the examiner intends as the prime mover is weak. Subjects will often shift body position, change direction of force, and otherwise change the parameters of the test. These factors must be observed and eliminated by the examiner so they can be placed into the equation which finally evaluates whether there is muscle strength or weakness of manual muscle testing. It is for this reason that in AK we refer to the science and art of MMT, rather than the art and science…It is more important for the examiner to have knowledge of how people change the parameters of the test, what muscles are being used as synergists, what stabilization requirements the examiner must make, and finally the subject's fixation requirements. In the deltoid test an individual will typically shift body position by leaning away from the examiner, as is obvious in this paper in Figure 2 on pg. 322. It must be questioned whether an actual test was being done at the time the picture was taken; however, it is a typical example of what an individual will do as one aspect of changing parameters of the test to appear strong when, in reality, the muscle is dysfunctioning and inhibited. The design of this study attempts to determine how positive suggestion will influence the results of the MMT. Clinical observations show that when positive suggestions are made, the individual uses more effort to recruit synergistic muscle activity or change the position of his/her body, thus changing the test parameter. Unfortunately, these factors could not be observed in this study because the examiner was prohibited from viewing the subject.
New simple early diagnostic methods using Omura's "Bi-Digital O-Ring Dysfunction Localization Method" and acupuncture organ	*Acupunct Electrother Res.* 1981;6(4):239-54. **Abstract:** By critically evaluating exceptions which may lead to false diagnoses, as well as by improving the currently-used **applied kinesiology diagnostic method** (="Dysfunction Localization Method"), the author was able to develop the "Thumb-Index Finger Bi-Digital O-

representation points, and their applications to the "drug & food compatibility test" for individual organs and to auricular diagnosis of internal organs--part I, Omura Y	Ring Diagnostic Method," **using the Applied Kinesiology Dysfunction Localization Principle.** By combining the author's "Bi-Digital O-Ring Dysfunction Localization Method" with clinically useful organ representation points in acupuncture medicine (where the presence of tenderness at the organ representation point is used for diagnosis as well as for the location of treatment), it has become possible to make early diagnoses of most of the internal organs, with an average diagnostic accuracy of over 85%, without knowing the patient's history or using any instruments. The method can detect dysfunctioning or diseased organs even before tenderness appears at the organ representation point, with an applied force of less than 1 gm/mm2 on the skin surface, while the detection of tenderness at the organ representation point often requires a minimum applied force of 80-100 gm/mm2. The method was applied to the "Drug and Food Compatibility Test" to determine the probable effects of a given food or drug on individual internal organs without going through time-consuming, expensive laboratory tests. It was also applied to auricular organ representation points and their evaluation, and has succeeded in increasing their diagnostic sensitivity. The method was also used for the evaluation of magnetic fields. Usually the North pole increased muscle strength and the South pole weakened it at most parts of the body. This simple, improved, economical diagnostic method may have invaluable implications in clinical diagnosis, treatment and drug research.
Neurophysiologic Inhibition of Strength Following Tactile Stimulation of the Skin, Nicholas, J.A., Melvin, M., Saraniti, A.J.	*American Journal of Sports Medicine*. 1980; 8:181-186. **Abstract:** A modified shoulder abduction manual muscle test was incorporated in this study to demonstrate strength changes following tactile stimulation of the skin. Resistance was applied to the distal radioulnar joint and the stimulus (scratching) was applied inferior to the clavicle on the clavicular head of the pectoralis major muscle after maximum contraction. An electromechanical device quantified the isotonic (eccentric) measurements. A standard dynamometer system (Cybex II) was used to measure isometric strength. The nondominant side was used as the "control." Two populations, a normal (random) and a strong (athletic) group, were studied. Twenty-three persons (52% women, 48% men; mean age, 27 years; mean height, 67 inches (170 cm); and mean weight, 147 lb (66.7 kg)) were in the "normal" group and 17 persons (100% men; mean age, 25 years; mean height, 74 inches (188 cm); and mean weight, 215 lb (97.5kg)) were in the "strong" group. The random population showed a 19% decrease in strength following tactile stimulation as measured by the manual muscle testing unit; the athletic population showed a 17% decrease in strength. With the isometric measurements, the random population had an 8% decrease in mean strength following the scratch but the athletic population showed no significant decrease. The capability to quantify objectively manual muscle tests is discussed in relation to the importance of the proximal musculature. **Comment:** This study demonstrates a small part of the potentiality of the AK technique called Therapy Localization or TL. In AK, TL is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system. "Neurophysiologic Inhibition of Strength Following Tactile Stimulation of the Skin" states this dynamic precisely. In AK, positive TL always calls for further investigation to the area concerned. The 17% and 8% decrease in strength following TL demonstrated in this study would create a MMT finding of 4 (or inhibited) as graded in the *Guides to the Evaluation of Permanent Impairment*, 4th Edition by the American Medical Association.
An Experimental Evaluation of Kinesiology in Allergy and Deficiency Disease Diagnosis, Scoop A.	*Journal of Orthomolecular Psychiatry*. 1979; 7(2):137-8. **Abstract:** An accurate, reliable, and quick method for determining vitamin-mineral imbalances and food allergies is critical in establishing a balanced behavioral biochemistry. Dr. George Goodheart has clinically observed that whenever a patient was deficient in a specific vitamin or food factor, a specific muscle which he found to be associated with the nutrient was almost always unilaterally weak (weak on right or left side of the body) when the muscle strength was tested using kinesiology procedures (Goodheart, 1976). Goodheart and coworkers have established an association between approximately 50 vitamins and minerals on the one hand, and

	50 associated muscles which are weak when the nutrient is deficient. According to Goodheart, chewing or ingestion of the critical food factor results in dramatic restoration of muscle strength within 10 seconds. The purpose of this study was to test some of Goodheart's observations in a more formal manner and to adapt his principles to cerebral allergy testing. 10 naïve subjects were given 10 muscle tests by 6 trained testers. **Pearson Product-Moment Correlation between testers was .91, suggesting that muscle testing is reliable between testers.** Subjects with unilateral weak muscles were then given either a placebo or the nutrient which Goodheart believes to be associated with the unilateral muscle. The increase in muscle tone measured approximately 10 seconds after ingestion was 21% for the nutrient group and was statistically significant ($p < .05$) increase in comparison with the placebo group. Muscle tone was measured by a Jaymar dynamometer with the muscle tested according to kinesiology procedures described by Kendall and Kendall. In the cerebral allergy testing part of the study, a 15% decrease in muscle tone of the pectoralis major clavicular was used as the criterion for cerebral allergy. The muscle testing method was then compared to results obtained by a Philpott-type fast with progressive reintroduction of foods**. Correlation between foods identified as provocative by muscle testing and by the fast was .81. Observation of clinical results obtained with muscle testing suggests the method has substantial clinical utility.**
Factors Influencing Manual Muscle Tests in Physical Therapy, Nicholas, J. A., Sapega, A., Kraus, H., Webb, J.N.	*Journal of Bone and Joint Surgery*. 1978; 60-A:186-190. **Abstract:** To determine whether it is the amount or the duration of the force applied manually by the tester, or both, that determines the tester's perception of the strength of the hip flexor or abductor muscles, an electromechanical device was designed which was placed between the tester's hand and the subject's limb. With the device we measured the force applied to the limb, the time interval during which it was applied, and the angular position of the limb during the entire test. In 240 such tests, the testers' ratings of the differences in strength between the right and left sides were correlated with seven variables involving force and time. It was found statistically that the impulse--that is, the duration of the tester's effort multiplied by the average applied force during each test--was the factor that most influenced the tester in the ratings.
Evaluation of Muscle-Organ Association, Part I and II, Carpenter SA, Hoffmann, J, Mendel R.	*J Clin Chiro,*1977; II(6):22-33 and III(1):42-60. **Abstract:** A study was performed at the Anglo-European College of Chiropractic to evaluate the muscle-organ association. In 80 subjects, a total of 139 organs were irritated, and the muscle associated with that organ was tested with an instrument. Then a control muscle was tested. 4 organ muscle associations were evaluated: the eye, ear, stomach, and lung. The stomach was irritated by placing cold water into it; the eye with chlorinated water; the ear with sound of a controlled frequency and decibel rate; and the lung with cigarette smoke. In all cases, the associated muscle weakened significantly after the irritation. The control muscle also weakened, but to a much lesser degree. **Comment:** This paper is an important contribution to the clinical research concerning AK theory. Louisa Burns, D.O., reported in the first half of the 20th century that structural alterations of spinal vertebra produce immediately observable changes in body tissues. The connection between spinal subluxations and the muscle components that allow this structural distortion to occur are were specifically evaluated in this study. AK proposes that neurological connections exist between muscles and organs, muscles and joints and that these connections may be the basis of the chiropractor's effectiveness in correcting visceral and/or glandular dysfunction. In this study, the fact that the control muscle also weakened parallels the AK finding that general muscles of the body weaken when an insult is placed into the nervous system or other controlling factor of the body.
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Objective recording of muscle strength. Wakim KG, Gersten JW, et al.	*Arch Phys Med Rehabil.* 1950 Feb;31(2):90-100. **Comment:** This study begins with a discussion of manual muscle testing. "Many factors, personal and otherwise, significant or insignificant, may alter the findings of tests in such a way that they may be misleading in an optimistic or pessimistic manner." The roles of four types of muscles (prime movers, antagonists, synergists, and fixators) are pointed out as important in the understanding of the MMT. Fixation is obtained by the action of other muscles by the position of the patient, by the examiner, or by more than one of these factors. Firmness of the table is pointed out, which includes the table not moving, a solid top, and possibly by a footboard or other factor for the patient to stabilize against. A table is provided showing the difference in strength when a footboard was provided for the subject. This paper shows that the expanded use of the MMT was occurring in many areas of the scientific literature by the 1950's. Kendall and Kendall's second book was called *Posture and Pain*, and there too it was already realized that the theoretical construct of the MMT should be expanded far beyond the "polio syndromes" that the MMT was originally designed to evaluate.4 Using the detailed records from 12,000 cases they state, "The importance of muscle testing in cases of postural disorders cannot be over-emphasized."
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	APPLIED KINESIOLOGY RELATED RESEARCH INFORMATION IN PEER REVIEWED JOURNALS
Relationship between foot strength and motor function in preschool-age children. Rose KJ, Burns J, North KN.	*Neuromuscul Disord.* 2009 Feb;19(2):104-7. Epub 2008 Dec 3. **Abstract: Foot weakness occurs in many paediatric neuromuscular disorders, which overtime can cause considerable functional motor difficulties.** Measuring foot strength with hand-held dynamometry is reliable in preschool-age children, but its validity in this age group is unknown. If foot strength measures are collected as endpoints in clinical trials, they should represent functionally meaningful outcomes. We evaluated the foot strength-motor function relationship in 60 healthy children aged 2-4 years. Foot strength measures included inversion, eversion, dorsiflexion and plantarflexion using hand-held dynamometry. Motor function parameters included time to run 10-m, standing long jump distance and vertical jump height. **Measures of foot strength showed significant correlations with all measures of motor function (r=0.40-0.57, p<0.001).** Hand-held dynamometry may be used as a valid and functionally meaningful measure of foot strength in very young children.
Reliability of clinical tests to evaluate nerve function and mechanosensitivity of the upper limb peripheral nervous system. Schmid AB, Brunner F, Luomajoki H, Held U, Bachmann LM, Kunzer S, Coppieters MW.	*BMC Musculoskelet Disord.* 2009 Jan 21;10(1):11. **ABSTRACT:** **BACKGROUND:** Clinical tests to assess peripheral nerve disorders can be classified into two categories: tests for afferent/efferent nerve function such as nerve conduction (bedside neurological examination) and tests for increased mechanosensitivity (e.g. upper limb neurodynamic tests (ULNTs) and nerve palpation). Reliability reports of nerve palpation and the interpretation of neurodynamic tests are scarce. This study therefore investigated the intertester reliability of nerve palpation and ULNTs. ULNTs were interpreted based on symptom reproduction and structural differentiation. To put the reliability of these tests in perspective, a comparison with the reliability of clinical tests for nerve function was made. **METHODS:** Two experienced clinicians examined 31 patients with unilateral arm and/or neck pain. **The examination included clinical tests for nerve function (sensory testing, reflexes and manual muscle testing (MMT)) and mechanosensitivity (ULNTs and palpation of the median, radial and ulnar nerve)**. Kappa statistics were calculated to evaluate intertester reliability. A meta-analysis determined an overall kappa for the domains with multiple kappa values (MMT, ULNT, palpation). We then compared the difference in reliability between the tests of mechanosensitivity and nerve function using a one-sample t-test. **RESULTS: We observed moderate to substantial reliability** for the tests for afferent/efferent nerve function (sensory testing: kappa=0.53; **MMT: kappa=0.68**; no kappa was calculated for reflexes due to a lack of variation). Tests to investigate mechanosensitivity demonstrated moderate reliability (ULNT: kappa=0.45; palpation: kappa=0.59). When compared statistically, there was no difference in reliability for tests for nerve function and mechanosensitivity (p[greater than or equal to]0.06). **CONCLUSIONS:** This study demonstrates that clinical tests which evaluate increased nerve mechanosensitivity and afferent/efferent nerve function have comparable moderate to substantial reliability. To further investigate the clinometric properties of these tests, more studies are needed to evaluate their validity. **Comment:** In this study, for all the tests used to assess peripheral nerve disorders, the manual muscle test (MMT) was found to have the highest kappa inter-tester reliability levels.
The immediate effects of local and adjacent acupuncture on the tibialis anterior muscle: a human study, Costa LA, de Araujo JE.	*Chin Med.* 2008 Dec 18;3(1):17. **ABSTRACT:** **BACKGROUND:** This study compares the immediate effects of local and adjacent acupuncture on the tibialis anterior muscle and the amount of force generated or strength in Kilogram Force (KGF) evaluated by a surface electromyography. **METHODS:** The study consisted of a single

	blinded trial of 30 subjects assigned to two groups: local acupoint (ST36) and adjacent acupoint (SP9). Bipolar surface electrodes were placed on the tibialis anterior muscle, while a force transducer was attached to the foot of the subject and to the floor. An electromyograph (EMG) connected to a computer registered the KGF and root mean square (RMS) before and after acupuncture at maximum isometric contraction. The RMS values and surface electrodes were analyzed with Student's t-test. **RESULTS:** Thirty subjects were selected from a total of 56 volunteers according to specific inclusion and exclusion criteria and were assigned to one of the two groups for acupuncture. A significant decrease in the RMS values was observed in both ST36 (t = -3.80, P = 0,001) and SP9 (t = 6.24, P = 0.001) groups after acupuncture. There was a decrease in force in the ST36 group after acupuncture (t = -2.98, P = 0.006). The RMS values did not have a significant difference (t = 0.36, P = 0.71); however, there was a significant decrease in strength after acupuncture in the ST36 group compared to the SP9 group (t = 2.51, P = 0.01). No adverse events were found. **CONCLUSION:** Acupuncture at the local acupoint ST36 or adjacent acupoints SP9 reduced the tibialis anterior electromyography muscle activity. However, acupuncture at SP9 did not decrease muscle strength while acupuncture at ST36 did. **Comment:** This is a fascinating study that demonstrates many of the contentions held in AK for many years about the meridian system's influence on muscle and neurological function. By needling ST36, Costa and de Araujo were able to induce functional changes (decreased strength) in the tibialis anterior muscle as evidenced by EMG. According to AK, the tibialis anterior muscle corresponds to the Bladder meridian. This sedation point stimulation of the Bladder meridian, and its weakening effect upon the tibialis anterior muscle, confirms one of the approaches AK has used for decades in evaluating the meridian system.

Possible factors related to functional ankle instability. Santos MJ, Liu W.	*J Orthop Sports Phys Ther.* 2008 Mar;38(3):150-7. **STUDY DESIGN:** Case control study. **OBJECTIVES:** To classify individuals with functional ankle instability (FAI) into deficit and non-deficit categories based on the evaluation of the most common factors that have been proposed to be related to FAI. **BACKGROUND:** Recent studies have suggested that FAI may be secondary to a combination of factors including ankle proprioceptive deficit, **muscular weakness**, impaired balance, delayed neuromuscular reaction time, and joint laxity. However, only a few authors have investigated the prevalence and association among these factors in a single group of individuals. **METHODS AND MEASURES:** The above 5 factors were tested bilaterally in 21 individuals with FAI and in 16 healthy control subjects. Data were analyzed for (1) within- and between-group comparison, (2) classification of subjects with FAI into deficit and no-deficit categories, and (3) magnitude of association between factors in the subjects with FAI using Pearson bivariate correlation. **RESULTS:** Balance control **and evertors' strength** were significantly less on the affected side in comparison to the unaffected side in subjects with FAI. **The evertors' strength was also significantly different between the side difference of the FAI group and the side difference of the control group.** Passive ankle stiffness was significantly correlated to balance control, ankle proprioception, and evertor peak torque. Individuals with FAI demonstrated a large variation in the deficit categories ranging from multiple deficits to no noticeable deficits. CONCLUSION: Mechanical alterations in the ankle joint may influence several aspects of the ankle's functional ability. **Alterations in the afferent processes, represented in this study by ankle proprioception, may effect the evertors' strength or vice versa.** More importantly, individuals with FAI might exhibit high variability in ankle deficits. **Comment:** This study showed that the most consistent factor found in patients with functional ankle instability was muscle weakness in the foot evertor muscles (peroneals). This is a consistent finding in AK examination of dysfunctional ankles as well.
A weak balance: the contribution of muscle weakness to postural instability and falls. Horlings CG, van Engelen BG, Allum JH, Bloem BR.	*Nat Clin Pract Neurol.* 2008 Sep;4(9):504-15. **Abstract:** Muscle strength is a potentially important factor contributing to postural control. In this article, we consider the influence of muscle weakness on postural instability and falling. We searched the literature for research evaluating muscle weakness as a risk factor for falls in community-dwelling elderly individuals, for evidence that strength training reduces falls, and for pathophysiological evidence from patients with neuromuscular disease that supports the link between muscle weakness and falls. **In virtually all studies that included strength testing, muscle weakness was a consistent risk factor for falls in the elderly. Studies that evaluated the merits of muscle strength training often showed a reduction in fall rates, particularly when strength training was a component of a multifactorial intervention, although it was unclear whether strength training alone led to a fall reduction.** Surprisingly few studies addressed the pathophysiological relationship between muscle strength and balance control. **We conclude that muscle weakness is an important risk factor for falls that is potentially amenable to therapeutic intervention**, and that future studies should further clarify the role of muscle weakness in balance control and the pathophysiology of falls.
Dishman JD, Greco DS, Burke JR. Motor-evoked potentials recorded from lumbar erector spinae muscles: a study of corticospinal excitability changes associated with spinal manipulation.	*J Manipulative Physiol Ther.* 2008 May;31(4):258-70. **OBJECTIVE:** The purpose of this study was to determine if high-velocity, low-amplitude spinal manipulation (SM) altered the effects of corticospinal excitability on motoneuron activity innervating the paraspinal muscles. In a previous study using transcranial magnetic stimulation (TMS), augmentation of motor-evoked potentials (MEPs) from the gastrocnemius muscle after lumbar SM was reported. To date, there is no known report of the effect of SM on paraspinal muscle excitability. **METHODS:** The experimental design was a prospective physiologic evaluation of the effects of SM on corticospinal excitability in asymptomatic subjects. The TMS-induced MEPs were recorded from relaxed lumbar erector spinae muscles of 72 asymptomatic subjects. The MEP amplitudes were evaluated pre-SM and post-SM or conditions involving

	prethrust positioning and joint loading or control. **RESULTS:** There was a transient increase in MEP amplitudes from the paraspinal muscles as a consequence of lumbar SM ($F([6,414]) = 8.49$; $P < .05$) without concomitant changes after prethrust positioning and joint loading or in control subjects ($P > .05$). These data findings were substantiated by a significant condition x time interaction term ($F([12,414]) = 2.28$; $P < .05$). **CONCLUSIONS:** These data suggest that there is a postsynaptic facilitation of alpha motoneurons and/or corticomotoneurons innervating paraspinal muscles as a consequence of SM. It appears that SM may offer unique sensory input to the excitability of the motor system as compared to prethrust positioning and joint loading and control conditions. **Comment:** This very important study shows a facilitation of motor evoked potentials in the paraspinal muscles after SMT. The MMT as used in AK also detects this facilitation of peripheral muscles after SMT. Similarly, in other studies in this compendium there are observations of a reduction in hypertonicity from EMG records of back and neck pain patients after SMT. Other investigators have reported a decrease in palpable lumbar muscle spasm and pain after SMT. These data offer further support for the hypothesis, long held in AK, that SMT procedures lead to an increase in central motor excitability rather than overall inhibition. Specifically, there is a post-synaptic facilitation of alpha-motoneurons and/or corticomotoneurons that may be unique to the HVLA thrust.

Reliability and validity of the Medical Research Council (MRC) scale and a modified scale for testing muscle strength in patients with radial palsy. Paternostro-Sluga T, Grim-Stieger M, Posch M, Schuhfried O, Vacariu G, Mittermaier C, Bittner C, Fialka-Moser V.	*J Rehabil Med.* 2008 Aug;40(8):665-71. **OBJECTIVE:** To assess the inter-rater and intra-rater reliability and validity of the original and a modified Medical Research Council scale for testing muscle strength in radial palsy. **DESIGN:** Prospective, randomized validation study. **PATIENTS:** Thirty-one patients with peripheral paresis of radial innervated forearm muscles were included. **METHODS:** Wrist extension, finger extension and grip strength were evaluated by manual muscle testing. Dynamometric measurement of grip strength was performed. Pair-wise weighted kappa coefficients were calculated to determine inter-rater and intra-rater reliability. The 2 scores were compared using the signed-rank test. Spearman's correlation coefficients of the maximal relative force measurements with the median (over-raters) Medical Research Council and modified Medical Research Council scores were calculated to determine validity. **RESULTS:** Inter-rater agreement of the Medical Research Council scale (finger extension: 0.77; wrist extension: 0.78; grip strength: 0.78) and the modified Medical Research Council scale (finger extension: 0.81; wrist extension: 0.78; grip strength: 0.81) as well as intra-rater agreement of the Medical Research Council scale (finger extension: 0.86; wrist extension: 0.82; grip strength: 0.84) and the modified Medical Research Council scale (finger extension: 0.84, wrist extension: 0.81; grip strength: 0.88) showed almost perfect agreement. Spearman's correlation coefficients of the maximal relative force measurements with the median Medical Research Council and modified Medical Research Council score were both 0.78. **CONCLUSION:** Medical Research Council and modified Medical Research Council scales are measurements with substantial inter-rater and intra-rater reliability in evaluating forearm muscles.
Comparison of EMG activity between maximal manual muscle testing and cybex maximal isometric testing of the quadriceps femoris. Lin HT, Hsu AT, Chang JH, Chien CS, Chang GL.	*J Formos Med Assoc.* 2008 Feb;107(2):175-80. **Abstract:** Two methods have been used to produce a maximal voluntary isometric contraction (MVIC) of the superficial quadriceps femoris muscles for normalization of electromyographic (EMG) data. **The purposes of this study were to compare the myoelectic activity of MVIC of manual muscle testing (MMT) versus Cybex maximal isometric testing.** Eighteen normal subjects were recruited. MMT and Cybex testing for MVIC of the dominant leg were performed. EMG activities of the vastus medialis, vastus lateralis and rectus femoris were recorded during MMT and Cybex trials. EMG amplitude and median frequency obtained from the two methods (MMT and Cybex testing) were used for statistical analysis of these three muscles. **Statistically, the difference in the mean of the EMG signal amplitude and median frequency between MMT and Cybex testing were not significant. Considering cost and time, MMT for MVIC technique appears to be reliable and highly valuable.** **Comment:** The concurrent validity of MMT has also been examined in many studies comparing strength scores obtained with MMT with strength readings obtained using quantitative instruments. The concurrent validity of a test refers to a test's ability to produce similar results when compared to a similar test that has established validity. The concurrent validity of the MMT would be examined when the MMT is compared to a "gold standard" confirmation diagnosis using EMG and/or dynamometer testing, for instance. Many studies have compared the findings of MMT with dynamometer tests favorably. As these authors state, "considering cost and time, MMT for MVIC technique appears to be reliable and highly valuable."
Muscle strength, aerobic	*Disabil Rehabil.* 2008 May 21:1-8.

capacity and physical activity in independent ambulating children with lumbosacral spina bifida. Schoenmakers MA, de Groot JF, Gorter JW, Hillaert JL, Helders PJ, Takken T.	**Purpose.** This cross-sectional study investigates deficits and associations in muscle strength, 6-minute walking distance (6MWD), aerobic capacity (VO(2peak)), and physical activity (PA) in independent ambulatory children with lumbosacral spina bifida. **Method.** Twenty-tree children participated (13 boys, 10 girls). Mean age (SD): 10.4 (+/-3.1) years. **Muscle strength (manual muscle testing** and hand-held dynamometry), 6MWD, VO(2peak) (maximal exercise test on a treadmill), and PA (quantity and energy expenditure [EE]), were measured and compared with aged-matched reference values. **Results. Strength of upper and lower extremity muscles, and VO(2peak) were significantly lower compared to reference values.** Mean Z-scores ranged from -1.2 to -2.9 for muscle strength, and from -1.7 to -4.1 for VO2peak. EE ranged from 73 - 84% of predicted EE. 6MWD was significantly associated with muscle strength of hip abductors and foot dorsal flexors. VO(2peak) was significantly associated with strength of hip flexors, hip abductors, knee extensors, foot dorsal flexors, and calf muscles. **Conclusions.** These children have significantly reduced muscle strength, 6MWD, VO(2peak) and lower levels of PA, compared to reference values. VO(2peak) and 6MWD were significantly associated with muscle strength, especially with hip abductor and ankle muscles. Therefore, even in independent ambulating children training on endurance and muscle strength seems indicated.
The reliability of isometric strength and fatigue measures in patients with knee osteoarthritis. McCarthy CJ, Callaghan MJ, Oldham JA.	*Man Ther.* 2008 May;13(2):159-64. Epub 2007 Feb 12. **Abstract: Patients with knee osteoarthritis have both poor strength and endurance of their quadriceps muscles.** It is possible to assess muscle fatigue by monitoring frequency spectrum using electromyography (EMG). This study used the closed kinetic chain approach to muscle assessment. Fifty-five subjects with knee osteoarthritis were examined twice within 1 week. To test maximum voluntary isometric contraction into extension an isokinetic dynamometer, with a closed kinetic chain "leg press" attachment was used. EMG assessment of signal median frequency was done by measuring median frequency shift associated with fatiguing of muscle during a 60s isometric contraction at 60% of maximum isometric contraction. Intra-class correlation coefficients with 95% confidence intervals, standard errors of measurement and smallest detectable differences were calculated. Results showed the reliability of the maximum voluntary isometric contraction extension strength test was ICC 0.99 and SEM 3.95Nm. The initial median frequency indices also demonstrated excellent ICC and SEM statistics (ICC 0.84-0.91, SEM 9.2-11Hz) for the three heads of the quadriceps; however, the fatigue slopes for all three muscles were unreliable with poor ICCs (0.04-0.72) and SDD values (2207-4000%). The assessment of peak muscle torque using a closed kinetic chain isometric technique is reliable, as is the determination of median frequency values for the quadriceps. Error for the assessment of fatigue was of an unacceptable scale. While the use of a closed kinetic chain leg press technique provides a reliable measurement of lower limb strength, EMG power spectrum decrease during an isometric contraction is of little value.
Effects of bedding systems selected by manual muscle testing on sleep and sleep-related respiratory disturbances, Tsai LL, Liu HM.	*Appl Ergon.* 2008 Mar;39(2):261-70. Epub 2007 May 22. **Abstract:** In this study, we investigated the feasibility of applying manual muscle testing (MMT) for bedding selection and examined the bedding effect on sleep. Four lay testers with limited training in MMT performed muscle tests for the selection of the bedding systems from five different mattresses and eight different pillows for 14 participants with mild sleep-related respiratory disturbances. For each participant individually, two bedding systems-one inducing stronger muscle forces and the other inducing weaker forces-were selected. **The tester-participant pairs showed 85% and 100% agreement, respectively, for the selection of mattresses and pillows that induced the strongest muscle forces.** The firmness of the mattress and the height of the pillow were significantly correlated with the body weight and body mass index of the participants for the selected strong bedding system but not for the weak bedding system. Finally, differences were observed between the strong and the weak bedding systems with regard to sleep-related respiratory disturbances and the percentage of slow-wave sleep. **It was concluded that MMT can be performed by inexperienced testers for the selection of**

	bedding systems.
Migraine with unilateral motor symptoms: a case-control study. Young WB, Gangal KS, Aponte RJ, Kaiser RS.	*J Neurol Neurosurg Psychiatry.* 2007 Jun;78(6):600-4. Epub 2006 Oct 20. **OBJECTIVE:** To characterise the clinical features of non-familial migraine with unilateral motor symptoms (MUMS) and compare these features with those of migraine without weakness. **METHODS:** 24 patients with MUMS and 48 matched controls were identified from a tertiary care headache centre. Using a structured interview, the migraine symptoms of both groups were characterised. Results of previously administered Beck Depression Inventories (BDI), Minnesota Multiphasic Personality Inventories and psychiatric diagnoses were collected, when available, and compared between groups. **RESULTS:** 9 patients had episodic migraine and 15 had chronic migraine. Patients with MUMS always had weakness involving the arm subjectively, and both arm and leg objectively. A give-way character was always present. Only 17% of patients with MUMS reported facial weakness; 58% reported persistent interictal weakness; 92% reported sensory symptoms. A rostrocaudal march of sensory and motor symptoms was frequently reported. Weakness was ipsilateral to unilateral headache in two thirds of the patients. Compared with controls, patients with MUMS had had similar pain intensities, but were more likely to report other migrainous symptoms, including allodynia. 38% of patients with MUMS were told they had had a stroke, and 17% believed they had had a stroke despite normal brain imaging. Patients with MUMS reported fewer affective disorders and more adjustment disorders than controls, and had similar BDI scores. **CONCLUSIONS:** A syndrome of severe migraine with accompanying give-way weakness is common in tertiary care headache centres. It is accompanied by other neurological symptoms. **Comment:** In this study, "Give-way weakness" is a sudden loss of resistance during muscle strength testing (MMT) of at least two sites on one side of the body. This study confirms and further characterizes other studies that show motor weakness frequently accompanies migraine headache.
Altered sensorimotor integration with cervical spine manipulation. Taylor HH, Murphy B.	*J Manipulative Physiol Ther.* 2008 Feb;31(2):115-26. **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 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. **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. **Comment:** From its inception AK chiropractic methods have been discovering specific muscle-joint dysfunctions, the correction of which has resulted in immediate muscular response.

The effect of chronic low back pain on trunk muscle activations in target reaching movements with various loads. Thomas JS, France CR, Sha D, Vander Wiele N, Moenter S, Swank K.	*Spine.* 2007 Dec 15;32(26):E801-8. **STUDY DESIGN:** A cross-sectional study of the timing of trunk muscle activations between 19 participants with chronic low back pain (LBP) compared with 19 matched controls. **OBJECTIVE:** To determine the effects of target height and load on trunk muscle coordination in whole body reaching tasks, and whether participants with chronic LBP display a shift in trunk muscle coordination performing these tasks. **SUMMARY OF BACKGROUND DATA:** Changes in the precise timing of trunk muscle activation may cause an initial episode of back pain, or contribute to the development of recurrent or chronic symptoms. However, most paradigms used to examine timing of trunk muscle activation did not necessitate large displacements of the trunk. **METHODS:** Participants with and without chronic LBP performed a series of bilateral reaching tasks to 3 target heights with 3 different loads held in the reaching hands. During reaching, joint motions were recorded with an optoelectric system and surface electromyographic signals were collected bilaterally from 5 trunk muscles: rectus abdominis, external oblique, internal oblique, iliocostalis lumborum, and the multifidis, and bilaterally from the deltoid muscle. The onset latencies of the antagonist trunk muscles relative to the deltoid muscle were analyzed to determine the effects of group, target height and load. **RESULTS: Onset of trunk extensor muscles was significantly delayed in participants with chronic LBP compared with control subjects.** Further, the onset latency of the antagonist trunk muscles increased with target distance, but decreased with target load. **CONCLUSION:** These findings suggest that a well documented control strategy generalizes beyond single joint movements and that individuals with chronic LBP display a shift in this strategy.
Back extensor strength and lumbar spinal mobility are predictors of quality of life in patients with postmenopausal osteoporosis. Miyakoshi N, Hongo M, Maekawa S, Ishikawa Y, Shimada Y, Itoi E.	*Osteoporos Int.* 2007 Oct;18(10):1397-403. Epub 2007 Apr 26. **SUMMARY: To assess the effect of multiple factors on quality of life (QOL) in osteoporosis**, relationships between the QOL and possible spinal factors were analyzed in 174 postmenopausal women with osteoporosis. **Back extensor strength and lumbar spinal mobility were the most important factors for QOL in these patients. INTRODUCTION:** Quality of life (QOL) in patients with osteoporosis and vertebral fractures is impaired by the decline of total spinal mobility, although it is not clear to what extent. This study aimed to assess the effect of multiple factors on QOL in patients with osteoporosis. **METHODS:** QOL of 174 postmenopausal women with osteoporosis (mean, 68 years old) was evaluated using the **Japanese Osteoporosis QOL Questionnaire (JOQOL)**. Correlations between the JOQOL score, bone mineral density (BMD) of the lumbar spine/proximal femur/whole body, the kyphosis angle and mobility of thoracic and lumbar spine, the number of vertebral fractures, grip strengths of dominant and non-dominant hands, and isometric back extensor strength (BES) were analyzed. RESULTS: JOQOL showed significant correlation ($p < 0.05$) with age ($r = -0.303$), BES ($r = 0.455$), dominant and non-dominant grip strengths ($r = 0.273$ and $r = 0.255$, respectively), number of vertebral fractures ($r = -0.282$), BMDs of proximal femur and whole body ($r = 0.200$ and $r = 0.157$, respectively), lumbar kyphosis angle ($r = -0.296$), and lumbar spinal mobility ($r = 0.345$). **Multiple regression analysis revealed that the BES and lumbar spinal mobility were the significant contributors to the JOQOL ($p < 0.05$). CONCLUSION: BES and lumbar spinal mobility are the important factors for QOL in patients with postmenopausal osteoporosis.**
Assessment of muscle strength of hip joints in children with idiopathic scoliosis, Pingot M, Czernicki J, Kubacki J.	*Ortop Traumatol Rehabil.* 2007 Nov-Dec;9(6):636-43. **BACKGROUND:** The choice of an appropriate approach to the treatment of idiopathic scoliosis is considerably complicated owing to the lack of a clear-cut aetiology of this condition. Idiopathic scoliosis impairs the body's biomechanical balance and adversely affects body statics. **MATERIAL AND METHODS: The muscle torques of the flexor and extensor muscles of the hip joints were assessed in 123 children (96 girls and 27 boys) aged from 8 to 16 with the I degrees scoliosis. Statistically significant differences ($p>0.05$) were revealed. RESULTS:** The primary lumbar scoliosis was to the left in 109 patients (Group 1) and to the

	right in 14 patients (Group 2). All children participated in a 6-month exercise programme to strengthen the weakened muscle groups. Torque measurements were performed twice: immediately after the child joined the rehabilitation programme and on completion of the programme. The strength of the weakened muscles was seen to increase to a statistically non-significant level ($p>0.05$). **CONCLUSIONS:** 1. Exercises strengthening weakened muscles of the hip joint improve the posture of scoliotic children and can be helpful in treating idiopathic scoliosis. 2. **Differences in the strength of the flexors and extensors of the hop joint impair body statics and may constitute one of the causes of idiopathic scoliosis in children.**

Deficits in neuromuscular control of the trunk predict knee injury risk: a prospective biomechanical-epidemiologic study. Zazulak BT, Hewett TE, Reeves NP, Goldberg B, Cholewicki J.	*Am J Sports Med.* 2007 Jul;35(7):1123-30. Epub 2007 Apr 27. **BACKGROUND:** Female athletes are at significantly greater risk of anterior cruciate ligament (ACL) injury than male athletes in the same high-risk sports. Decreased trunk (core) neuromuscular control may compromise dynamic knee stability. **HYPOTHESES:** (1) Increased trunk displacement after sudden force release would be associated with increased knee injury risk; (2) coronal (lateral), not sagittal, plane displacement would be the strongest predictor of knee ligament injury; (3) logistic regression of factors related to core stability would accurately predict knee, ligament, and ACL injury risk; and (4) the predictive value of these models would differ between genders. **STUDY DESIGN:** Cohort study (prognosis); Level of evidence, 2. **METHODS:** In this study, 277 collegiate athletes (140 female and 137 male) were prospectively tested for trunk displacement after a sudden force release. Analysis of variance and multivariate logistic regression identified predictors of risk in athletes who sustained knee injury. **RESULTS:** Twenty-five athletes (11 female and 14 male) sustained knee injuries over a 3-year period. Trunk displacement was greater in athletes with knee, ligament, and ACL injuries than in uninjured athletes ($P < .05$). Lateral displacement was the strongest predictor of ligament injury ($P = .009$). A logistic regression model, consisting of trunk displacements, proprioception, and history of low back pain, predicted knee ligament injury with 91% sensitivity and 68% specificity ($P = .001$). This model predicted knee, ligament, and ACL injury risk in female athletes with 84%, 89%, and 91% accuracy, but only history of low back pain was a significant predictor of knee ligament injury risk in male athletes. **CONCLUSIONS:** Factors related to core stability predicted risk of athletic knee, ligament, and ACL injuries with high sensitivity and moderate specificity in female, but not male, athletes. **Comment:** In AK it has been found that the presence of muscular imbalance and joint dysfunction will alter the ability of the patient to perform stereotypic movement patterns. This paper demonstrates the common and strong correlation between muscle dysfunction and joint dysfunction, a primary thesis of the AK approach. To remain upright and steady in their surroundings, people use all the information about their position provided by their sensory organs in relation to their surroundings. The eyes, the vestibular apparatus, the proprioceptors in muscles and joints all maintain the trunk in proper position when working properly. In this paper, the prevention of joint fatigue and wear and sprain in the knee depends upon the precise integration of sensory information and motor response and strength from the periphery to the trunk.
Neuromuscular consequences of reflexive covert orienting Corneil1 BD, Munoz DP, Chapman BB, Adman T, Cushing SL.	*Nature Neuroscience* 2007;11:13–15. **Abstract:** Visual stimulus presentation activates the oculomotor network without requiring a gaze shift. Here, we demonstrate that primate neck muscles are recruited during such reflexive covert orienting in a manner that parallels activity recorded from the superior colliculus (SC). Our results indicate the presence of a brainstem circuit whereby reflexive covert orienting is prevented from shifting gaze, but recruits neck muscles, predicting that similarities between SC and neck muscle activity should extend to other cognitive processes that are known to influence SC activity. **Comment:** In AK methodology the method for testing the integration of the muscles in the body with the function of the eyes is termed ocular lock testing. It demonstrates the failure of the eyes to work together on a binocular basis through the cardinal fields of gaze. When the eyes are turned in a specific direction, a previously strong indicator muscle will weaken when the ocular lock test is positive, and there may be a disturbance in the visual righting, vestibulo-ocular, or opto-kinetic reflexes. Proper cranial, cervical, or other spinal correction is usually found to eliminate the positive ocular lock test and to improve binocular activiy. The importance of the cervical spine's interaction with the function of the eyes is frequently found in AK evaluation, as well as the Freeman-Wyke one-leg standing test introduced into AK examination by Goodheart 2 decades ago.
Effects of anterior cruciate ligament (ACL) injury on	*Cranio.* 2007 Jul;25(3):177-85.

muscle activity of head, neck and trunk muscles: a cross-sectional evaluation. Tecco S, Salini V, Teté S, Festa F.	**Abstract:** This study evaluated the effects a pathology of the knee, due to an anterior cruciate ligament (ACL) injury, has on muscular activity of neck, head, and trunk muscles. Twenty-five (25) subjects (mean age 28+/-9 years) with ACL injury of the left knee were compared with a control no-pathology group. Surface electromyography (sEMG) at mandibular rest position and maximal voluntary clenching (MVC) wasused to evaluate muscular activity of the areas: masseter, anterior temporalis, posterior cervicals, sternocleidomastoid (SCM), and upper and lower trapezius. The sEMG activity of each muscle, as well as the asymmetry index between the right and the left sides, were compared between the two groups. Subjects in the study group showed a significant increase in the asymmetry index of the sEMG activity of the anterior temporalis at mandibular rest position ($p<0.05$). At rest, the areas of anterior temporalis and masseter in the control group showed a significantly lower sEMG activity compared with subjects in the study group, both in the right and the left sides ($p<0.05$). The same was found for the sEMG activity of the areas of SCM and lower trapezius. At MVC, the right areas of anterior temporalis and masseter in the study subjects showed a significantly lower sEMG activity compared with the control group. The same was observed for the lower trapezius area, both in the right and the left sides. **In general, ACL injury appears to provide a change in the sEMG activity of head, neck and trunk muscles.** **Comment:** The most common pain generators are likely to be those structures housing the most nociceptors (articular surfaces, joint capsules, ligaments). Regardless of what is the exact pain generator, the entire motor system will react and compensate. Long after strained soft tissues have been injured, adaptive patterns will persist. One of the great advantages of AK is for the ability to specifically "challenge" the body itself to discover where these maladaptations and reactions are occurring.
Handgrip strength as a hospital admission nutritional risk screening method, Matos LC, Tavares MM, Amaral1 TF.	*European Journal of Clinical Nutrition* 2007;61:1128–1135. **Objective:** To investigate if handgrip strength (HGS) could be used as a single screening procedure in identifying patients who are classified as being undernourished or nutritionally-at-risk at hospital admission. **Design:** Cross-sectional study. In the second day of hospital admission, HGS was evaluated and results were compared with Nutritional Risk Screening (NRS-2002). **Setting:** Two public hospitals in Porto, Portugal, a university and a district one. **Subjects:** A probabilistic sample of 50% in-patients from each hospital of 314 patients (age range of 18–96) was studied. Patients were considered eligible if they were 18 years old and able to give informed consent. Hand pain, upper limb deformities, incapacity to perform muscle strength measurements and pregnancy were considered further exclusion criteria. **Results:** Patients identified as undernourished by NRS-2002 (37.9%) were older, shorter and lighter, with a lower functional capacity, a longer length of stay and a lower HGS ($P<0.001$). When comparing patients with lower HGS (first quartile) with those with the highest HGS (fourth quartile), this parameter revealed good sensitivity (86.7%) and specificity (70.2%) and a $k=0.56$. Multivariate analysis showed that patients with higher HGS had an independent decreased risk of being at nutritional risk (P for trend <0.001) odds ratio=0.19 (95% confidence interval=0.08–0.48). Our entire sample of hospitalized patients was -1.96 Z-score below the HGS cutoff of distribution data for healthy individuals. **Conclusions: HGS identifies a high proportion of nutritionally-at-risk patients and can be a reliable first screening tool for nutritional risk in hospitals.** **Comment:** Much research has established a relationship between nutritional deficiencies and myofascial dysfunction. This has been an important component of the AK "total person" approach to health care from its beginning.
Neck flexor muscle fatigue in adolescents with headache - An electromyographic study. Oksanen A, Pöyhönen T, Metsähonkala L, Anttila P, Hiekkanen H, Laimi K,	*Eur J Pain.* 2007 Oct;11(7):764-72. Epub 2007 Feb 8. **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

Salminen JJ.	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.
Changes in postural activity of the trunk muscles following spinal manipulative therapy. Ferreira ML, Ferreira PH, Hodges PW.	*Man Ther.* 2007 Aug;12(3):240-8. Epub 2007 Apr 23. **Abstract:** Spinal manipulative therapy (SMT) is common in the management of low back pain (LBP) and has been associated with changes in muscle activity, but evidence is conflicting. **This study investigated the effect of SMT on trunk muscle activity in postural tasks in people with and without LBP.** In 20 subjects (10 with LBP and 10 controls), EMG recordings were made with fine-wire electrodes inserted into transversus (TrA), obliquus internus (OI), and externus (OE) abdominis. Rectus abdominis (RA) and anterior deltoid EMG was recorded with surface electrodes. Standing subjects rapidly flexed an arm in response to a light, before and after a small amplitude end range rotational lumbar mobilization at L4-5. In controls, there was no change in trunk muscle EMG during the postural perturbation after SMT. In LBP subjects there was an increase in the postural response of OI and an overall increase in OE EMG. There was no change in TrA or RA EMG. **These results indicate that SMT changes the functional activity of trunk muscles in people with LBP, but has no effect on control subjects. Importantly, SMT increased the activity of the oblique abdominal muscles with no change in the deep trunk muscle TrA, which is often the target of exercise interventions.**
Considerations in evaluating new treatment alternatives following peripheral nerve injuries: a prospective clinical study of methods used to investigate sensory, motor and functional recovery. Aberg M, Ljungberg C, Edin E, Jenmalm P, Millqvist H, Nordh E, Wiberg M.	*J Plast Reconstr Aesthet Surg.* 2007;60(2):103-13. Epub 2006 Jul 28. The current problem finding reliable and objective methods for evaluating results after peripheral nerve repair is a challenge when introducing new clinical techniques. The aim of this study was to obtain reference material and to evaluate the applicability of different tests used for clinical assessment after peripheral nerve injuries. Fifteen patients with a history of complete median nerve transsection and repair, and 15 healthy volunteers were included. Each subject was investigated using a battery of conventional and new tests for functional, sensory and motor recovery including questionnaires, clinical evaluations, neurophysiological and physiological findings. The results were statistically analysed and comparisons were made within the patient group and between patients and healthy volunteers using a 'per protocol' and an 'intention to treat' approach. Criteria for success were stipulated in order to be able to judge the usefulness of each method. The results showed that 19 of 34 variables, representing six of 16 methods, were not able to fulfil the criteria and were thus questionable for the evaluations of nerve repair in a clinical trial setting. However, 2pd, sensory recovery according to the non-modified British Medical Research Council, sensory neurography**, manual muscle test**, electromyography, questionnaires (i.e. DASH and the 4 question form) and performance tests (i.e. AMPS and Sollerman's subtests 4 and 8) **did fulfil the criteria defined for being useful.**
Interrater reliability and diagnostic accuracy of pelvic	*J Manipulative Physiol Ther.* 2007 May;30(4):252-8.

girdle pain classification. Cook C, Massa L, Harm-Ernandes I, Segneri R, Adcock J, Kennedy C, Figuers C.	**OBJECTIVE:** The purpose of this study was to measure the reliability of a classification system for pelvic girdle pain (PGP) and diagnostic accuracy of selected examination and clinical special findings for diagnosis of PGP. **METHODS:** The design involved a prospective epidemiological study of **pregnancy-related PGP.** Consecutive subjects were recruited and classified using criteria defined by previous studies. Two clinicians examined the subjects and classified each patient into 1 of 5 classification groups. Clinical examination and clinical special tests were performed on the patients with PGP. Statistical analysis involved interobserver agreement using a kappa statistic and sensitivity and specificity values for the examination and clinical special testing. **RESULTS:** Twenty-one subjects were included in the analyses. Aggregated percentage of agreement for the classification system was 84.6%. The Cohen kappa was 0.78 (CI, 0.64-0.92; P < .0001), which indicated substantial agreement during selection of the classification system. Most clinical examination and clinical special-test findings demonstrated low sensitivity and high specificity, whereas clusters of findings including the lunge, **manual muscle testing of the hip (lower extremities)**, and passive range of motion of the hip demonstrated the strongest diagnostic value. CONCLUSION: Selected tests and measures are moderately discriminatory in diagnosing PGP. A classification system for diagnosing PGP demonstrates strong agreement and may be useful for clinicians. **Comment:** The MMT method used in this study was the standard one used in AK (Kendall and Kendall's original MMT methods), and the MMT test was found to show the strongest accuracy and sensitivity of all the tests used for evaluation of PGP.
Isometric force parameters and trunk muscle recruitment strategies in a population with low back pain, Descarreaux M, Lalonde C, Normand MC.	*J Manipulative Physiol Ther.* 2007 Feb;30(2):91-7. **OBJECTIVE:** This study correlates changes in trunk isometric force parameters and trunk muscle recruitment strategies in subjects with low back pain (LBP) and healthy participants. **METHODS:** A control group study with repeated measures was performed. Study participants included 15 control subjects and 14 patients with LBP. Participants were required to exert 50% and 75% of their maximal trunk flexion and extension. In a learning phase, feedback was provided, after which study participants were asked to perform 10 trials without any feedback. Spatiotemporal parameters of muscular activity and force production were recorded. Dependent variables included time to peak force, peak force variability, absolute error in peak force, electromyogram (EMG) burst duration for agonist muscles, and normalized integrated EMG. **RESULTS:** Average time to peak force was significantly longer for subjects with LBP than for healthy subjects. Subjects with LBP showed longer burst duration for all 4 muscles recorded. No group difference was noted in normalized integrated EMG. **CONCLUSIONS:** We suggest that the observed changes in trunk motor control and trunk muscle recruitment strategies are not only mediated by a neurophysiologic adaptation to chronic pain but also by cognitive adaptations modulated by fear of movement and fear of reinjury.
Spinal muscle evaluation in healthy individuals and low-back-pain patients: a literature review, Demoulin C, Crielaard JM, Vanderthommen M.	*Joint Bone Spine.* 2007 Jan;74(1):9-13. Epub 2006 Nov 13. **Abstract:** This article reviews available techniques for spinal muscle investigation, as well as data on spinal muscles in healthy individuals and in patients with low back pain. In patients with chronic low back pain, medical imaging studies show paraspinal muscle wasting with reductions in cross-sectional surface area and fiber density. In healthy individuals, the paraspinal muscles contain a high proportion of slow-twitch fibers (Type I), reflecting their role in maintaining posture. The proportion of Type I fibers is higher in females, leading to better adaptation to aerobic exertion compared to males. Abnormalities seen in paraspinal muscles from patients with chronic low back pain include marked Type II fiber atrophy, conversion of Type I to Type II fibers, and an increased number of nonspecific abnormalities. Limited data are available from magnetic resonance spectroscopy used to investigate muscle metabolism and from near infrared spectroscopy used to measure oxygen uptake by the paraspinal muscles. Surface electromyography in patients with chronic low back pain shows increased paraspinal muscle fatigability, often with abolition of the flexion-relaxation phenomenon. **Comment:** This study demonstrates that LBP usually correlates with demonstrable muscle

	changes(fatigue) that will most likely to produce weakness upon MMT.
The association of low back pain, neuromuscular imbalance, and trunk extension strength in athletes. Renkawitz T, Boluki D, Grifka J.	*Spine J.* 2006 Nov-Dec;6(6):673-83. **BACKGROUND CONTEXT:** Imbalanced patterns of erector spinae activity and reduced trunk extension strength have been observed among patients with low back pain (LBP). The association between LBP and neuromuscular imbalance still remains unclear. **PURPOSE:** To examine the relationship between LBP, neuromuscular imbalance, clinical symptoms, and trunk extension strength on two independent occasions, after dynamic neuromuscular changes through a back exercise program. **STUDY DESIGN/SETTING:** Experimental longitudinal study of the lower back in a clinical setting. **PATIENT SAMPLE:** Eighty-two elite amateur tennis players with and without LBP. **OUTCOME MEASURES:** Clinical testing of spinal mobility and muscular flexibility of the lower back. Isometric voluntary maximum trunk extension strength. Surface electromyography (EMG) of lumbar erector spinae. **METHODS:** Athletes underwent a standardized clinical examination with common tests for spinal mobility and muscular flexibility, followed by an isometric trunk extension tests in a specially built apparatus with simultaneous surface EMG recording from right and left lumbar erector spinae. Imbalance quotients were calculated using integrated EMG (IEMG) measures. The relationships between LBP, neuromuscular imbalance, trunk extension strength, and clinical findings were investigated before and after a back exercise program using univariate and multivariate logistic regression models. RESULTS: **A significant association between neuromuscular imbalance of erector spinae and the occurrence of LBP was observed, whereas no significant imbalances were found in subjects without LBP.** The number of subjects with LBP decreased proportionally with the occurrence of neuromuscular imbalance in the lumbar region after the completion of a back exercise program. **However, neuromuscular imbalances were still present during retesting among subjects whose LBP did not resolve; the relationship between neuromuscular imbalance of lumbar erector spinae and LBP was significant again.** On the contrary, no significant association between LBP and maximum isometric trunk extension strength or neuromuscular imbalance and maximum isometric trunk extension strength was found before or after the exercise program. No clear relationship between LBP and clinical testing of the lumbar spine or neuromuscular imbalance and clinical testing was found on the two independent testing occasions. **CONCLUSION: A direct relationship between LBP and neuromuscular imbalance was documented in athletes with LBP.** Maximum isometric trunk extension strength had no relationship to the presence of LBP or the occurrence of neuromuscular imbalance of erector spinae. Common clinical testing of spinal mobility and muscular flexibility had only limited correlation to LBP and neuromuscular imbalance. **Comment:** This paper demonstrates what AK physicians find consistently: impairment of muscle strength in patients with low back pain. The "construct validity" of the manual muscle test in the evaluation of patients with low back pain syndromes is presented in this report.
EMG analysis of shoulder muscle fatigue during resisted isometric shoulder elevation, Minning S, Eliot CA, Uhl TL, Malone TR.	*J Electromyogr Kinesiol.* 2006 Mar 16; [Epub ahead of print] **Abstract:** The purpose of this study was to determine if a difference existed in the rate of fatigue of select shoulder muscles during isometric shoulder elevation and if the measured rate of fatigue was consistent from day to day. **Shoulder muscle fatigue has been associated with alterations in joint mechanics and possibly contributes to shoulder dysfunction.** While research exists, there is limited information on an objective and reliable measure of shoulder fatigue. Sixteen asymptomatic subjects were evaluated. The subjects held a weight equivalent to 60% of his/her Maximum Voluntary Isometric Contraction (MVIC) while elevating in the scapular plane. Surface electrodes were applied to collect electromyographic activity from the upper trapezius, middle deltoid, serratus anterior, and lower trapezius muscles while the arm was held at 90 degrees elevation. Data collection ceased when the subject was no longer able to maintain 90 degrees of elevation. The subject then rested and a second trial performed. One week later, the two-trial procedure was repeated. A significant interaction of trialxdayxmuscle was found for the rate of fatigue. **Post hoc analysis revealed that the rate of fatigue of the middle deltoid was**

	significantly greater than the other muscles tested. The intraday reliability was good for all muscles but interday reliability was poor except for the middle deltoid. This study suggests that the middle deltoid appears to fatigue faster than the other shoulder muscles tested at the selected level of shoulder elevation. This should be considered in designing a rehabilitation program to develop a sequence that does not overly fatigue the middle deltoid.
Short- and long-term modulation of upper limb motor-evoked potentials induced by acupuncture. Maioli C, Falciati L, Marangon M, Perini S, Losio A.	*Eur J Neurosci.* 2006 Apr;23(7):1931-8. **Abstract:** The aim of this study was to investigate in humans the effects of acupuncture upon upper-limb motor-evoked potentials (MEPs), elicited by transcranial magnetic stimulation of the primary motor cortex. It is known that peripheral sensory stimulation can be used to induce short- and long-term changes in motor cortex excitability. Data show that the simple insertion of the needle is an adequate somatosensory stimulus to induce a significant modulation of MEP amplitude, the sign of which (facilitation or inhibition) is specific to the investigated muscle and to the point of needle insertion. Moreover, MEP changes in upper-limb muscles are also observed following needling of lower-limb sites, revealing the presence of long-distance effects of acupuncture. Finally, the modulation in muscle excitability considerably outlasts the time period of needle application, demonstrating the induction of long-term plastic changes in the central nervous system. In addition, results have shown that the effects on muscle excitability are not restricted to the stimulation of well-coded acupoints, as described in traditional Chinese medicine, but they can also be induced by needling of nonacupoints, normally not used for therapeutic purposes. The possible neuronal mechanisms underlying the observed effects of acupuncture are discussed in relation to the available neurophysiological data regarding the interlimb reflexes and the changes in the representational cortical maps induced in humans by a prolonged somatosensory stimulation. **Comment:** This is a fascinating study that demonstrates many of the contentions held in AK for many years about the meridian system's influence on muscle and neurological function. This study shows that specific stimulation of the meridian system and acupuncture points can change the strength of the muscular system which is assessable by the manual muscle test. This study confirms one of the contentions held in AK for decades regarding the meridian system.
Reversible pelvic asymmetry: an overlooked syndrome manifesting as scoliosis, apparent leg-length difference, and neurologic symptoms, Timgren J, Soinila S.	*J Manipulative Physiol Ther.* 2006 Sep;29(7):561-5. **OBJECTIVE:** The objective of this study was to investigate the occurrence of pelvic asymmetry in neurologic patients with symptoms not explained by their neurologic diagnosis. **METHODS:** We analyzed 150 consecutive neurologic patients referred to physiatric consultation based on their clinical examination findings. **RESULTS:** We observed pelvic asymmetry associated with either C-type or S-type scoliosis and apparent leg-length difference in 87% of the patients. Symmetry could be reestablished by all patients, although 15% showed immediate or imminent relapse. Maintenance of symmetry showed a highly significant ($P < .001$) correlation with improvement in functional ability and reduction of pain as evaluated during the last visit to the physiatrist. In the follow-up questionnaire, 78% of the patients reported improvement in functional ability and reduced pain. **CONCLUSIONS:** Our results support the view that leg-length difference and scoliosis may be more often of reversible nature than previously considered. Acquired postural asymmetry of the sacroiliac joint may be a neglected cause of several neurologic and other pain-related symptoms that can be relieved by a simple and safe treatment.
Effect of Counterstrain on Stretch Reflexes, Hoffmann Reflexes, and Clinical Outcomes in Subjects With Plantar Fasciitis, Wynne MW, Burns JM, Eland	*JAOA* Sept 2006;106(9):547-556. **Context:** Previous research indicates that osteopathic manipulative treatment based on counterstrain produces a decrease in the stretch reflex of the calf muscles in subjects with Achilles tendinitis. **Objectives:** To study the effects of counterstrain on stretch reflex activity and clinical outcomes in subjects with plantar fasciitis. **Methods:** In a single-blind, randomized controlled trial of crossover design, the effects of counterstrain were compared with those of

DC, Conatser RR, Howell JN.	placebo in adult subjects (N=20) with plantar fasciitis. The subjects were led to believe that both the counterstrain and placebo were therapeutic modalities whose effects were being compared. Ten subjects (50%) were assigned to receive 3 weeks of counterstrain treatment during phase 1 of the trial, while the other 10 subjects were given placebo capsules. After a 2- to 4-week washout period, phase 2 of the trial began with the interventions reversed. Clinical outcomes were assessed with daily questionnaires. Stretch reflex and H-reflex (Hoffmann reflex) in the calf muscles were assessed twice during each laboratory visit, before and after treatment in the counterstrain phase. **Results:** No significant changes in the electrically recorded reflexes of the calf muscles were observed in response to treatment. However, changes in the mechanical characteristics of the twitches resulting from the electrical responses were observed. Peak force and time to reach peak force both increased ($P \leq .05$) in the posttreatment measurements, with the increase being significantly more pronounced in the counterstrain phase ($P < .05$). A comparison of pretreatment and posttreatment symptom severity demonstrated significant relief of symptoms that was most pronounced immediately following treatment and lasted for 48 hours. **Conclusions: Clinical improvement occurs in subjects with plantar fasciitis in response to counterstrain treatment. The clinical response is accompanied by mechanical, but not electrical, changes in the reflex responses of the calf muscles.** The causative relation between the mechanical changes and the clinical responses remains to be explored.
A method for comparing manual muscle strength measurements with joint moments during walking, Fosang A, Baker R.	*Gait Posture.* 2006 Dec;24(4):406-11. Epub 2006 Jan 18. **Abstract:** This paper describes a protocol for dynamometer assisted manual muscle testing of the major muscle groups of the lower extremity and its application to 11 able-bodied children who also had conventional gait analysis to obtain joint kinetics. Data from the manual muscle testing was processed in such a way that the results for maximum muscle strength (grade 5) and resistance against gravity alone (grade 3) were presented in Nm/kg allowing direct comparison with conventional joint kinetics. The strength measurements of the hip muscles and the knee extensors were between two and three times the moments exerted during normal walking. Those of the knee flexors and dorsiflexors were about five times the joint moments. Measured plantarflexor strength was only just greater than the moment exerted during walking. These results, particularly those for the plantarflexors, question how valid it is to use measures of isometric muscle strength as indicators of muscle function during activity. The study also compares grade 3 muscle strength with both grade 5 strength and the maximum joint moments. For all muscle groups tested grade 3 muscle strength was less than the maximum moment exerted during normal walking. For the plantarflexors it was less than 1% of that moment. The study demonstrates that reliable isometric muscle testing is possible in able-bodied children but requires considerable care and is time consuming. More work is required to understand how measurements made in this way relate to how muscles function during activity. **Comment:** Many studies have compared the findings of MMT with dynamometer tests favorably, however dynamometers are not as sensitive to changes in strength nor to strength measurements below 3 during the MMT. The human examiner is the most sensitive of all instruments in relationship to interpreting the MMT.
Clinical and muscular evaluation in patients with subclinical hypothyroidism, Reuters VS, Buescu A, Reis FA, Almeida CP, Teixeira PF, Costa AJ, Wagman MB, Ferreira MM, de Castro CL, Vaisman M.	*Arq Bras Endocrinol Metabol.* 2006 Jun;50(3):523-31. **Abstract:** Some symptoms and signs of hypothyroidism, as well as some laboratory abnormalities, may be present in subclinical hypothyroidism (SH). This study evaluates the prevalence of signs and symptoms of hypothyroidism and skeletal muscle dysfunction in 57 patients with SH compared to 37 euthyroid controls. The participants received a clinical score based on signs and symptoms of hypothyroidism. **The muscle strength was estimated by manual testing** and chair dynamometer and inspiratory force by manuvacuometer. Thyroid hormones and muscle enzymes were measured. **The SH group presented with higher score ($p < 0.01$), complained about myalgia and weakness more frequently ($p < 0.05$), and showed strength disability in scapular and pelvic girdles ($p < 0.05$).** The median free T4 serum levels were lower in SH ($p < 0.001$). These findings suggest that signs and symptoms of thyroid

	dysfunction may be related to lower levels of FT4 in SH and should be taken into account in the decision of beginning LT4 therapy.
Physiopathology of respiratory muscles, Close P, Dang MN, Bury T. (Article in French)	*Rev Med Liege.* 2006 Apr;61(4):227-32. **Abstract:** Different factors can have deleterious effect the inspiratory muscles: increased intrinsic mechanical loading of the inspiratory muscles, **functional inspiratory muscle weakness**, increased ventilatory demand related to capacity...**These muscle changes influence exercise tolerance and contribute to dyspnea.**
Conservative chiropractic management of recalcitrant foot pain after fasciotomy: a retrospective case review, Wyatt LH.	*J Manipulative Physiol Ther.* 2006 Jun;29(5):398-402. **OBJECTIVE:** The objective of this study was to describe the safety and potential therapeutic benefit of joint mobilization and manipulation in the conservative management of patients with recalcitrant foot pain after plantar fasciotomy. **METHODS:** The study design was a retrospective review of outcomes of 15 patients seen in a multidisciplinary office setting. All patients had undergone plantar fasciotomy within the 9 months before their admission and had developed lateral foot pain after operation. Each patient had exhibited suboptimal improvement with at least a 4- to 6-week trial of nonsteroidal anti-inflammatory drugs, shoe padding, and rest as prescribed by the attending podiatric surgeon. Manual therapy consisted of either grade III or grade IV joint mobilization and/or high-velocity, low-amplitude chiropractic manipulation to the affected joints in the foot and ankle, and home-based exercise. Outcome criteria were empirically defined as significant improvement, moderate improvement, or no change as assessed by each patient based on a verbal rating scale. **RESULTS:** There was no long-lasting complication associated with any of the procedures, although a common pattern of transient pain migration over the dorsum of the foot into the ankle was noted in some patients; this resolved by the time of discharge. Of the patients with pain in the calcaneocuboid and/or fifth tarsometatarsal articulation, 11 noted significant improvement, 3 experienced moderate improvement, and 1 reported no change. Patients who complied with home care instructions responded better to therapy in most instances. **CONCLUSIONS:** These preliminary findings suggest that joint mobilization and manipulation are safe conservative procedures to use in the treatment of patients with lateral column foot pain in status post plantar fasciotomy. **Comment:** When muscles fail to support the arch of the foot the ligaments can be stretched, and the medial longitudinal arch of the foot is lost. The many causes of foot pronation, which produces plantar fascitis in many cases, are evaluated in AK including the ligaments, muscles, and joints of the foot and leg.
The effect of chiropractic adjustments on movement time: a pilot study using Fitts Law, Smith DL, Dainoff MJ, Smith JP.	*J Manipulative Physiol Ther.* 2006 May;29(4):257-66. **OBJECTIVE:** To investigate the effect of chiropractic adjustments on movement time using Fitts Law. **METHODS:** This was a prospective, randomized controlled trial. Ten patients from a private chiropractic practice participated. Participants in the treatment group received high-velocity, low-amplitude chiropractic adjustments to areas of joint dysfunction (chiropractic subluxation). A nonintervention group was used to control for improvement resulting from time and practice effects. Movement time was measured as participants moved a cursor onto a target appearing on a computer screen. A range of target widths and target distances were used to vary the index of difficulty. **RESULTS:** All participants in the experimental group had significantly improved movement times following spinal adjustments compared with only 1 participant in the control group. The average improvement in movement time for the experimental group was 183 ms, a 9.2% improvement, whereas the average improvement in movement time for the control group was 29 ms, a 1.7% improvement. The difference (improvement) scores after the intervention were significantly greater for the chiropractic group compared with the control group as measured by a 2-tailed independent samples t test ($P < .05$). **CONCLUSION:** The results of this study demonstrated a significant improvement in movement time with chiropractic care. **These results suggest that spinal adjustments may influence motor behavior.**

	Comment: Movement time (MT) is an important variable influencing how people control their movements. At the elite sport level even small changes in MT can have a large effect. For instance, differences between the personal best times of the top sprinters in the world in the 100 yard dash can differ by only 1% (i.e. Greene 9.79 seconds, Bailey 9.84 s, and Christie 9.87 s). MT improvement following treatment has been related to Parkinson's disease severity also. This study demonstrates another investigation into the potential motor control and functional improvements in chiropractic patients.
Improvement in paraspinal muscle tone, autonomic function and quality of life in four children with cerebral palsy undergoing subluxation based chiropractic care: Four retrospective case studies and review of the literature, McCoy M, Malakhova E, Safronov Y, Kent C, Scire P.	*J Vertebral Subluxation Research,* June 21, 2006:1-15. **Objective:** To review the literature and present results experienced by four children with cerebral palsy who underwent chiropractic care to reduce vertebral subluxation. **Clinical Features:** Four children previously diagnosed with cerebral palsy secondary to birth trauma. All four demonstrated objective evidence of vertebral subluxation. **Intervention and Outcomes:** Chiropractic care directed at reduction of subluxation was undertaken. Paraspinal surface electromyography and thermography readings were taken prior to the initiation of care and approximately one month (12 visits) later. The mothers and care providers in each case monitored changes in activities of daily living and quality of life. All four children showed improvement in paraspinal muscle tone (improved symmetry and decreased amplitude) as well as a decrease in the number of levels of abnormal thermography readings. All four children showed improvement in activities of daily living including mobility, feeding, and postural control. **Conclusion:** Improvement in muscle tone and autonomic function coupled with improvement in activities of daily living occurred in these four patients undergoing chiropractic care for reduction of vertebral subluxation. It is suggested that larger studies of this nature be carried out.
The effect of sacroiliac joint manipulation on feed-forward activation times of the deep abdominal musculature, Marshall P, Murphy B.	*J Manipulative Physiol Ther.* 2006 Mar-Apr;29(3):196-202. **OBJECTIVES:** To determine the incidence of delayed feed-forward activation (FFA) times in a group of healthy young males; to retest those subjects who showed delayed FFA after 6 months to determine the reliability of the measure in the absence of treatment or injury in the intervening period; and to determine the effect of sacroiliac joint manipulation on delayed FFA times. **METHODS:** Ninety young males were assessed for the FFA of their deep abdominal muscles in relation to rapid upper limb movements. Those who met the criteria for delayed FFA (failure of deep abdominal activation within 50 milliseconds of deltoid activation) were then reassessed 6 months later. These subjects then underwent sacroiliac joint manipulation on the side demonstrating decreased joint movement during hip flexion and lateral flexion. Feed-forward activation times were then reassessed after joint manipulation. **RESULTS:** Seventeen (18.9%) of 90 subjects met the criteria of impaired FFA. Thirteen of 17 were available to be remeasured at 6-month follow-up. The intraclass correlation coefficient for FFA at this time was greater than 0.70 for all movement directions. There was a significant improvement (38.4%) in FFA times for this group when remeasured immediately after the sacroiliac joint manipulation. **CONCLUSIONS:** Delayed FFA is a highly reproducible measure at long-term follow-up. This technique appears to be a sensitive marker of the neural effects of sacroiliac joint manipulation. Future prospective studies are needed to determine if delayed FFA times are a marker for those at risk for developing back pain. **Comment:** This study demonstrates that an immediately measurable change in muscle function and synergism with other muscles in the body occurs after SI joint manipulation.
Whiplash injury and oculomotor dysfunctions: clinical-posturographic correlations, Storaci R, Manelli A, Schiavone N, Mangia L, Prigione G,	*Eur Spine J.* 2006 Mar 22 **Abstract:** Oculomotor dysfunctions are hidden causes of invalidity following whiplash injury. Many patients with whiplash injury grade II present oculomotor dysfunctions related to input disturbances of cervical or vestibular afferents. We used static posturography to investigate 40 consecutive patients with whiplash injury grade II and oculomotor dysfunctions. We demonstrated a relation between length and surface of body sway: the surface value (A) was

Sangiorgi S.	higher than the length value (L) and this led to an open graph of body sway in the statokinesigram. Oculomotor rehabilitation can resolve the impairment of vestibular function but if therapy is delayed or the patient has been wearing an orthopaedic neck collar, more therapeutic sessions are required. In conclusion, without rehabilitation of the oculomotor muscles other therapies are not sufficient to recover the impairment caused by whiplash injury. **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. In this report oculomotor dysfunction was present in 62% of the patients affected by whiplash injury. The opening of this paper's Abstract states the problem: "**Oculomotor dysfunctions are hidden causes of invalidity following whiplash injury**." In applied kinesiology chiropractic methodology, a means for testing the integration of the muscles in the body with the visual reflexes has been termed *ocular lock*. Ocular lock testing demonstrates the failure of the eyes to work together on a binocular basis through the cardinal fields of gaze. This is usually not gross pathology of cranial nerves III, IV, and VI; rather it is poor functional organization. The ocular lock phenomenon is theorized to be a consequence, most frequently, to cranial faults. Diagnosis of the oculomotor function in patients with post-whiplash syndromes has been expedited by AK testing.
Diagnostic accuracy of the neurological upper limb examination I: inter-rater reproducibility of selected findings and patterns, Jepsen JR, Laursen LH, Hagert CG, Kreiner S, Larsen AI.	*BMC Neurol.* 2006 Feb 16;6:8. **BACKGROUND:** We have previously assessed the reproducibility of manual testing of the strength in 14 individual upper limb muscles in patients with or without upper limb complaints. This investigation aimed at additionally studying sensory disturbances, the mechanosensitivity of nerve trunks, and the occurrence of physical findings in patterns which may potentially reflect a peripheral neuropathy. The reproducibility of this part of the neurological examination has never been reported. **METHODS:** Two blinded examiners performed a semi-quantitative assessment of 82 upper **limbs (strength in 14 individual muscles**, sensibility in 7 homonymous territories, and mechanosensitivity of nerves at 10 locations). Based on the topography of nerves and their muscular and cutaneous innervation we defined 10 neurological patterns each suggesting a focal neuropathy. The individual findings and patterns identified by the two examiners were compared. **RESULTS: Strength, sensibility to touch, pain and vibration, and mechanosensitivity were predominantly assessed with moderate to very good reproducibility (median kappa-values 0.54, 0.69, 0.48, 0.58, and 0.53, respectively). The reproducibility of the defined patterns was fair to excellent (median correlation coefficient = 0.75) and the overall identification of limbs with/without pattern(s) was good (kappa = 0.75). CONCLUSION:** This first part of a study on diagnostic accuracy of a selective neurological examination has demonstrated a promising inter-rater reproducibility of individual neurological items and patterns. Generalization and clinical feasibility require further documentation: 1) Reproducibility in cohorts of other composition, 2) validity with comparison to currently applied standards, and 3) potential benefits that can be attained by the examination.
Disorders of breathing and continence have a stronger association with back pain than obesity and physical activity, Smith MD, Russell A, Hodges PW.	*Aust J Physiother.* 2006;52(1):11-6. **Abstract:** Although obesity and physical activity have been argued to predict back pain, these factors are also related to incontinence and breathing difficulties. Breathing and continence mechanisms may interfere with the physiology of spinal control, and may provide a link to back pain. The aim of this study was to establish the association between back pain and disorders of continence and respiration in women. We conducted a cross-sectional analysis of self-report, postal survey data from the Australian Longitudinal Study on Women's Health. We used

	multinomial logistic regression to model four levels of back pain in relation to both the traditional risk factors of body mass index and activity level, and the potential risk factors of incontinence, breathing difficulties, and allergy. A total of 38,050 women were included from three age-cohorts. When incontinence and breathing difficulties were considered, obesity and physical activity were not consistently associated with back pain. In contrast, odds ratios (OR) for often having back pain were higher for women often having incontinence compared to women without incontinence (OR were 2.5, 2.3 and 2.3 for young, mid-age and older women, respectively). Similarly, mid-aged and older women had higher odds of having back pain often when they experienced breathing difficulties often compared to women with no breathing problems (OR of 2.0 and 1.9, respectively). Unlike obesity and physical activity, disorders of continence and respiration were strongly related to frequent back pain. This relationship may be explained by physiological limitations of co-ordination of postural, respiratory and continence functions of trunk muscles. **Comment:** This study confirms a frequent clinical finding in AK, i.e. that problems with respiration involving the phrenic and intercostals nerves affect may produce incontinence in patients. Correction of problems that produce an elevated level of CO_2 in the blood, using AK methods of treatment, can improve the management and outcome of patients with incontinence.
A pilot study comparing the effects of spinal manipulative therapy with those of extra-spinal manipulative therapy on quadriceps muscle strength, Hillermann B, Gomes AN, Korporaal C, Jackson D.	*J Manipulative Physiol Ther,* 2006 Feb;29(2):145-9. **OBJECTIVE:** The objective of this study was to assess whether tibiofemoral joint manipulation is as effective as sacroiliac (SI) joint manipulation in increasing quadriceps muscle strength. **DESIGN AND SETTING:** Twenty subjects were divided into two groups of 10. After all base measurements of the maximum voluntary force of the quadriceps muscles were taken, subjects in group A received tibiofemoral joint manipulation and those in group B received ipsilateral SI joint manipulation. After these treatments, the maximum voluntary forces of the subjects' quadriceps muscles were retested. **RESULTS:** A significant improvement (P = .05) in quadriceps muscle strength was noted in the subjects who received an SI joint manipulation. **CONCLUSION:** This study showed a significant change within the SI joint manipulation group before and after the manipulation but did not show any significant difference between the groups (tibiofemoral joint vs. SI joint manipulation) in increasing quadriceps muscle strength. **Comment:** This study demonstrates that an immediately measurable change in muscle strength, from inhibition to strength, occurs after SI joint manipulation. A weakness in this study's design is that the manipulation of the tibiofemoral joint was a long-axis manipulation of the joint. There was no evaluation done as to whether this joint had any mechanical problem or subluxation present within it. A more specific design would have been to compose group B of subjects who had knee pain in the area of the tibiofemoral joint. Better yet would have been to find subjects for group B who had specific dysfunctions of the tibiofemoral joint. After manipulating the subluxated tibiofemoral joint into proper position, an evaluation of the inhibited quadriceps muscle might have found an improvement in it strength upon testing. In AK, adjustment of the articulations of the knee frequently improves the function of the quadriceps muscle, as does adjustment of the SI joint when it is subluxated.
A prospective randomized controlled trial of spinal manipulation and ultrasound in the treatment of chronic low back pain, Mohammad A, Mohseni-Bandpei, Critchley J, Staunton T, Richardson B	*Physiotherapy* 92(1) March 2006, Pages 34-42 **Objectives**. To assess the short- and long-term effectiveness of spinal manipulation therapy, and to identify the effect of manipulation on lumbar muscle endurance in patients with chronic low back pain (LBP). **Design.** A randomized controlled trial comparing manipulation and exercise treatment with ultrasound and exercise treatment. **Setting** An outpatient physiotherapy department. **Participants** One hundred and twenty patients with chronic LBP were allocated at random into the manipulation/exercise group or the ultrasound/exercise group. **Interventions** Both groups were given a program of exercises. In addition, one group received spinal manipulation therapy and the other group received therapeutic ultrasound. **Main outcome measures** Pain intensity, functional disability, lumbar movements and muscle endurance were measured shortly before treatment, at the end of the treatment program and 6 months after

	randomization using surface electromyography. **Results** Following treatment, the manipulation/exercise group showed a statistically significant improvement ($P = 0.001$) in pain intensity [mean 16.4 mm, 95% confidence interval (CI) 6.1–26.8], functional disability (mean 8%, 95% CI 2–13) and spinal mobility (flexion: mean 9.4 mm, 95% CI 5.5–13.4; extension: mean 3.4 mm, 95% CI 1.0–5.8). There was no significant difference ($P = 0.068$) between the two groups in the median frequency of surface electromyography (multifidus: mean 6.8 Hz, 95% CI 1.24–14.91; iliocostalis: mean 2.4 Hz, 95% CI 2.5–7.1), although a significant difference ($P = 0.013$) was found in the median frequency slope of surface electromyography in favor of spinal manipulation for multifidus alone (mean 0.3, 95% CI 0.1–0.5). A significant difference was also found between the two groups in favor of the manipulation/exercise group at 6-month follow-up. **Conclusions** Although improvements were recorded in both groups, patients receiving manipulation/exercise showed a greater improvement compared with those receiving ultrasound/exercise at both the end of the treatment period and at 6-month follow-up.
Reliability of techniques to assess human neuromuscular function in vivo, Clark BC, Cook SB, Ploutz-Snyder LL	*J Electromyogr Kinesiol.* 2006 Jan 18 **Abstract:** The purpose of this study was to comprehensively evaluate the reliability of a large number of commonly utilized experimental tests of in vivo human neuromuscular function separated by 4-weeks. Numerous electrophysiological parameters (i.e., voluntary and evoked electromyogram [EMG] signals), contractile properties (i.e., evoked forces and rates of force development and relaxation), muscle morphology (i.e., MRI-derived cross-sectional area [CSA]) and performance tasks (i.e., steadiness and time to task failure) were assessed from the plantarflexor muscle group in 17 subjects before and following 4-weeks where they maintained their normal lifestyle. The reliability of the measured variables had wide-ranging levels of consistency, with coefficient of variations (CV) ranging from approximately 2% to 20%, and intraclass correlation coefficients (ICC) between 0.53 and 0.99. **Overall, we observed moderate to high-levels of reliability in the vast majority of the variables we assessed** (24 out of the 29 had ICC>0.70 and CV<15%). The variables demonstrating the highest reliability were: CSA (ICC=0.93-0.98), strength (ICC=0.97), an index of nerve conduction velocity (ICC=0.95), and H-reflex amplitude (ICC=0.93). Conversely, the variables demonstrating the lowest reliability were: the amplitude of voluntary EMG signal (ICC=0.53-0.88), and the time to task failure of a sustained submaximal contraction (ICC=0.64). Additionally, relatively little systematic bias (calculated through the limits of agreement) was observed in these measures over the repeat sessions. **In conclusion, while the reliability differed between the various measures, in general it was rather high even when the testing sessions are separated by a relatively long duration of time.**
Evaluation of Apparent and Absolute Supraspinatus Strength in Patients With Shoulder Injury Using the Scapular Retraction Test, Kibler WB, Sciascia A, Dome D.	*Am J Sports Med.* 2006 May 30; [Epub ahead of print] **BACKGROUND: Physical examination of patients with shoulder injury not involving actual rotator cuff tears frequently demonstrates decreased rotator cuff strength on manual muscle testing.** This decrease has been attributed to supraspinatus muscle weakness, but it may be owing to alterations in scapular position. **HYPOTHESIS:** The position of stabilized scapular retraction, by minimizing proximal kinetic chain factors and providing a stable base of muscle origin, positively influences demonstrated supraspinatus strength. **STUDY DESIGN**: Controlled laboratory study. **METHODS:** Supraspinatus strength was tested in 20 injured patients and 10 healthy controls in both the empty-can arm position and a position of scapular retraction using a handheld dynamometer. Pain in both maneuvers was measured by use of a visual analog scale. **RESULTS**: Paired t tests indicated the scapular retraction position resulted in statistically significantly (P = .001) higher supraspinatus strength values within both groups. There was no significant difference between the 2 positions in visual analog scale scores. **CONCLUSION:** This study shows that demonstrated apparent supraspinatus weakness on clinical examination in symptomatic patients may be dependent on scapular position. The weakness may be owing to other factors besides supraspinatus muscle weakness, such as a lack of a stable base in the kinetic chain or scapula. **CLINICAL RELEVANCE:** The clinical

	examination that addresses scapular posture and includes scapular retraction will allow more accurate determination of absolute supraspinatus muscle strength and allow efficacious rehabilitation protocols to address the source of the demonstrated weakness. **Comment:** In AK, precise positioning of the patient is critical to consistently dependable findings in MMT. There are many synergistic muscles to the muscle being primarily evaluated during MMT, and these muscles must be correlated to make final determination of the muscle's function. Proper muscle testing is the key to an effective examination. Poor or inexact testing may result in misinformation or in the wrong choice of therapies.
The visceromotor responses to colorectal distension and skin pinch are inhibited by simultaneous jejunal distension, Shafton AD, Furness JB, Ferens D, Bogeski G, Koh SL, Lean NP, Kitchener PD.	*Pain.* 2006 Jul;123(1-2):127-36. Epub 2006 May 16. **Abstract:** Noxious stimuli that are applied to different somatic sites interact; often one stimulus diminishes the sensation elicited from another site. By contrast, inhibitory interactions between visceral stimuli are not well documented. We investigated the interaction between the effects of noxious distension of the colorectum and noxious stimuli applied to the jejunum, in the rat. Colorectal distension elicited a visceromotor reflex, which was quantified using electromyographic (EMG) recordings from the external oblique muscle of the upper abdomen. The same motor units were activated when a strong pinch was applied to the flank skin. Distension of the jejunum did not provoke an EMG response at this site, but when it was applied during colorectal distension it blocked the EMG response. Jejunal distension also inhibited the response to noxious skin pinch. The inhibition of the visceromotor response to colorectal distension was prevented by local application of tetrodotoxin to the jejunum, and was markedly reduced when nicardipine was infused into the local jejunal circulation. Chronic sub-diaphragmatic vagotomy had no effect on the colorectal distension-induced EMG activity or its inhibition by jejunal distension. The nicotinic antagonist hexamethonium suppressed phasic contractile activity in the jejunum, had only a small effect on the inhibition of visceromotor response by jejunal distension. It is concluded that signals that arise from skin pinch and colorectal distension converge in the central nervous system with pathways that are activated by jejunal spinal afferents; the jejunal signals strongly inhibit the abdominal motor activity evoked by noxious stimuli.
Altered patterns of superficial trunk muscle activation during sitting in nonspecific chronic low back pain patients: importance of subclassification. Dankaerts W, O'Sullivan P, Burnett A, Straker L.	*Spine.* 2006 Aug 1;31(17):2017-23. **STUDY DESIGN:** A cross-sectional comparative study between healthy controls and two subgroups of nonspecific chronic low back pain (LBP) patients. **OBJECTIVES:** To determine differences in trunk muscle activation during usual unsupported sitting. **SUMMARY OF BACKGROUND DATA:** Patients with LBP commonly report exacerbation of pain on sitting. Little evidence exists to confirm that subgroups of patients with nonspecific chronic LBP patients use different motor patterns in sitting than pain-free controls. **METHODS:** A total of 34 pain-free and 33 nonspecific chronic LBP subjects were recruited. Two blinded clinicians classified nonspecific chronic LBP patients into two subgroups (active extension pattern and flexion pattern). Surface electromyography (sEMG) was recorded from five trunk muscles during subjects' unsupported "usual" and "slumped" sitting. **RESULTS:** No differences in trunk muscle activity were observed between healthy controls and nonspecific chronic LBP groups for usual sitting. When the classification system was applied, differences were identified. Compared with no-LBP controls, the active extension pattern group presented with higher levels of cocontraction of superficial fibers of lumbar multifidus (12%), iliocostalis lumborum pars thoracis (36%) and transverse fibers of internal oblique (43%). while the flexion pattern group showed a trend toward lower activation patterns (lumbar multifidus, -7%; iliocostalis lumborum pars thoracis, -6%, and transverse fibers of internal oblique, -5%). The flexion relaxation ratio of the back muscles was lower for nonspecific chronic LBP (superficial lumbar multifidus: $t = 4.5$; $P < 0.001$ and iliocostalis lumborum pars thoracis:$t = 2.7$; $P < 0.001$), suggesting a lack of flexion relaxation for the nonspecific chronic LBP. **CONCLUSION:** Subclassifying nonspecific chronic LBP patients revealed clear differences in sEMG activity during sitting between pain-free subjects and subgroups of nonspecific chronic LBP patients.

Measurement of electrical skin impedance of dermal-visceral zones as a diagnostic tool for inner organ pathologies: a blinded preliminary evaluation of a new technique, Zimlichman E, Lahad A, Aron-Maor A Kanevsky A, Shoenfeld Y.	*Isr Med Assoc J.* 2005 Oct;7(10):631-4 **BACKGROUND:** As complementary and alternative medicine is gaining popularity among health consumers, diagnostic screening tools based on neuroreflexology are also being developed. These techniques, which are based on the rationale that measurement of electrical impedance of specific dermatomes reflects corresponding internal organ pathologies, have not yet been the subject of conventional scientific research. **OBJECTIVES:** To determine the effectiveness of a neuroreflexology-based screening test, specifically the Medex device (Medex Screen Ltd.), for diagnosing patients undergoing conventional internal organ assessment, in a hospital setting. METHODS: Patients admitted to an internal medicine department, who met the inclusion criteria and agreed to participate, underwent conventional medical evaluation that included past medical history and physical examination. Another examination was conducted by a second physician using the Medex device to determine internal organ pathologies. A third researcher compared the actual "conventional" diagnosis with the Medex device output using standard statistical analysis. **RESULTS:** Overall, 150 patients participated in the study. Correlation was significant for all categories ($P < 0.01$) except for blood and lymphatic disease. A high sensitivity (>70%) was measured for cardiovascular, respiratory, gastrointestinal and genitourinary diseases. The highest measure of agreement, as represented by the Cohen-Kappa factor, was found for respiratory disease (0.57). **CONCLUSIONS:** Although the exact mechanism is not entirely clear, measurement of electroskin impedance of dermal-visceral zones has the potential to serve as a screening tool for inner organ pathologies. Further research should be conducted to create more evidence to support or dispute the use of this technique as a reliable diagnostic tool. **Comment:** This study demonstrates a small part of the potentiality of the AK technique called Therapy Localization or TL. In AK, TL is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system.
Modulation of intracortical excitability in human hand motor areas. The effect of cutaneous stimulation and its topographical arrangement, Ridding MC, Pearce SL, Flavel SC.	*Exp Brain Res.* 2005 Jun;163(3):335-43. Epub 2005 Jan 15 **Abstract:** Changes in afferent input can alter the excitability of intracortical inhibitory systems. For example, using paired transcranial magnetic stimulation (TMS), both electrical digital stimulation and muscle vibration have been shown to reduce short-interval intracortical inhibition (SICI). The effects following muscle vibration are confined to the corticospinal projection to the vibrated muscles. The results following digital stimulation are less clear and the relative timing of the cutaneous stimulation and TMS is critical. Here we investigated further whether changes in SICI following digit stimulation exhibit topographic specificity. Eleven normal subjects were investigated (age 28.2+/-7.5 years, mean+/-SD). Electromyographic recordings were made from the right first dorsal interosseous (FDI), abductor digiti minimi (ADM) and abductor pollicis brevis (APB) muscles. SICI was measured, with and without preceding electrical digit II or digit V cutaneous stimulation. The interval between the digital nerve stimulus and test magnetic stimulus was independently set for each subject and established by subtracting the onset latency of the motor evoked potential (MEP) from the latency of the E2 component of the cutaneomuscular reflex. Therefore, measures of intracortical excitability were made at a time at which it is known that cutaneous input is capable of modulating cortical excitability. Single digital nerve stimuli applied to digit II significantly reduced SICI in FDI but not in ADM. Single digital nerve stimuli applied to digit V significantly reduced SICI in ADM but not in FDI or APB. There was a more generalised effect on intracortical facilitation (ICF) with both digit II and digit V stimulation significantly increasing ICF in FDI and ADM. Digital stimulation (either DII or DV) did not significantly affect SICI/ICF in APB. These findings show that appropriately timed cutaneous stimuli are capable of modulating SICI in a topographically specific manner. We suggest that the selective decrease in SICI seen with cutaneous stimulation may be important for focusing of muscle activation during motor tasks. **Comment:** This study demonstrates also a small part of the potentiality of the AK technique called Therapy Localization or TL. The cutaneomuscular reflexes have been extensively

	investigated in the scientific literature, and they are part of the mechanism for what is found clinically with TL testing.
Delayed trunk muscle reflex responses increase the risk of low back injuries, Cholewicki J, Silfies SP, Shah R, Greene HS, Reeves NP, Alvi K, Goldberg B	*Spine.* 2005 Dec 1;30(23):2614-20. **STUDY DESIGN:** Prospective observational study with a 2- to 3-year follow-up. **OBJECTIVES:** To determine whether delayed muscle reflex response to sudden trunk loading is a result of or a risk factor for sustaining a low back injury (LBI). **SUMMARY OF BACKGROUND DATA:** Differences in motor control have been identified in individuals with chronic low back pain and in athletes with a history of LBI when compared with controls. However, it is not known whether these changes are a risk for or a result of LBI. **METHODS:** Muscle reflex latencies in response to a quick force release in trunk flexion, extension, and lateral bending were measured in 303 college athletes. Information was also obtained regarding their personal data, athletic experience, and history of LBI. The data were entered into a binary logistic regression model to identify the predictors of future LBI. **RESULTS:** A total of 292 athletes were used for the final analysis (148 females and 144 males). During the follow-up period, 31 (11%) athletes sustained an LBI. The regression model, consisting of history of LBI, body weight, and the latency of muscles shutting off during flexion and lateral bending load releases, predicted correctly 74% of LBI outcomes. The odds of sustaining LBI increased 2.8-fold when a history of LBI was present and increased by 3% with each millisecond of abdominal muscle shut-off latency. On average, this latency was 14 milliseconds longer for athletes who sustained LBI in comparison to athletes who did not sustain LBI (77 [36] vs. 63 [31]). There were no significant changes in any of the muscle response latencies on retest following the injury. **CONCLUSIONS**: The delayed muscle reflex response significantly increases the odds of sustaining an LBI. These delayed latencies appear to be a preexisting risk factor and not the effect of an LBI.
Comparison between handgrip strength, subjective global assessment, and prognostic nutritional index in assessing malnutrition and predicting clinical outcome in cirrhotic outpatients. Alvares-da-Silva MR, Reverbel da Silveira T.	*Nutrition.* 2005 Feb;21(2):113-7. **OBJECTIVE:** This study compared three methods of assessing malnutrition in cirrhotics and correlated nutritional status with clinical outcome. **METHODS:** This cross-sectional study evaluated nutritional status by subjective global assessment (SGA), prognostic nutritional index (PNI), and handgrip strength (HG) in outpatients with cirrhosis (n = 50) and two control groups with hypertension (n = 46) and functional gastrointestinal disorders (n = 49). Patients with cirrhosis were followed for 1 y to verify the incidence of major complications, the need for transplantation, and death. **RESULTS:** Among patients with cirrhosis, 88% were Child-Pugh A and only 12% were Child-Pugh B. Among these, prevalences of malnutrition were 28% by SGA, 18.7% by PNI, and 63% by HG ($P < 0.05$). HG, but not SGA or PNI, predicted a poorer clinical outcome in patients with cirrhosis because major complications such as uncontrolled ascites, hepatic encephalopathy, spontaneous bacterial peritonitis, and hepatorenal syndrome developed in 65.5% of malnourished patients versus 11.8% of well-nourished ones ($P < 0.05$). No significant differences by any method were seen between the two groups regarding liver transplantation or death. **CONCLUSIONS: There was a high prevalence of malnutrition in cirrhotic outpatients, especially when assessed by HG, which was superior to SGA and PNI in this study. HG was the only technique that predicted a significant incidence of major complications in 1 y in undernourished cirrhotic patients.** **Comment:** This study shows that testing the muscles of the hand for weakness specifically correlates with patients with liver cirrhosis. In AK, the relationship between muscle function and nutritional status has been posited. Studies like these show that there is continuity between muscle strength and organic/viscero-somatic function. A number of research papers are now in the literature showing the relationship between handgrip strength and many other neuro-metabolic conditions and syndromes.
Trunk muscle recruitment patterns in specific chronic	*Clin Biomech (Bristol, Avon).* 2005 Jun;20(5):465-73.

low back pain populations, Silfies SP, Squillante D, Maurer P, Westcott S, Karduna AR.	**BACKGROUND: It is hypothesized that injury or degeneration of osteoligamentous spinal structures would require compensation by trunk musculature and alterations in motor control to maintain spine stability.** While, biomechanical modeling has supported this hypothesis, studies of muscle recruitment patterns in chronic low back pain patients both with and without significant osteoligamentous damage have been limited. This study utilized a non-randomized case-control design to investigate trunk muscle recruitment patterns around the neutral spine position between subgroups of patients with chronic mechanical low back pain and asymptomatic controls. METHODS: Twenty subjects with chronic low back pain attributed to clinical lumbar instability were matched to 20 asymptomatic controls. In addition 12 patients with non-specific chronic low back pain were studied. Surface EMG from five trunk muscles was analyzed to determine activation levels and patterns of recruitment during a standing reach under two different loading conditions. FINDINGS: **The chronic low back pain group with symptoms attributed to clinical instability demonstrated significantly higher activation levels of the external oblique and rectus abdominus muscles and lower abdominal synergist ratios than the control group.** No significant differences were found between patient subgroups. INTERPRETATION: **While these data demonstrate altered muscle recruitment patterns in patients with chronic low back pain,** the changes are not consistent with Panjabi's theory suggesting that these alterations are driven by passive subsystem damage. **However, the higher activation of global abdominal musculature and altered synergist patterns may represent a motor control pattern that has consequences for continued dysfunction and chronic pain.** **Comment:** In this compendium of evidence for the AK approach to health care there have been more than 20 studies documenting that motor control does not function properly in patients with chronic LBP and neck pain. This type of muscular dysfunction, recognized as critical in patients with LBP and neck pain, involves the disruption of the what Dr. Panjabi terms the stability system of the spine, leading to the suggestion that improper stabilization responses may serve as a perpetuating factor in patients. It would therefore be beneficial for clinicians to have at their disposal simple, reliable, and accurate tests that are capable of detecting the disturbance of these motor control responses and of monitoring the effectiveness of treatment measures designed to correct this dysfunction. AK MMT provides this type of simple, reliable, repeatable physical test.
A model of dynamic sacro–iliac joint instability from malrecruitment of gluteus maximus and biceps femoris muscles resulting in low back pain, Hossain M, Nokes LDM.	*Medical Hypotheses*, 2005;65(2):278-281. **Abstract:** The objective of this work is to propose a biomechanical model of sacro–iliac joint dysfunction as a cause of low back pain. Sacro–iliac joint is known to be a source of low back pain. We also know that it is a very stable joint with little mobility. Surrounding lower limb and back muscles contribute a major part of this stability. Gait analysis studies have revealed an orderly sequence of muscle activation when we walk – that contributes to efficient stabilisation of the joint and effective weight transfer to the lower limb. Gluteus maximus fibres-lying almost perpendicular to the joint surfaces are ideally oriented for this purpose. Biceps femoris is another important muscle that can also influence joint stability by its proximal attachment to sacrotuberous ligament. Altered pattern of muscle recruitment has been observed in patients with low back pain. But we do not know the exact cause–effect relationship. Because of its position as a key linkage in transmission of weight from the upper limbs to the lower, poor joint stability could have major consequences on weight bearing**. It is proposed that sacro–iliac joint dysfunction can result from malrecruitment of gluteus maximus motor units during weight bearing. This results in compensatory biceps over activation. The resulting soft tissue strain and joint instability may manifest itself in low back pain.** If our hypothesis holds true, it may have positive implications for patients with sacro–iliac joint dysfunction – who could be offered a definite diagnosis and targeted physiotherapy. It may be possible to identify patients early in a primary care setting and offer direct physio referral. They could benefit from exercises to improve strengthening and recruitment of the affected muscles.
Effect of gaze direction on neck muscle activity during	*Exp Brain Res.* 2005 Dec;167(3):422-32. Epub 2005 Sep 29.

cervical rotation, Bexander CS, Mellor R, Hodges PW.	**Abstract: Control of the neck muscles is coordinated with the sensory organs of vision, hearing and balance.** For instance, activity of splenius capitis (SC) is modified with gaze shift. This interaction between eye movement and neck muscle activity is likely to influence the control of neck movement. The aim of this study was to investigate the effect of eye position on neck muscle activity during cervical rotation. In eleven subjects we recorded electromyographic activity (EMG) of muscles that rotate the neck to the right [right obliquus capitis inferior (OI), multifides (MF), and SC, and left sternocleidomastoid (SCM)] with intramuscular or surface electrodes. In sitting, subjects rotated the neck in each direction to specific points in range that were held statically with gaze either fixed to a guide (at three different positions) that moved with the head to maintain a constant intra-orbit eye position or to a panel in front of the subject. Although right SC and left SCM EMG increased with rotation to the right, contrary to anatomical texts, OI EMG increased with both directions and MF EMG did not change from the activity recorded at rest. During neck rotation SCM and MF EMG was less when the eyes were maintained with a constant intra-orbit position that was opposite to the direction of rotation compared to trials in which the eyes were maintained in the same direction as the head movement. **The inter-relationship between eye position and neck muscle activity may affect the control of neck posture and movement.** **Comment:** In applied kinesiology chiropractic methodology, a means for testing the integration of the muscles in the body with the visual reflexes has been termed *ocular lock*. It demonstrates the failure of the eyes to work together on a binocular basis through the cardinal fields of gaze. This is usually not gross pathology of cranial nerves III, IV, and VI; rather it is poor functional organization. Mechanical irritation of cranial nerves III, IV, or VI (usually VI) may be responsible for disturbed binocular function leading to discordant sensory inputs from the visual righting reflex. When the eyes are turned in a specific direction, a previously strong indicator muscle will weaken when the ocular lock test is positive. AK evaluation makes the discovery of dysfunction between the movement of the eyes and their coordination with the muscles of the neck possible in the clinical setting.
Myotendinous alterations and effects of resistive loading in old age, Narici M, Maganaris C, Reeves N. -- Institute for Biophysical and Clinical Research into Human Movement (IRM), Manchester Metropolitan University	*Scand J Med Sci Sports.* 2005 Dec;15(6):392-401. **Abstract:** The loss of muscle mass associated with ageing only partly explains the observed decline in muscle strength. This paper provides evidence of the contribution of muscular, tendinous and neural alterations to muscle weakness in old age and discusses the complex interplay between the changes of the contractile tissue with those of the tendinous tissue in relation to the mechanical behavior of the muscle as a whole. Despite the considerable structural and functional alterations, the elderly musculoskeletal system displays remarkable adaptability to training in old age and many of these adverse effects may be substantially mitigated, if not reversed, by resistive loading. The interplay between these muscular and tendinous adaptations has an impact both on the length-force and force-velocity relationships of the muscle and is likely to affect the range of motion, rate of force development, maximum force development and speed of movement of the older individual.
Erector Spinae and Quadratus Lumborum Muscle Endurance Tests and Supine Leg-Length Alignment Asymmetry: An Observational Study, Knutson, G., Owens, E.	*J Manipulative Physiol Ther*, 2005;28(8):575-581 **Objective**: To determine if there is an association between supine leg-length alignment (LLA) asymmetry and the endurance of the erector spinae (ES) and quadratus lumborum (QL) muscles. **Methods:** Forty-seven subjects (21 women; average age, 36 years old) were tested for ES endurance using the Biering-Sorensen (B-S) test, and 69 (31 women; average age, 34.5 years) were tested for QL endurance. Subjects were examined for supine LLA and tested for ES and QL muscle endurance. The muscle endurance times were compared against those who did and did not demonstrate LLA asymmetry and the side of the "short leg." **Results:** In the B-S test, volunteers with LLA asymmetry (n = 27) had a mean endurance time of 89.7 seconds (SD, 43.3), and the no-LLA asymmetry group (n = 20) had a mean endurance time of 161.5 seconds (SD, 57.1), a significant difference (P < .001). In the QL test, after correction for the effects of sex and exercise, those with a right "short leg" (n = 22) had a right QL endurance time of 25.9 seconds

	(SE, 4.2) and a left QL endurance time of 34.7 seconds (SE, 4.3). The right QL endurance time was significantly different from those subjects with balanced legs (P = .001). Those with a left "short leg" (n = 20) had a left QL endurance time of 28.6 seconds (SE, 4.7) and a right QL endurance time of 38.1 seconds (SE, 4.5). Both QL endurance times were significantly different from those with balanced leg-length (P = .002 and .016, respectively). **Conclusion:** This study suggests that, using the B-S test, the group of volunteers who demonstrated a commonly used sign of subluxation/joint dysfunction, supine LLA asymmetry, had a decreased endurance times over those who did not. The QL endurance tests showed that the QL muscle ipsilateral to the supine short leg had significantly decreased endurance times over the same-side QL fatigue times in the no leg-length asymmetry group.
Spinal manipulation alters electromyographic activity of paraspinal muscles: a descriptive study, DeVocht J, Pickar J, Wilder D.	*J Manipulative Physiol Ther*, 2005;28(7):465-471 **Objective:** To examine the effect of spinal manipulation on electromyographic (EMG) activity in areas of localized tight muscle bundles of the low back. **Methods:** Surface EMG activity was collected from 16 participants in 2 chiropractic offices during the 5 to 10 minutes of the treatment protocol. Electrodes were placed over the 2 sites of greatest paraspinal muscle tension as determined by manual palpation. Spinal manipulation was administered to 8 participants using Activator protocol; the other 8 were treated using Diversified protocol. **Results:** Electromyographic activity decreased by at least 25% after treatment in 24 of the 31 sites that were monitored. There was less than 25% change at 3 sites and more than 25% increase at 4 sites. Multiple distinct increases and decreases were observed in many data plots. **Conclusion:** The results of this study indicate that manipulation induces a virtually immediate change, usually a reduction, in resting EMG levels in at least some patients with low back pain and tight paraspinal muscle bundles. In some cases, EMG activity increased during the treatment protocol and then usually, but not always, decreased to a level lower than the pretreatment level.
A hypothesis of chronic back pain: ligament subfailure injuries lead to muscle control dysfunction, Panjabi M.	*Eur Spine J.* 2005 Jul 27 **Abstract:** Clinical reports and research studies have documented the behavior of chronic low back and neck pain patients. A few hypotheses have attempted to explain these varied clinical and research findings. A new hypothesis, based upon the concept that subfailure injuries of ligaments (spinal ligaments, disc annulus and facet capsules) may cause chronic back pain due to muscle control dysfunction, is presented. The hypothesis has the following sequential steps. Single trauma or cumulative microtrauma causes subfailure injuries of the ligaments and embedded mechanoreceptors. The injured mechanoreceptors generate corrupted transducer signals, which lead to corrupted muscle response pattern produced by the neuromuscular control unit. Muscle coordination and individual muscle force characteristics, i.e. onset, magnitude, and shut-off, are disrupted. This results in abnormal stresses and strains in the ligaments, mechanoreceptors and muscles, and excessive loading of the facet joints. Due to inherently poor healing of spinal ligaments, accelerated degeneration of disc and facet joints may occur. The abnormal conditions may persist, and, over time, may lead to chronic back pain via inflammation of neural tissues. The hypothesis explains many of the clinical observations and research findings about the back pain patients. The hypothesis may help in a better understanding of chronic low back and neck pain patients, and in improved clinical management. **Comment:** This is one of the most important articles published to date on the musculoskeletal aspects of the subluxation. Dr. Panjabi is the world's most published human biomechanical researcher, with 263 published articles to date. The hypothesis he presents in this paper places the functionality of muscles, as both a cause and a consequence of mechanoreceptor dysfunction in chronic back pain patients, at the center of a sequence of events that ultimately results in back pain. As a result of spinal subluxations, muscle coordination and individual muscle force characteristics, i.e. inhibited muscles on MMT, are disrupted. The injured mechanoreceptors generate corrupted transducer signals (that could be detected by EMG, dynamometers, or MMT), which lead to corrupted muscle response patterns produced by the neuromuscular control unit. This article is very important for those in the chiropractic profession who are evaluating the

	existence and the consequences of the subluxation. The key technical factor that makes AK indispensable in the detection of spinal dysfunction is the MMT that makes the detection of muscular imbalance verifiable.
Parallel comparison of grip strength measures obtained with a MicroFET 4 and a Jamar dynamometer, Bohannon RW. -- Department of Physical Therapy, School of Allied Health, U-2101, University of Connecticut, Storrs, CT 06269-2101, USA.	*Percept Mot Skills.* 2005 Jun;100(3 Pt 1):795-8. **Abstract:** Repeated measures of grip strength obtained bilaterally with a Jamar and a MicroFET 4 dynamometer were compared. Measurements obtained with the MicroFET 4 tended to be slightly (2.2-3.1 lb.) higher but were highly correlated (r > or = .96) with those obtained with the Jamar. Parallel reliability for the two devices was excellent (intraclass correlation coefficient > or = .96). Although clinicians should be cautious about using the devices interchangeably, the MicroFET 4 appears to be a legitimate alternative to the Jamar dynamometer.
Quantifying shoulder rotation weakness in patients with shoulder impingement, Tyler TF, Nahow RC, Nicholas SJ, McHugh MP. -- Nicholas Institute of Sports Medicine and Athletic Trauma, Lenox Hill Hospital, New York, NY, USA; PRO Sports Physical Therapy of Westchester, New York, NY, USA.	*J Shoulder Elbow Surg.* 2005 Nov-Dec;14(6):570-4. **Abstract:** The purpose of this study was to determine whether strength deficits could be detected in individuals with and without shoulder impingement, all of whom had normal shoulder strength bilaterally according to grading of manual muscle testing. Strength of the internal rotators and external rotators was tested isokinetically at 60 degrees /s and 180 degrees /s, as well as manually with a handheld dynamometer (HHD) in 17 patients and 22 control subjects. Testing was performed with the shoulder positioned in the scapular plane and in 90 degrees of shoulder abduction with 90 degrees of elbow flexion (90-90). The peak torque was determined for each movement. The strength deficit between the involved and uninvolved arms (patients) and the dominant and nondominant arms (control subjects) was calculated for each subject. Comparisons were made for the scapular-plane and 90-90 positions between isokinetic and HHD testing. Despite a normal muscle grade, patients had marked weakness (28% deficit, P < .01) in external rotators at the 90-90 position tested with the HHD. In contrast, external rotator weakness was not evident with isokinetic testing at the 90-90 position (60 degrees /s and 180 degrees /s, 0% deficit, P = .99). In control subjects, greater internal rotator strength in the dominant compared with the nondominant arm was evident with the HHD at the 90-90 position (11%, P < .01) and in the scapular plane (7%, P < .05). Using an HHD while performing manual muscle testing can quantify shoulder strength deficits that may not be apparent with isokinetic testing. By using an HHD during shoulder testing, clinicians can identify weakness that may have been presumed normal.
Scapular muscle tests in subjects with shoulder pain and functional loss: reliability and construct validity, Michener LA, Boardman ND, Pidcoe PE, Frith AM.	*Phys Ther.* 2005 Nov;85(11):1128-38. **BACKGROUND AND PURPOSE:** Scapular muscle performance evaluated with a handheld dynamometer (HHD) has been investigated only in people without shoulder dysfunction for test-retest reliability of data obtained with a single scapular muscle test. The purpose of this study was to assess the reliability, error, and validity of data obtained with an HHD for 4 scapular muscle tests in subjects with shoulder pain and functional loss. **SUBJECTS AND METHODS:** Subjects (N=40) with shoulder pain and functional loss were tested by measuring the kilograms applied with an HHD during 3 trials for muscle tests for the lower trapezius, upper trapezius, middle trapezius, and serratus anterior muscles. Concurrently, surface electromyography (sEMG) data were collected for the 4 muscles. The same procedures were performed 24 to 72 hours after the initial testing by the same tester. Muscle tests were performed 3 times, and the results were averaged for data analysis. **RESULTS: Intraclass correlation coefficients for intratester reliability of measurements of isometric force obtained using an HHD ranged from .89 to .96.** The standard error of the measure (90% confidence interval [CI]) ranged from 1.3 to 2.7 kg; the minimal detectable change (90% CI) ranged from 1.8 to 3.6 kg. **Construct validity**

	assessment, done by comparing the amounts of isometric muscle activity (sEMG) for each muscle across the 4 muscle tests, revealed that the muscle activity of the upper trapezius and lower trapezius muscles was highest during their respective tests. Conversely, the isometric muscle activity of the middle trapezius and serratus anterior muscles was not highest during their respective tests. DISCUSSION AND CONCLUSION: In people with shoulder pain and functional loss, the intrarater reliability and error over 1 to 3 days were established using an HHD for measurement of isometric force for the assessment of scapular muscle performance. Error values can be used to make decisions regarding individual patients. **Construct validity was established for the lower and upper trapezius muscle tests; therefore, these tests are advocated for use. However, construct validity was not demonstrated for the serratus anterior and middle trapezius muscle tests as performed in this study.** Further investigation of these muscle tests is warranted. **Comment:** The correlation between MMT and HHD findings has been established in much of the research literature. This paper shows that there is a construct validity and reliability to employing MMT and HHD testing in patients with shoulder injuries. The *Guide to Physical Therapist Practice* indicates that measures of scapular muscle performance provide unique impairment information for use in determining diagnosis, prognosis, and plan of care for patients with shoulder dysfunctions. It should be mentioned that the middle trapezius and serratus anterior MMT's in this study were the two tests that did not follow the standardized protocols for MMT advocated by the Kendalls and the ICAK. This may have been the reason for the failure of the MMT to correlate with the sEMG in this report.
Hip muscle weakness and overuse injuries in recreational runners, Niemuth PE, Johnson RJ, Myers MJ, Thieman TJ.	*Clin J Sport Med.* 2005 Jan;15(1):14-21. **OBJECTIVE:** To test for differences in strength of 6 muscle groups of the hip on the involved leg in recreational runners with injuries compared with the uninvolved leg and a control group of noninjured runners. **DESIGN:** Descriptive analysis. **SETTING:** Three outpatient physical therapy clinics in the Minneapolis/St. Paul metropolitan area. **PARTICIPANTS:** Thirty recreational runners (17 female, 13 male) experiencing a single leg overuse injury that presented for treatment between June and September 2002. Thirty noninjured runners (16 female, 14 male) randomly selected from a pool of 46 volunteers from a distance running club served as controls. **MAIN OUTCOME MEASURES:** Self-report demographic information on running habits, leg dominance demonstrated by preferred kicking leg, and injury information. Muscle strength of the 6 major muscle groups of the hip was recorded using a hand-held dynamometer. The highest value of 2 trials was used, and strength values were normalized to body mass(2/3). **RESULTS:** Results comparing the injured and noninjured groups showed that leg dominance did not influence the leg of injury (chi(2)(1) = 0.134; P = 0.71). **Correlations for internal reliability of muscle measurements between trials 1 and 2 with the hand-held dynamometer ranged from 0.80 to 0.90 for the 6 muscle groups measured, and all P values were less than 0.0001.** No significant side-to-side differences in hip group muscle strength were found in the noninjured runners (P = 0.62-0.93). **Among the injured runners, the injured side hip abductor (P = 0.0003) and flexor muscle groups (P = 0.026) were significantly weaker than the noninjured side. In addition, the injured side hip adductor muscle group was significantly stronger (P = 0.010) than the noninjured side.** Duration of symptoms was not a contributing factor to the extent of injury as measured by muscle strength imbalance between injured and uninjured sides. **CONCLUSIONS:** Although no cause-and-effect relationship has been established**,** this is the first study to **show an association between hip abductor, adductor, and flexor muscle group strength imbalance and lower extremity overuse injuries in runners.** Because most running injuries are multifaceted in nature, areas secondary to the site of pain, such as hip muscle groups exhibiting strength imbalances, must also be considered to gain favorable outcomes for injured runners. **The addition of strengthening exercises to specifically identified weak hip muscles may offer better treatment results in patients with running injuries.** **Comment:** This study shows an important evidence-based component of the treatment of hip and pelvic problems in runners as being methods of strengthening the weak muscles around the hip and to improve muscular balance, the *sine qua non* of AK treatment.

Long-term follow-up of a randomized clinical trial assessing the efficacy of medication, acupuncture, and spinal manipulation for chronic mechanical spinal pain syndromes, Muller R, Giles LG.	*J Manipulative Physiol Ther.* 2005 Jan;28(1):3-11. **OBJECTIVE:** To assess the long-term benefits of medication, needle acupuncture, and spinal manipulation as exclusive and standardized treatment regimens in patients with chronic (>13 weeks) spinal pain syndromes. **STUDY DESIGN:** Extended follow-up (>1 year) of a randomized clinical trial was conducted at the multidisciplinary spinal pain unit of Townsville's General Hospital between February 1999 and October 2001. **PATIENTS AND METHODS:** Of the 115 patients originally randomized, 69 had exclusively been treated with the randomly allocated treatment during the 9-week treatment period (results at 9 weeks were reported earlier). These patients were followed up and assessed again 1 year after inception into the study reapplying the same instruments (i.e., Oswestry Back Pain Index, Neck Disability Index, Short-Form-36, and Visual Analogue Scales). Questionnaires were obtained from 62 patients reflecting a retention proportion of 90%. The main analysis was restricted to 40 patients who had received exclusively the randomly allocated treatment for the whole observation period since randomization. **RESULTS:** Comparisons of initial and extended follow-up questionnaires to assess absolute efficacy showed that only the application of spinal manipulation revealed broad-based long-term benefit: 5 of the 7 main outcome measures showed significant improvements compared with only 1 item in each of the acupuncture and the medication groups. **CONCLUSIONS:** ***In patients with chronic spinal pain syndromes, spinal manipulation, if not contraindicated, may be the only treatment modality of the assessed regimens that provides broad and significant long-term benefit.***
Muscle reflex classification of low-back pain, Reeves NP, Cholewicki J, Milner TE.	*J Electromyogr Kinesiol.* 2005 Feb;15(1):53-60. Epub 2004 Nov 21. **Abstract:** It has been well documented that low-back pain (LBP) patients have longer muscle response latencies to perturbation than healthy controls. These muscle responses appear to be reflexive and not voluntary in nature, and as a result, might be useful for objectively classifying LBP. The goal of the study was to develop an objective and accurate method for classifying LBP using a sudden load-release protocol. Subjects were divided into two groups: learning group (20 patients and 20 controls), and holdout group (15 patients and 12 controls). Subjects exerted isometric trunk force against a cable in four different directions. Following cable release, the trunk was suddenly displaced eliciting a muscle reflex response. Reflex latencies for muscles switching-on and shutting-off were determined using electromyogram signals from 8 trunk muscles. Independent t tests were performed on the learning group to determine which reflex parameters were to be entered into logistic regression analysis to produce a classification model. The holdout group was used to validate this classification model. The three-parameter model was able to correctly classify 83% of the learning group, and 81% of the holdout group. **Using reflex parameters appears to be an accurate and objective method for classifying LBP.**
Motor unit synchronization is reduced in anterior knee pain, Mellor R, Hodges PW.	*J Pain.* 2005 Aug;6(8):550-8. **Abstract:** Anterior knee pain (AKP) is common and has been argued to be related to poor patellofemoral joint control due to impaired coordination of the vasti muscles. However, there are conflicting data. Changes in motor unit firing may provide more definitive evidence. Synchronization of motor unit action potentials (MUAPs) in vastus medialis obliquus (VMO) and vastus lateralis (VL) may contribute to coordination in patellofemoral joint control. We hypothesized that synchronization may be reduced in AKP. Recordings of single MUAPs were made from VMO and multiunit electromyograph (EMG) recordings were made from VL. Averages of VL EMG recordings were triggered from the single MUAPs in VMO. Motor units in VL firing in association with the VMO motor units would appear as a peak in the VL EMG average. Data were compared to previous normative data. The proportion of trials in which a peak was identified in the triggered averages of VL EMG was reduced in people with AKP (38%) compared to controls (90%). Notably, although 80% of subjects had values less than controls, 20% were within normal limits. These results provide new evidence that motor unit synchronization is modified in the presence of pain and provide evidence for motor control

	dysfunction in AKP. PERSPECTIVE: **This study shows that coordination of motor units between the medial and lateral vasti muscles in people with anterior knee pain is reduced compared to people without knee pain. It confirms that motor control dysfunction is a factor in this condition and has implications for selection of rehabilitation strategies. Comment:** This study suggests that in some cases, correcting knee pain is often as simple as correcting the muscles that stabilize the knee. AK evaluation of knee dysfunction always involves testing the knee-supporting muscles' function.
Chronic spinal pain: a randomized clinical trial comparing medication, acupuncture, and spinal manipulation, Giles LG, Muller R.	*Spine.* 2005 Jan 1;30(1):166. **STUDY DESIGN:** A randomized controlled clinical trial was conducted. **OBJECTIVE:** To compare medication, needle acupuncture, and spinal manipulation for managing chronic (>13 weeks duration) spinal pain because the value of medicinal and popular forms of alternative care for chronic spinal pain syndromes is uncertain. **SUMMARY OF BACKGROUND DATA:** Between February 1999 and October 2001, 115 patients without contraindication for the three treatment regimens were enrolled at the public hospital's multidisciplinary spinal pain unit. **METHODS:** One of three separate intervention protocols was used: medication, needle acupuncture, or chiropractic spinal manipulation. Patients were assessed before treatment by a sports medical physician for exclusion criteria and by a research assistant using the Oswestry Back Pain Disability Index (Oswestry), the Neck Disability Index (NDI), the Short-Form-36 Health Survey questionnaire (SF-36), visual analog scales (VAS) of pain intensity and ranges of movement. These instruments were administered again at 2, 5, and 9 weeks after the beginning of treatment. **RESULTS:** Randomization proved to be successful. The highest proportion of early (asymptomatic status) recovery was found for manipulation (27.3%), followed by acupuncture (9.4%) and medication (5%). Manipulation achieved the best overall results, with improvements of 50% ($P = 0.01$) on the Oswestry scale, 38% ($P = 0.08$) on the NDI, 47% ($P < 0.001$) on the SF-36, and 50% ($P < 0.01$) on the VAS for back pain, 38% ($P < 0.001$) for lumbar standing flexion, 20% ($P < 0.001$) for lumbar sitting flexion, 25% ($P = 0.1$) for cervical sitting flexion, and 18% ($P = 0.02$) for cervical sitting extension. However, on the VAS for neck pain, acupuncture showed a better result than manipulation (50% vs. 42%). **CONCLUSIONS:** *The consistency of the results provides, despite some discussed shortcomings of this study, evidence that* ***in patients with chronic spinal pain, manipulation, if not contraindicated, results in greater short-term improvement than acupuncture or medication.*** However, the data do not strongly support the use of only manipulation, only acupuncture, or only nonsteroidal anti-inflammatory drugs for the treatment of chronic spinal pain. The results from this exploratory study need confirmation from future larger studies.
Cervical muscles weakness in chronic whiplash patients. Prushansky T, Gepstein R, Gordon C, Dvir Z.	*Clin Biomech* (Bristol, Avon). 2005 Oct;20(8):794-8. **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.

	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.
Navigating a sensorimotor loop, Fanselow EE, Connors BW.	*Neuron.* 2005 Feb 3;45(3):329-30. **Abstract:** Touch is an active process, but how do the body's somatic sensors influence its movement? In this issue of Neuron, Nguyen and Kleinfeld show that afferent activity from the whiskers on a rat's face trigger rapid and prolonged excitation of the motor neurons that drive movements of the same whiskers. Positive feedback through this sensorimotor loop may serve to optimize the interaction between sensors and stimuli. **Comment:** This study demonstrates that there exists a sensori-motor loop that may be responsible for changes in muscle strength after tactile stimulation. This paper shows a small part of the potentiality of the AK technique called Therapy Localization or TL. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and they may be a part of the mechanism for what is found clinically with TL testing.
Evidence for strong synaptic coupling between single tactile afferents from the sole of the foot and motoneurons supplying leg muscles, Fallon JB Bent LR, McNulty PA, Macefield VG.	*J Neurophysiol.* 2005 Dec;94(6):3795-804. Epub 2005 Aug 3. **Abstract:** It has been known for some time that populations of cutaneous and muscle afferents can provide short-latency facilitation of motoneuron pools. Recently, it has been shown that the input from individual low-threshold mechanoreceptors in the glabrous skin of the hand can modulate ongoing activity in muscles acting on the fingers via spinally mediated pathways. We have extended this work to examine whether such strong synaptic coupling exists between tactile afferents in the sole of the foot and motoneurons supplying muscles that act about the ankle. We recorded from 53 low-threshold mechanoreceptors in the glabrous skin of the foot via microelectrodes inserted percutaneously into the tibial nerve of awake human subjects. Reflex modulation of ongoing whole muscle electromyography (EMG) was observed for each of the four classes of low-threshold cutaneous mechanoreceptors (17 of 21 rapidly adapting type I; 2 of 4 rapidly adapting type II; 7 of 18 slowly adapting type I; and 4 of 10 slowly adapting type II). Reflex modulation of the firing probability in single motor units (5 of 11) was also observed. These results indicate that strong synaptic coupling between tactile afferents and spinal motoneurons is not a specialization of the hand and emphasizes the potential importance of cutaneous inputs from the sole of the foot in the control of gait and posture. **Comment:** This study demonstrates that stimulation of the skin may be responsible for changes in muscle strength. This paper shows a small part of the potentiality of the AK technique called Therapy Localization or TL. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and they may be a part of the mechanism for what is found clinically with TL testing.
Measurement of electrical skin impedance of dermal-visceral zones as a diagnostic tool for inner organ pathologies: a blinded preliminary evaluation of a new technique, Zimlichman E, Lahad A, Aron-Maor A, Kanevsky A, Shoenfeld Y.	*Isr Med Assoc J.* 2005 Oct;7(10):631-4. **BACKGROUND:** As complementary and alternative medicine is gaining popularity among health consumers, diagnostic screening tools based on neuroreflexology are also being developed. These techniques, which are based on the rationale that measurement of electrical impedance of specific dermatomes reflects corresponding internal organ pathologies, have not yet been the subject of conventional scientific research. **OBJECTIVES:** To determine the effectiveness of a neuroreflexology-based screening test, specifically the Medex device (Medex Screen Ltd.), for diagnosing patients undergoing conventional internal organ assessment, in a hospital setting. **METHODS:** Patients admitted to an internal medicine department, who met the inclusion criteria and agreed to participate, underwent conventional medical evaluation that included past medical history and physical examination. Another examination was conducted by a second physician using the Medex device to determine internal organ pathologies. A third

	researcher compared the actual "conventional" diagnosis with the Medex device output using standard statistical analysis. **RESULTS:** Overall, 150 patients participated in the study. Correlation was significant for all categories ($P < 0.01$) except for blood and lymphatic disease. A high sensitivity (>70%) was measured for cardiovascular, respiratory, gastrointestinal and genitourinary diseases. The highest measure of agreement, as represented by the Cohen-Kappa factor, was found for respiratory disease (0.57). **CONCLUSIONS:** Although the exact mechanism is not entirely clear, measurement of electroskin impedance of dermal-visceral zones has the potential to serve as a screening tool for inner organ pathologies. Further research should be conducted to create more evidence to support or dispute the use of this technique as a reliable diagnostic tool. **Comment:** This study demonstrates that the electrodermal reflexes of the skin may be reflective of internal organ pathologies. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and new research is now showing that electro-dermal impedance measurements of the skin may serve as a screening tool for inner organ pathologies. The significance of these findings to the AK concepts of therapy localization may be evident to the reader.
Neck flexor muscle fatigue is side specific in patients with unilateral neck pain, Falla D, Jull G, Rainoldi A, Merletti R.	*Eur J Pain.* 2004 Feb;8(1):71-7. **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.
Paraspinal muscles and intervertebral dysfunction: part two, Fryer G, Morris T, Gibbons P.	*J Manipulative Physiol Ther.* 2004 Jun;27(5):348-57. **BACKGROUND:** One of the diagnostic characteristics of the manipulable spinal lesion--a musculoskeletal disturbance that is claimed to be detected with manual palpation and corrected with manipulation--is said to be altered segmental tissue texture. Little evidence for the nature of abnormal paraspinal tissue texture exists, but indirect evidence from experimental studies supports the plausibility of the concept of protective muscle spasm, although investigations of increased paraspinal electromyography (EMG) associated with low back pain suggests complex changes in motor control rather than simple protective reflexes. **OBJECTIVES:** To review the literature for evidence that may support or refute proposed explanations for clinically observed altered paraspinal tissue texture associated with the manipulable spinal lesion. This review aims to highlight areas that require further research and make recommendations for future studies.Data Source MEDLINE and CINAHL databases were searched using various combinations of the keywords paraspinal, muscle, palpation, EMG, spine, low back pain, pain, myofascial, hardness, manipulation, reliability, and somatic dysfunction, along with searching the bibliographies of selected articles and textbooks.Data Extraction All relevant data were used. **RESULTS: Decreased paraspinal muscle activity and strength associated with low back pain is well established**, and there is evidence of changes in muscle fiber composition and localized selective multifidus atrophy. Disturbances in microcirculation have been implicated in nonparaspinal muscle pain. The effect of spinal manipulation on paraspinal EMG activity is inconclusive but promising. **CONCLUSION:** Little direct evidence exists to support the existence or nature of

	paraspinal tissue texture change that is claimed to be detected with palpation. The proposal of segmental reflex paraspinal muscle contraction was not supported, at least in association with low back pain. There appears to be a complex relationship between deep paraspinal muscle inhibition during dynamic activity and nonvoluntary guarding behavior during static activity. The relationship between these findings and palpable tissue change is speculative, but increased activity, decreased activity, or both may be responsible for paraspinal tissues detected as abnormal with palpation. Recommendations are outlined for future research.
Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients, Jull G, Kristjansson E, Dall'Alba P.	*Man Ther.* 2004 May;9(2):89-94. **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.
Muscle dysfunction versus wear and tear as a cause of exercise related osteoarthritis: an epidemiological update. Shrier I.	*Br J Sports Med.* 2004 Oct;38(5):526-35. **Abstract: There are two main hypotheses for the cause of exercise related osteoarthritis: wear and tear of the articular cartilage and muscle dysfunction.** This is a review of the clinical literature to see which hypothesis has the greatest support. **Clinical studies support the muscle dysfunction hypothesis over the wear and tear hypothesis.** **Comment:** This study is very important and suggests that the validity of MMT in cases of osteoarthritis is sound. Patients with painless osteoarthritis that may appear on X-ray probably should be tested for muscle weakness and given treatment to correct this as prevention. Shrier suggests that when muscles are unable to contract adequately due to age, fatigue, disuse atrophy, decreased proprioception or strain, more force is transmitted to the bone, leading to sclerosis. The microtrabecular damage of the bone and eventual sclerosis could create stress on the articular cartilage with eventual joint space narrowing.
Chronic back pain is associated with decreased prefrontal and thalamic gray matter density, Apkarian AV, Sosa Y, Sonty S, Levy RM, Harden RN, Parrish TB, Gitelman DR	*J Neurosci.* 2004 Nov 17;24(46):10410-5. **Abstract:** The role of the brain in chronic pain conditions remains speculative. We compared brain morphology of 26 chronic back pain (CBP) patients to matched control subjects, using magnetic resonance imaging brain scan data and automated analysis techniques. CBP patients were divided into neuropathic, exhibiting pain because of sciatic nerve damage, and non-neuropathic groups. Pain-related characteristics were correlated to morphometric measures. Neocortical gray matter volume was compared after skull normalization. Patients with CBP showed 5-11% less neocortical gray matter volume than control subjects. The magnitude of this decrease is equivalent to the gray matter volume lost in 10-20 years of normal aging. The decreased volume was related to pain duration, indicating a 1.3 cm3 loss of gray matter for every year of chronic pain. Regional gray matter density in 17 CBP patients was compared with

	matched controls using voxel-based morphometry and nonparametric statistics. Gray matter density was reduced in bilateral dorsolateral prefrontal cortex and right thalamus and was strongly related to pain characteristics in a pattern distinct for neuropathic and non-neuropathic CBP. Our results imply that CBP is accompanied by brain atrophy and suggest that the pathophysiology of chronic pain includes thalamocortical processes. **Comment:** The relationship between spinal malfunction and cerebral malfunction, specifically greatly accelerated atrophy of the brain, is an important concept for the chiropractic profession. This is especially important in light of the research articles that document that chiropractic spinal adjustments are more effective in treating chronic spinal pain when compared to medication, exercise, and needle acupuncture.
Hypothyroidism: A New Model for Conservative Management in Two Cases, Bablis, P. and Pollard, H.	*Chiro J Aust*, 2004;34:11-18 **Objective:** To review the function, anatomy, physiology, development, hormone synthesis and dysfunction of the thyroid gland. Treatment options are discussed, and 2 case studies of a mind-body therapy (Neuro-Emotional Technique—NET) successfully managing hypothyroid dysfunction are presented. **Data Sources:** MEDLINE search using key words: thyroid, synthesis, development, anatomy, physiology, hyperthyroidism and hypothyroidism. **Data Selection:** Eighty-five papers fit the key words and were selected based on relevance to the topic. Papers were selected that contained relevant information on normal and abnormal thyroid function and its management. **Data Extraction:** Selected papers had to contain information that directly related to the diagnosis, anatomy, physiology and management of hypothyroid conditions. Papers were also selected that described a possible neurophysiological mechanism for the observed treatment effects. **Data Synthesis:** Objective measures of a new mind-body approach to hypothyroid dysfunction are presented, and its relevance to the biopsychosocial model is discussed. This new treatment is compared to the existing biomedical approaches to treatment. **Conclusion:** Thyroid dysfunction has been effectively treated with medicine for many years. This paper presents a new therapy that produced objective pre-post changes to hypothyroid dysfunction in 2 cases. This therapy may have potential in future circumstances, with further research recommended to confirm its reliability/validity.
Rhomboid muscle electromyography activity during 3 different manual muscle tests. Smith J, Padgett DJ, Kaufman KR, Harrington SP, An KN, Irby SE.	*Arch Phys Med Rehabil.* 2004 Jun;85(6):987-92. **OBJECTIVE:** To determine which of 3 previously published rhomboid manual muscle tests (MMTs) elicits the maximal rhomboid electromyographic activity in an asymptomatic population. **DESIGN:** Criterion standard. **SETTING:** Motion analysis laboratory at tertiary care medical center. **PARTICIPANTS:** Eleven male volunteers (age range, 24-40y) without shoulder or neck pain. **INTERVENTIONS:** Not applicable. **MAIN OUTCOME MEASURES:** Peak 1-second normalized electromyographic activity in the rhomboid muscle during 8 different MMT positions, including 3 different rhomboid MMT positions (Kendall, Kendall-Alternative, Hislop-Montgomery). **RESULTS: The Kendall MMT (78% maximal voluntary contraction [MVC]) produced higher rhomboid electromyographic activity than the Kendall-Alternative (71% MVC) or the Hislop-Montgomery MMT (52% MVC), but the differences were not statistically significant. The posterior deltoid MMT generated the greatest rhomboid electromyographic activity of all MMTs, and 4% to 30% greater rhomboid electromyographic activity than the 3 rhomboid MMTs (P=.0001; posterior deltoid > Hislop-Montgomery). Electromyographic profiles of the Kendall and Kendall-Alternative MMTs were similar**, whereas the Hislop-Montgomery MMT produced less upper trapezius activity (P=.0001 vs Kendall and Kendall-Alternative) and more latissimus dorsi activity (P=.0001 vs Kendall-Alternative). **The standard MMT positions for the middle trapezius, levator scapula, posterior deltoid, and latissimus dorsi produced the maximal electromyographic activity for their respective target muscles.** CONCLUSIONS: The posterior deltoid MMT position should be used to produce maximal rhomboid electromyographic activity for normalization purposes during kinesiologic studies. The Kendall and Kendall-Alternative rhomboid MMT are likely to be clinically indistinct. It is unlikely that clinicians can

	use standard MMT positions to distinguish rhomboid strength from synergists, such as the levator scapula and middle trapezius muscle, for diagnostic purposes.
Reliability of hand-held dynamometry in assessment of knee extensor strength after hip fracture, Roy, MA, Doherty, TJ. -- School of Kinesiology, University of Western Ontario, London, Ontario, Canada.	*Am J Phys Med Rehabil.* 2004 Nov;83(11):813-8. **OBJECTIVES:** To examine the reliability of hand-held dynamometry in assessing knee extensor strength in inpatients undergoing rehabilitation after hip fracture and to examine the discriminant validity of this measure. **DESIGN:** A total of 16 subjects (14 women; mean +/- SD, 79 +/- 7 yrs) undergoing inpatient rehabilitation after hip fracture volunteered to participate. Isometric knee extensor strength of the fractured and unfractured sides was determined with a hand-held dynamometer. Subjects were retested 1-2 days after the initial testing session. **RESULTS:** Test-retest intraclass correlation coefficients were high for both the fractured (0.91) and unfractured legs (0.90). A low coefficient of variation was observed for both the fractured (15.3%) and unfractured (14.7%) sides. The maximal knee extensor strength was significantly different when comparing the fractured (7.9 +/- 3 kg) and unfractured (15.6 +/- 4 kg) legs. When comparing test 1 and test 2 mean values for the fractured leg, the scores significantly differed ($t = 3.14$, $P < 0.01$), with 13 of 16 subjects scoring higher on test 2. **CONCLUSIONS:** Hand-held dynamometry is a reliable and valid tool for assessment of knee extensor strength after hip fracture. Reduced knee extensor strength in the fractured leg may be an important component limiting rehabilitation progress in these patients.
Differences in motor recruitment and resulting kinematics between low back pain patients and asymptomatic participants during lifting exertions, Ferguson SA, Marras WS, Burr DL, Davis KG, Gupta P.	*Clin Biomech (Bristol, Avon).* 2004 Dec;19(10):992-9. **BACKGROUND:** Low back disorders are a prevalent problem in society today and may lead to chronic debilitating low back pain. Developing our understanding of temporal muscle and kinematic patterns during manual material handling tasks may provide insight for preventing the cascading series of events leading to chronic low back pain. **METHODS:** Sixty-two low back pain patients and 61 asymptomatic participants performed a variety of lifting exertions that varied in lift origin horizontal and vertical distance, lift asymmetry, and weight. Electromyographic activity of 10 trunk muscles as well as trunk and pelvic kinematics was recorded during each exertion. Differences in muscle activation and kinematic parameters were compared between low back pain patients and asymptomatic participants as a function of experimental conditions. **FINDINGS**: Both the left and right erector spinae activated significantly earlier and were on significantly longer in low back pain patients compared to asymptomatic participants. The horizontal and vertical location of the lift influenced the EMG and kinematic differences between the low back pain patients and asymptomatic participants. **INTERPRETATION:** These finding indicate that low back pain patients would be exposed to increase muscle activity resulting in higher spine loads for a greater length of time compared to asymptomatic participants. The longer exposure time to increased spine load may lead to greater risk of future low back injury and cascading events leading to debilitating low back pain. The longer muscle activation time suggests that low back pain patients have changed their motor program from an open to a closed loop system.
Changes in recruitment of the abdominal muscles in people with low back pain: ultrasound measurement of muscle activity, Ferreira PH, Ferreira ML, Hodges PW.	*Spine.* 2004 Nov 15;29(22):2560-6. **STUDY DESIGN:** Ultrasound and electromyographic (EMG) measures of trunk muscle activity were compared between low back pain (LBP) and control subjects in a cross-sectional study. **OBJECTIVES:** To compare the recruitment of the abdominal muscles (measured as a change in thickness with ultrasound imaging) between people with and without low back pain and to compare these measurements with EMG recordings made with intramuscular electrodes. **SUMMARY OF BACKGROUND DATA:** Although ultrasonography has been advocated as a noninvasive measure of abdominal muscle activity, it is not known whether it can provide a valid measure of changes in motor control of the abdominal muscles in LBP. **METHODS:** Ten subjects with recurrent LBP and 10 matched controls were tested during isometric low load tasks with their limbs suspended. Changes in thickness from resting baseline values were obtained for

	transversus abdominis (TrA), obliquus internus (OI), and obliquus externus (OE) using ultrasonography. Fine wire EMG was measured concurrently. **RESULTS:** Study participants with LBP had a significantly smaller increase in TrA thickness with isometric leg tasks compared with controls. No difference was found between groups for OI or OE. Similar results were found for EMG. People with LBP had less TrA EMG activity with leg tasks, and there was no difference between groups for EMG activity for OI or OE. **CONCLUSIONS:** This study reinforces evidence for changes in automatic control of TrA in people with LBP. Furthermore, the data establish a new test of recruitment of the abdominal muscles in people with LBP. This test presents a feasible noninvasive test of automatic recruitment of the abdominal muscles. **Comment:** Manual muscle testing is an obvious, feasible, and noninvasive test for the adequate recruitment of the abdominal muscles in patients with low back pain. The inhibition of the abdominal muscles in patients with low back pain is a consistent finding in AK therapeutics.
Delayed onset of transversus abdominus in long-standing groin pain, Cowan SM, Schache AG, Brukner P, Bennell KL, Hodges PW, Coburn P, Crossley KM.	*Med Sci Sports Exerc.* 2004 Dec;36(12):2040-5. **Abstract:** Long-standing groin pain is a persistent problem that is commonly difficult to rehabilitate. **Theoretical rationale indicates a relationship between the motor control of the pelvis and long-standing groin pain; however, this link has not been investigated. PURPOSE:** The current experiment aimed to evaluate motor control of the abdominal muscles in a group of Australian football players with and without long-standing groin pain. **METHODS:** Ten participants with long-standing groin pain and 12 asymptomatic controls were recruited for the study. Participants were elite or subelite Australian football players. Fine-wire and surface electromyography electrodes were used to record the activity of the selected abdominal and leg muscles during a visual choice reaction-time task (active straight leg raising). **RESULTS:** When the asymptomatic controls completed the active straight leg raise (ASLR) task, the transversus abdominus contracted in a feed-forward manner. However, when individuals with long-standing groin pain completed the ASLR task, the onset of transversus abdominus was delayed ($P < 0.05$) compared with the control group. There were no differences between groups for the onset of activity of internal oblique, external oblique, and rectus abdominus (all $P > 0.05$). **CONCLUSIONS:** The finding that the onset of transversus abdominus is delayed in individuals with long-standing groin pain is important, as it demonstrates an association between long-standing groin pain and transversus abdominus activation.
Core stability measures as risk factors for lower extremity injury in athletes. Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM.	*Med Sci Sports Exerc.* 2004 Jun;36(6):926-34. **INTRODUCTION/PURPOSE:** Decreased lumbo-pelvic (or core) stability has been suggested to contribute to the etiology of lower extremity injuries, particularly in females. This prospective study compares core stability measures between genders and between athletes who reported an injury during their season versus those who did not. Finally, **we looked for one or a combination of these strength measures that could be used to identify athletes at risk for lower extremity injury. METHODS:** Before their season, 80 female (mean age = 19.1 +/- 1.37 yr, mean weight 65.1 +/- 10.0 kg) and 60 male (mean age = 19.0 +/- 0.90 yr, mean weight 78.8 +/- 13.3 kg) intercollegiate basketball and track athletes were studied. Hip abduction and external rotation strength, abdominal muscle function, and back extensor and quadratus lumborum endurance was tested for each athlete. **RESULTS:** Males produced greater hip abduction (males = 32.6 +/- 7.3%BW, females = 29.2 +/- 6.1%BW), hip external rotation (males = 21.6 +/- 4.3%BW, females = 18.4 +/- 4.1%BW), and quadratus lumborum measures (males = 84.3 +/- 32.5 s, females = 58.9 +/- 26.0 s). **Athletes who did not sustain an injury were significantly stronger in hip abduction** (males = 31.6 +/- 7.1%BW, females = 28.6 +/- 5.5%BW) **and external rotation** (males = 20.6 +/- 4.2%BW, females = 17.9 +/- 4.4%BW). Logistic regression analysis revealed that hip external rotation strength was the only useful predictor of injury status (OR = 0.86, 95% CI = 0.77, 0.097). **CONCLUSION:** Core stability has an important role in injury prevention. Future study may reveal that differences in postural stability partially explain the gender bias among female athletes.

	Comment: To remain upright and steady in their surroundings, people use all the information about their position provided by their sensory organs in relation to their surroundings. The eyes, the vestibular apparatus, the proprioceptors in muscles and joints all maintain the trunk in proper position when working properly. In this paper, the prevention of joint fatigue and wear and sprain in the lower extremity depends upon the precise integration of sensory information and motor response and strength from the periphery to the trunk.
Changes in the cross-sectional area of multifidus and psoas in patients with unilateral back pain: the relationship to pain and disability, Barker KL, Shamley DR, Jackson D.	*Spine.* 2004 Nov 15;29(22):E515-9. **STUDY DESIGN:** Prospective, cross-sectional observational study. **OBJECTIVES:** The aim of this study was to determine if there was an association between wasting of psoas and multifidus as observed on MRI scans and the presenting symptoms, reported pathology, pain, or disability of a cohort of patients presenting with unilateral low back pain. **SUMMARY OF BACKGROUND DATA:** Current physiotherapy practice is often based on localized spine stabilizing muscle exercises; most attention has been focused on transversus abdominus and multifidus with relatively little on psoas. **METHOD:** Fifty consecutive patients presenting to a back pain triage clinic with unilateral low back pain lasting more than 12 weeks were recruited. The cross-sectional surface area (CSA) of the muscles was measured. Duration of symptoms, rating of pain, self-reported function, and the presence of neural compression were recorded. **RESULTS:** Data analysis compared the CSA between the symptomatic and asymptomatic sides. There was a statistically significant difference in CSA between the sides ($P < 0.001$). There was a positive correlation between the percentage decrease in CSA of psoas on the affected side and with the rating of pain ($rho = 0.608$, $P < 0.01$), reported nerve root compression ($rho = 0.812$, $P < 0.01$), and the duration of symptoms ($rho = 0.886$, $P < 0.01$). There was an association between decrease in the CSA of multifidus and duration of symptoms. **CONCLUSIONS:** Atrophy of multifidus has been used as one of the rationales for spine stabilization exercises. The evidence of coexisting atrophy of psoas and multifidus suggests that a future area for study should be selective exercise training of psoas, which is less commonly used in clinical practice. **Comment:** Psoas muscle dysfunction has been suggested as a major contributor to many cases of low back pain. Successful treatment of the psoas muscle dysfunction is critical to the resolution of low back pain in these cases.
Unravelling the complexity of muscle impairment in chronic neck pain. Falla D.	*Man Ther.* 2004 Aug;9(3):125-33. **Abstract:** Exercise interventions are deemed essential for the effective management of patients with neck pain. However, there has been a lack of consensus on optimal exercise prescription, which has resulted from a paucity of studies to quantify the precise nature of muscle impairment, in people with neck pain. This masterclass will present recent research from our laboratory, which has utilized surface electromyography to investigate cervical flexor muscle impairment in patients with chronic neck pain. This research has identified deficits in the motor control of the deep and superficial cervical flexor muscles in people with chronic neck pain, characterized by a delay in onset of neck muscle contraction associated with movement of the upper limb. In addition, people with neck pain demonstrate an altered pattern of muscle activation, which is characterized by reduced deep cervical flexor muscle activity during a low load cognitive task and increased activity of the superficial cervical flexor muscles during both cognitive tasks and functional activities. The results have demonstrated the complex, multifaceted nature of cervical muscle impairment, which exists in people with a history of neck pain. In turn, this has considerable implications for the rehabilitation of muscle function in people with neck pain disorders. **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.
Neuromuscular efficiency of	*Disabil Rehabil.* 2004 Jun 17;26(12):712-7.

the sternocleidomastoid and anterior scalene muscles in patients with chronic neck pain. Falla D, Jull G, Edwards S, Koh K, Rainoldi A.	**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 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.
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.	*Neurophysiol Clin.* 2004 Oct;34(3-4):159-65. **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.
Impaired trunk muscle function in sub-acute neck	*Man Ther.* 2004 Aug;9(3):157-63.

pain: etiologic in the subsequent development of low back pain? Moseley GL.	**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 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.** **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.
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.	*Eur J Pain.* 2004 Oct;8(5):473-8. **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. **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.
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.	*Arch Phys Med Rehabil.* 2004 Aug;85(8):1303-8. 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 (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.
Walking ability and its relationship to lower-extremity muscle strength in children with idiopathic inflammatory myopathies. Lohmann Siegel K, Hicks JE, Koziol DE, Gerber LH, Rider LG.	*Arch Phys Med Rehabil.* 2004 May;85(5):767-71. **OBJECTIVE:** To describe gait deficits and their association with lower-extremity muscle strength in children with juvenile idiopathic inflammatory myopathies (IIM). DESIGN: Cross-sectional, descriptive study. **SETTING:** Clinical research center. **PARTICIPANTS:** Consecutive sample of 25 ambulatory children diagnosed with juvenile IIM. **INTERVENTIONS:** Not applicable. **MAIN OUTCOME MEASURES: Manual muscle test (MMT) of bilateral hip flexor, extensor, and abductor; knee extensor; and ankle plantarflexor strength, all measured on a 0- to 10-point scale and summary strength measures.** Video-based movement analysis to determine walking speed; gait cycle time; right and left step time; stride length; right and left step length; and stance, swing, and double-limb support phase durations. **RESULTS:** Walking speed (1.03+/-0.27 m/s) was reduced because of shortened stride lengths (1.03+/-0.21 m) more than prolonged gait cycle times (1.05+/-0.22s). Walking speed highly correlated with the number of muscle groups weaker than grade 7 out of 10 (r=-.89) and the strength of the hip flexors (r=.85). **CONCLUSIONS: Lower-extremity strength measures, including MMT scores of individual muscle groups and the number of weak muscle groups, were predictive of gait limitations in children with juvenile IIM.**
The efficiency of spinal manipulation in otorhinolaryngology. A retrospective long-term study, Hulse M, Holzl M.	*HNO.* 2004 Mar;52(3):227-34. **BACKGROUND:** The vertebral genesis of many functional disorders in otorhinolaryngology, such as dizziness, hearing-impairment, ear-pressure, ear-pain, foreign body sensation in the throat and dysphonia, is suggested by the success of spinal manipulative therapy, particularly of the atlanto-occipital joint. Up to now, there are no retrospective investigations which show the duration of the therapeutic effect. **METHODS:** We examined 220 patients with cervical otorhinolaryngological disorders (100 patients with dizziness, 49 with hearing impairment, 47 with tinnitus and 24 with dysphonia) after cervical manipulation lasting more than 6 months. **RESULTS AND CONCLUSIONS:** The extraordinary satisfaction with the manipulative therapy in 82% of patients with dizziness (46% total relief, 36% high improvement) reflects the high efficiency of this manual therapy. In contrast to these results, only 10% of patients with tinnitus showed an improvement (P<0.001). **This retrospective investigation demonstrates that a successful outcome after manual therapy is not based on a "placebo effect".**
An exploratory study of provocation testing with padded wedges: can prone blocking demonstrate a	*J Manipulative Physiol Ther.* 2004 Feb;27(2):103-8 **BACKGROUND:** Currently, no traditional chiropractic examination method to determine a spinal listing offers demonstrated guidance in treatment decisions for low back pain (LBP)

directional preference? Lisi AJ, Cooperstein R, Morschhauser E.	patients. Development of an examination that bypasses the difficulty of accurately and reliably identifying a listing, yet provides guidance on manipulative vectors, could be very valuable to clinicians and patients. **OBJECTIVE:** To explore 2 potential protocols for provocation testing and assessment of directional preference using padded wedges. **METHODS:** Two groups of 20 subjects were examined while lying prone on various positions of padded wedges. In the first group, pain pressure threshold (PPT) was measured at 4 anatomic points; in the second group, tenderness was measured at 1 anatomic point. We investigated whether either method could demonstrate a directional preference response. **RESULTS:** When tenderness was measured at 1 anatomic point, 70% of subjects demonstrated a directional response, and only 1 subject exhibited an increase in baseline tenderness at the end of the procedure. When PPT was measured at 4 anatomic points, 40% of subjects demonstrated a directional response, but 12 subjects exhibited decreased PPT at the end of the procedure. **CONCLUSION:** Measuring changes in tenderness at 1 anatomic point in response to various padded wedge patterns appears promising as an examination procedure to determine directional preference. **Comment:** The category system of analysis was developed by DeJarnette and expanded by Goodheart. This system organizes patterns of various possible bodily distortions, particularly the disturbances that occur in the sacroiliac and lumbosacral regions. Briefly, Category I relates to imbalance or torque at the anterior aspect of the sacroiliac junction and its affect on meningeal balance and CSF fluctuation. Category II is associated with various degrees of posterior sacroiliac joint ligamentous sprain and trauma. A Category III condition will occur when the pelvis can no longer maintain weight-bearing capacity and shifts the "burden" to the lumbosacral junction with resultant discopathy and radiculopathy. These pelvic distortions produce reciprocal distortions throughout the body, especially in the pectoral girdle and first rib heads, the TMJ, the cervical spine, and the skull. Many muscle groups will be involved in the compensations a body makes to these pelvic category distortions.
Clinical spinal instability and low back pain. Panjabi MM.	*J Electromyogr Kinesiol.* 2003 Aug;13(4):371-9. **Abstract:** Clinical instability is an important cause of low back pain. Although there is some controversy concerning its definition, it is most widely believed that the loss of normal pattern of spinal motion causes pain and/or neurologic dysfunction. The stabilizing system of the spine may be divided into three subsystems: (1) the spinal column; (2) the spinal muscles; and (3) the neural control unit. A large number of biomechanical studies of the spinal column have provided insight into the role of the various components of the spinal column in providing spinal stability. The neutral zone was found to be a more sensitive parameter than the range of motion in documenting the effects of mechanical destabilization of the spine caused by injury and restabilization of the spine by osteophyle formation, fusion or muscle stabilization. Clinical studies indicate that the application of an external fixator to the painful segment of the spine can significantly reduce the pain. Results of an in vitro simulation of the study found that it was most probably the decrease in the neutral zone, which was responsible for pain reduction. A hypothesis relating the neutral zone to pain has been presented. The spinal muscles provide significant stability to the spine as shown by both in vitro experiments and mathematical models. Concerning the role of neuromuscular control system, increased body sway has been found in patients with low back pain, indicating a less efficient muscle control system with decreased ability to provide the needed spinal stability. **Comment:** Dr. Panjabi is the world's most published human biomechanical researcher, with over 263 published articles to date. The hypothesis he presents places the functionality of muscles, as both a cause and a consequence in chronic back pain patients, at the center of a sequence of events that ultimately results in back pain. The role of the muscular system, as "the stabilizing system of the spine," has been investigated by Dr. Panjabi in numerous other papers.
Dishman JD, Burke J. Spinal reflex excitability changes after cervical and lumbar spinal manipulation: a	*Spine J.* 2003 May-Jun;3(3):204-12. **BACKGROUND CONTEXT:** Spinal manipulation (SM) is a commonly employed nonoperative treatment modality in the management of patients with neck, low back or pelvic

comparative study.	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 a 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 form 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.
A comparison of muscle strength testing techniques in amyotrophic lateral sclerosis, Great Lakes ALS Study Group.	*Neurology.* 2003 Dec 9;61(11):1503-7. **OBJECTIVE: To assess the reliability of strength testing techniques among centers investigating patients with amyotrophic lateral sclerosis. METHODS:** The authors compared test reliability in manual muscle testing (MMT) and maximal voluntary isometric contraction (MVIC) scores among institutions and test validity by comparing change over time between MMT and MVIC. The authors examined 63 subjects at 3-month intervals for 12 months. At enrollment and at 6 months, two physical therapists each examined the subjects twice. MMT scores were calculated as modifications of the Medical Research Council scale. MVIC scores were generated as standardized megascores. Intraclass correlation coefficients and coefficients of variation compared reproducibility, and Pearson correlation coefficients compared change over time. The power of each measure to detect disease progression over time was assessed by estimating coefficients of variation for the average change. **RESULTS: Reproducibility between MVIC and MMT was equivalent. Sensitivity to detect progressive weakness and power to detect this change, however, favored MMT, an effect largely accounted for by the number of muscles sampled. CONCLUSIONS:** In multicentered trials**, uniformly trained physical therapists reproducibly and accurately measure strength by both MMT and MVIC. The authors found MMT to be the preferred measure of global strength because of its better Pearson correlation coefficients, essentially equivalent reproducibility, and more favorable coefficient of variation.** **Comment:** This paper is very important in understanding the clinical value (validity) of MMT in patients with neurologic disorders. It demonstrates that MMT is a more sensitive, more reliable and valid measure of dysfunction in patients with ALS than MVIC, which is another common method of muscle function evaluation.
Development of motor system dysfunction following whiplash injury, Sterling M,	*Pain.* 2003 May;103(1-2):65-73. **Abstract: Dysfunction in the motor system is a feature of persistent whiplash associated**

Jull G, Vicenzino B, Kenardy J, Darnell R.	**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), 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.** **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.
Neck muscle fatigue affects postural control in man, Schieppati M, Nardone A, and Schmid M.	*Neuroscience,* 2003;121(2):277-285. **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.
Myoelectric manifestations of sternocleidomastoid and	*Clin Neurophysiol.* 2003 Mar;114(3):488-95.

anterior scalene muscle fatigue in chronic neck pain patients, Falla D, Rainoldi A, Merletti R, Jull G.	**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) 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-1 fibres to fast-twitch type-IIB fibres, as well as the clinical observation of reduced endurance in the cervical flexors in neck pain patients.
Hip strength in females with and without patellofemoral pain. Ireland ML, Willson JD, Ballantyne BT, Davis IM.	*J Orthop Sports Phys Ther.* 2003 Nov;33(11):671-6. **STUDY DESIGN:** Cross-sectional. **OBJECTIVES:** To determine if females with anterior knee pain are more likely to demonstrate hip abduction or external rotation weakness than a similar, asymptomatic, age-matched control group. **BACKGROUND:** Diminished hip strength has been implicated as being contributory to lower-extremity malalignment and patellofemoral pain. The identification of reliable and consistent patterns of weakness in this population may assist health care professionals establish a more effective treatment plan. **METHODS AND MEASURES:** Hip abduction and external rotation isometric strength measurements were recorded for the injured side of 15 female subjects with patellofemoral joint pain (mean +/- SD age, 15.7 +/- 2.7 years; age range, 12-21 years). These were compared with strength measurements from the corresponding hip of 15 age-matched female control subjects (mean +/- SD age, 15.7 +/- 2.7 years; age range, 12-21 years). All strength measurements were made using hand-held dynamometers. **RESULTS:** Subjects with patellofemoral pain demonstrated 26% less hip abduction strength ($P<.001$) and 36% less hip external rotation strength ($P<.001$) than similar age-matched controls. **CONCLUSIONS: The results indicate that young women with patellofemoral pain are more likely to demonstrate weakness in hip abduction as well as external rotation than age-matched women who are not symptomatic.** **Comment:** A key factor in the successful treatment of patients with knee pain is the detection and correction of muscle weakness.
Decreased strength and mobility in patients after anterior cervical diskectomy compared with healthy subjects. Ylinen JJ, Savolainen S, Airaksinen O, Kautiainen H, Salo P, Häkkinen A.	*Arch Phys Med Rehabil.* 2003 Jul;84(7):1043-7. **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 diskectomy 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.
Chronic neck pain disability due to an acute whiplash injury. Nederhand MJ, Hermens HJ, IJzerman MJ, Turk DC, Zilvold G.	*Pain.* 2003 Mar;102(1-2):63-71. **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 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'. **Comment:** This paper shows that in patients less disabled by whiplash associated disorder injuries that upper trapezius underactivity is the norm.
Management of patellofemoral pain targeting hip, pelvis, and trunk muscle function: 2 case reports. Mascal CL, Landel R, Powers C.	*J Orthop Sports Phys Ther.* 2003 Nov;33(11):647-60. **STUDY DESIGN:** Case report. **OBJECTIVE:** To describe an alternative treatment approach for patellofemoral pain. **BACKGROUND: Weakness of the hip, pelvis, and trunk musculature has been hypothesized to influence lower-limb alignment and contribute to patellofemoral pain.** Two patients who had a chief complaint of patellofemoral pain and demonstrated lack of control of the hip in the frontal and transverse planes during functional movements were treated with an exercise program targeting the hip, pelvis, and trunk musculature. **METHODS AND MEASURES:** The patients presented in these 2 case reports did not exhibit obvious patellar malalignment or tracking problems; however, on qualitative assessment, both demonstrated excessive hip adduction, internal rotation, and knee valgus during gait and while performing a step-down maneuver. **In addition, both patients exhibited weakness of the hip abductors, extensors, and external rotators, as demonstrated by hand-held dynamometry testing.** Treatment in both cases occurred over a 14-week period and focused on recruitment and endurance training of the hip, pelvis, and trunk musculature. Functional status, pain, muscle force production, as well as subjective and objective assessment of lower-extremity kinematics during gait and a step-down maneuver were assessed preintervention and postintervention. **RESULTS:** Both patients experienced a significant reduction in patellofemoral pain, improved lower-extremity kinematics during dynamic testing, and were able to return to their original levels of function. Gluteus medius force production improved by 50% in patient A and 90% in patient B, while gluteus maximus force production improved 55% in patient A and 110% in patient B. Objective kinematic improvements in the step-down task also were demonstrated in patient A. **CONCLUSION: Assessment and treatment of the hip, pelvis, and trunk musculature should be considered in the rehabilitation of patients who present with patellofemoral pain and demonstrate abnormal**

	lower-extremity kinematics.
Association of widespread body pain with an increased risk of cancer and reduced cancer survival: a prospective, population-based study, McBeth J, Silman AJ, Macfarlane GJ	*Arthritis Rheum.* 2003 Jun;48(6):1686-92. **OBJECTIVE:** To determine whether reported widespread body pain is related to an increased incidence of cancer and/or reduced survival from cancer, since our previous population surveys have demonstrated a relationship between widespread body pain and a subsequent 2-fold increase in mortality from cancer over an 8-year period. **METHODS:** A total of 6565 subjects in Northwest England participated in 2 health surveys during 1991-1992. The subjects were classified according to their reported pain status (no pain, regional pain, and widespread pain), and were subsequently followed up prospectively until December 31, 1999. During follow up, information was collected on incidence of cancer and survival rates among those developing cancer. Associations between the original pain status and development of cancer and cancer survival were expressed as the incidence rate ratio (IRR) and mortality rate ratio (MRR), respectively. All analyses were adjusted for age, sex, and study location, the latter being a proxy measure of socioeconomic status. **RESULTS:** Among the study population, 6331 had never been diagnosed with cancer at the time of participation in the survey. Of these subjects, 956 (15%) were classified as having widespread pain, 3061 (48%) as having regional pain, and 2314 (37%) as having no pain. There were a total of 395 first malignancies recorded during follow up. In comparison with subjects reporting no pain, those with regional pain (IRR 1.19, 95% confidence interval [95% CI] 0.94-1.50) and widespread pain (IRR 1.61, 95% CI 1.21-2.13) experienced an excess incidence of cancer during the follow up period. The increased incidence among subjects previously reporting widespread pain was related, most strongly, to breast cancer (IRR 3.67, 95% CI 1.39-9.68), but there were also cancers of the prostate (IRR 3.46, 95% CI 1.25-9.59), large bowel (IRR 2.35, 95% CI 0.96-5.77), and lung (IRR 2.04, 95% CI 0.96-4.34). Subjects reporting widespread pain who subsequently developed cancer, in comparison with those previously reporting no pain, had an increased risk of death (MRR 1.82, 95% CI 1.18-2.80). This decreased survival was highest among subjects with cancers of the breast and prostate, although the effects on site-specific survival were nonsignificant. **CONCLUSION:** This study has demonstrated that widespread pain reported in population surveys is associated with a substantial subsequent increased incidence of cancer and reduced cancer survival. At present there are no satisfactory biologic explanations for this observation, although several possible leads have been identified. **Comment:** The importance of this study is that patients with spinal injuries that lead to aberrant afferent mechanical input into the spinal cord, ultimately resulting in chronic back pain, may face a statistically significant increase in death rates from cancer.
The use of osteopathic manipulative treatment as adjuvant therapy in children with recurrent acute otitis media, Mills MV, Henley CE, Barnes LL, Carreiro JE, Degenhardt BF.	*Arch Pediatr Adolesc Med.* 2003 Sep;157(9):861-6. **OBJECTIVE:** To study effects of osteopathic manipulative treatment as an adjuvant therapy to routine pediatric care in children with recurrent acute otitis media (AOM). **STUDY DESIGN:** Patients 6 months to 6 years old with 3 episodes of AOM in the previous 6 months, or 4 in the previous year, who were not already surgical candidates were placed randomly into 2 groups: one receiving routine pediatric care, the other receiving routine care plus osteopathic manipulative treatment. Both groups received an equal number of study encounters to monitor behavior and obtain tympanograms. Clinical status was monitored with review of pediatric records. The pediatrician was blinded to patient group and study outcomes, and the osteopathic physician was blinded to patient clinical course. **MAIN OUTCOME MEASURES:** We monitored frequency of episodes of AOM, antibiotic use, surgical interventions, various behaviors, and tympanometric and audiometric performance. **RESULTS:** A total of 57 patients, 25 intervention patients and 32 control patients, met criteria and completed the study. Adjusting for the baseline frequency before study entry, intervention patients had fewer episodes of AOM (mean group difference per month, -0.14 [95% confidence interval, -0.27 to 0.00]; P =.04), fewer surgical procedures (intervention patients, 1; control patients, 8; P =.03), and more mean surgery-free months (intervention patients, 6.00; control patients, 5.25; P =.01). Baseline and final tympanograms obtained by the audiologist showed an increased frequency of more normal tympanogram types

	in the intervention group, with an adjusted mean group difference of 0.55 (95% confidence interval, 0.08 to 1.02; P =.02). No adverse reactions were reported. **CONCLUSIONS:** The results of this study suggest a potential benefit of osteopathic manipulative treatment as adjuvant therapy in children with recurrent AOM; it may prevent or decrease surgical intervention or antibiotic overuse.
Presence of Chapman reflex points in hospitalized patients with pneumonia, Washington K, Mosiello R, Venditto M, Simelaro J, Coughlin P, Crow WT, Nicholas A.	*J Am Osteopath Assoc.* 2003 Oct;103(10):479-83. **Abstract:** The authors undertook a case control study to determine whether hospitalized patients with pneumonia had reflex points in the anterior chest wall as described by Frank Chapman, DO, specifically those classified as relating to the lung. Sixty-nine hospitalized patients were enrolled in the study. Patients with an admitting diagnosis of pneumonia were compared to those without pneumonia as their admitting diagnosis. All patients were examined to determine if Chapman reflex points for the lungs were present. The study controlled for potential confounding diagnoses by excluding patients with lung pathology other than pneumonia. Results demonstrated a statistically significant relationship between the presence of Chapman reflex points and pneumonia in hospitalized patients.
Reliability of 4 outcome measures in pediatric spinal muscular atrophy, Iannaccone ST, Hynan LS, American Spinal Muscular Atrophy Randomized Trials (AmSMART) Group.	*Arch Neurol.* 2003 Aug;60(8):1130-6. **BACKGROUND:** Spinal muscular atrophy is a common neurologic disorder of infants and children with a high mortality rate. Clinical trials have not been attempted in this population until recently. **OBJECTIVE:** To demonstrate that 4 outcome measures are reliable for use in clinical trials in patients with spinal muscular atrophy. **DESIGN, SETTING, PATIENTS**: Thirty-eight children with spinal muscular atrophy who fulfilled inclusion and exclusion criteria were enrolled at 5 pediatric centers for a reliability study. Paired samples statistics were performed comparing results of the qualifying variance visit with a fourth visit. **MAIN OUTCOME MEASURES: Quantitative muscle testing and the Gross Motor Function Measure.** RESULTS: Thirty-four patients and 7 evaluators completed the study. Thirteen patients were aged 2 through 4 years and 21 were 5 through 17 years. The Gross Motor Function Measure was completed by 34 subjects. Six variables for pulmonary function tests were measured in 20 subjects. Quantitative muscle testing was performed on 21 subjects in 8 muscle groups. Thirty-three subjects completed the PedsQL Neuromuscular Module for Parents. **The intraclass correlation coefficient and Bradley-Blackwood procedures indicated a very high level of agreement between measures**. **CONCLUSION: The Gross Motor Function Measure, pulmonary function tests, quantitative muscle testing, and quality of life are reliable outcome measures for clinical trials in pediatric spinal muscular atrophy.**
Pain and motor control of the lumbopelvic region: effect and possible mechanisms, Hodges PW, Moseley GL.	*J Electromyogr Kinesiol.* 2003 Aug;13(4):361-70. **Abstract:** Many authors report changes in the control of the trunk muscles in people with low back pain (LBP). Although there is considerable disagreement regarding the nature of these changes, we have consistently found differential effects on the deep intrinsic and superficial muscles of the lumbopelvic region. Two issues require consideration; first, the potential mechanisms for these changes in control, and secondly, the effect or outcome of changes in control for lumbopelvic function. Recent data indicate that experimentally induced pain may replicate some of the changes identified in people with LBP. While this does not exclude the possibility that changes in control of the trunk muscles may lead to pain, it does argue that, at least in some cases, pain may cause the changes in control. There are many possible mechanisms, including changes in excitability in the motor pathway, changes in the sensory system, and factors associated with the attention demanding, stressful and fearful aspects of pain. A new hypothesis is presented regarding the outcome from differential effects of pain on the elements of the motor system. Taken together these data argue for strategies of prevention and rehabilitation of LBP. **Comment:** In the AK clinical setting, MMT that produces pain during the test will also

	demonstrate inhibition of the muscle tested. When the proper therapy is employed, the MMT inhibition of the muscle and the pain during the MMT of the muscle are improved. This correlation is explored in this paper.
Evidence of altered lumbopelvic muscle recruitment in the presence of sacroiliac joint pain, Hungerford B, Gilleard W, Hodges P.	*Spine.* 2003 Jul 15;28(14):1593-600. **STUDY DESIGN:** Cross-sectional study of electromyographic onsets of trunk and hip muscles in subjects with a clinical diagnosis of sacroiliac joint pain and matched control subjects. **OBJECTIVES:** To determine whether muscle activation of the supporting leg was different between control subjects and subjects with sacroiliac joint pain during hip flexion in standing. **BACKGROUND:** Activation of the trunk and gluteal muscles stabilize the pelvis for load transference; however, the temporal pattern of muscle activation and the effect of pelvic pain on temporal parameters has not been investigated. **METHODS:** Fourteen men with a clinical diagnosis of sacroiliac joint pain and healthy age-matched control subjects were studied. Surface electromyographic activity was recorded from seven trunk and hip muscles of the supporting leg during hip flexion in standing. Onset of muscle activity relative to initiation of the task was compared between groups and between limbs. **RESULTS**: The onset of obliquus internus abdominis (OI) and multifidus occurred before initiation of weight transfer in the control subjects. The onset of obliquus internus abdominis, multifidus, and gluteus maximus was delayed on the symptomatic side in subjects with sacroiliac joint pain compared with control subjects, and the onset of biceps femoris electromyographic activity was earlier. In addition, electromyographic onsets were different between the symptomatic and asymptomatic sides in subjects with sacroiliac joint pain. **CONCLUSIONS:** The delayed onset of obliquus internus abdominis, multifidus, and gluteus maximus electromyographic activity of the supporting leg during hip flexion, in subjects with sacroiliac joint pain, suggests an alteration in the strategy for lumbopelvic stabilization that may disrupt load transference through the pelvis. **Comment:** The importance of specific treatment of muscle imbalances related to the sacroiliac joints is apparent from this study.
Comorbidity of internal derangement of the temporomandibular joint and silent dysfunction of the cervical spine, Stiesch-Scholz M, Fink M, Tschernitschek H.	*J Oral Rehabil.* 2003 Apr;30(4):386-91. **Abstract:** The aim of this evaluation was to examine correlations between internal derangement of the temporomandibular joint (TMJ) and cervical spine disorder (CSD). A prospective controlled clinical study was carried out. Thirty patients with signs and symptoms of internal derangement but without any subjective neck problems and 30 age- and gender-matched control subjects without signs and symptoms of internal derangement were examined. The investigation of the temporomandibular system was carried out using a 'Craniomandibular Index'. Afterwards an examiner-blinded manual medical investigation of the craniocervical system was performed. This included muscle palpation of the cervical spine and shoulder girdle as well as passive movement tests of the cervical spine, to detect restrictions in the range of movement as well as segmental intervertebral dysfunction. The internal derangement of the TMJ was significantly associated with 'silent' CSD (t-test, $P < 0.05$). Patients with raised muscle tenderness of the temporomandibular system exhibited significantly more often pain on pressure of the neck muscles than patients without muscle tenderness of the temporomandibular system (t-test, $P < 0.05$). As a result of the present study, for patients with internal derangement of the TMJ an additional examination of the craniocervical system should be recommended. **Comment:** In AK there is recognition of the stomatognathic system, and of the importance of the cervical spine to the treatment of the TMJ. The stomatognathic system involves the complex interaction between structures and functions of the head and neck.
The functional relationship between the craniomandibular system, cervical spine, and the sacroiliac joint: a preliminary	*Cranio.* 2003 Jul;21(3):202-8. **Abstract:** The hypothesis of a functional coupling between the muscles of the craniomandibular system and the muscles of other body areas is still controversial. The purpose of this pilot study was to examine whether there is a relationship between the craniomandibular system, the

investigation, Fink M, Wahling K, Stiesch-Scholz M, Tschernitschek H.	craniocervical system and the sacropelvic region. To test this hypothesis, the prevalence and localization of dysfunction of the cervical spine and the sacroiliac joint were examined in a prospective, experimental trial. Twenty healthy students underwent an artificial occlusal interference, which caused an occlusal interference. The upper cervical spine (CO-C3) and the sacroiliac joint were examined before, during and after this experimental test. The primary outcome with these experimental conditions was the occurrence of hypomobile functional abnormalities. In the presence of occlusal interference, functional abnormalities were detected in both regions examined and these changes were statistically significant. The clinical implications of these findings may be that a complementary examination of these areas in CMD patients could be useful.
Relationship between lower extremity muscle strength and dynamic balance in people post-stroke, Kligyte I, Lundy-Ekman L, Medeiros JM.	*Medicina (Kaunas).* 2003;39(2):122-8. **Abstract:** The purpose of this study was to determine how lower extremity muscle weakness is related to post-stroke difficulties in balancing. METHODS: Dynamic balance of 30 people post-stroke and 30 neurologically sound people was assessed by the Functional Reach Test and the Timed Up and Go Test. Bilateral lower extremity muscle strength was **measured in classical manual muscle testing positions using a Lafayette instrument**. RESULTS: There was a weak correlation between lower extremity muscle strength and the Functional Reach Test: from r=0.05 to r=0.53 for the impaired extremity and from r=0.23 to r=0.53 for the sound extremity. Control group results were from r=0.51 to r=0.86. The correlation between lower extremity muscle strength and the Timed Up and Go Test was from r=-0.33 to r=-0.64 for the impaired extremity and from r=-0.35 to r=-0.58 for the sound extremity. Control group results in this testing situation were from r=-0.63 to r=-0.90. CONCLUSION: The results of the study indicate that the loss of lower extremity muscle strength as a result of cerebrovascular accident has a poor influence on dynamic balance problems in people post-stroke.
Dishman JD, Ball KA, Burke J. First Prize: Central motor excitability changes after spinal manipulation: a transcranial magnetic stimulation study.	*J Manipulative Physiol Ther.* 2002 Jan;25(1):1-9. **BACKGROUND:** The physiologic mechanism by which spinal manipulation may reduce pain and muscular spasm is not fully understood. One such mechanistic theory proposed is that spinal manipulation may intervene in the cycle of pain and spasm by affecting the resting excitability of the motoneuron pool in the spinal cord. Previous data from our laboratory indicate that spinal manipulation leads to attenuation of the excitability of the motor neuron pool when assessed by means of peripheral nerve Ia-afferent stimulation (Hoffmann reflex). **OBJECTIVE:** The purpose of this study was to determine the effects of lumbar spinal manipulation on the excitability of the motor neuron pool as assessed by means of transcranial magnetic stimulation. **METHODS:** Motor-evoked potentials were recorded subsequent to transcranial magnetic stimulation. The motor-evoked potential peak-to-peak amplitudes in the right gastrocnemius muscle of healthy volunteers (n = 24) were measured before and after homolateral L5-S1 spinal manipulation (experimental group) or side-posture positioning with no manipulative thrust applied (control group). Immediately after the group-specific procedure, and again at 5 and 10 minutes after the procedure, 10 motor-evoked potential responses were measured at a rate of 0.05 Hz. An optical tracking system (OptoTRAK, Northern Digital Inc, Waterloo, Canada [<0.10 mm root-mean-square]) was used to monitor the 3-dimensional (3-D) position and orientation of the transcranial magnetic stimulation coil, in real time, for each trial. **RESULTS:** The amplitudes of the motor-evoked potentials were significantly facilitated from 20 to 60 seconds relative to the prebaseline value after L5-S1 spinal manipulation, without a concomitant change after the positioning (control) procedure. **CONCLUSIONS:** When motor neuron pool excitability is measured directly by central corticospinal activation with transcranial magnetic stimulation techniques, **a transient but significant facilitation occurs as a consequence of spinal manipulation. Thus, a basic neurophysiologic response to spinal manipulation is central motor facilitation.** **Comment:** This very important study shows a facilitation of motor evoked potentials in the gastrocnemius muscle after SMT. The MMT as used in AK also detects this facilitation of peripheral muscles after SMT. Similarly, in other studies in this compendium there are

	observations of a reduction in hypertonicity from EMG records of back and neck pain patients after SMT. Other investigators have reported a decrease in palpable lumbar muscle spasm and pain after SMT. These data offer further support for the hypothesis, long held in AK, that SMT procedures lead to an increase in central motor excitability rather than overall inhibition.
The "iliacus test": new information for the evaluation of hip extension dysfunction, Eland DC, Singleton TN, Conaster RR, Howell JN, Pheley AM, Karlene MM, Robinson JM.	*JAOA.* March 2002;102(3):130-142. **Abstract:** This study confirms the clinical value of investigating the "iliacus complex" during evaluations of the low back. A new "iliacus test" isolates this iliacus complex component of limited hip extension. Designed for a single joint, the test isolates motion across the hip joint. Study results include the following: (1) in a comparison with the clinical standard, the Thomas test, data show that the two tests are significantly different in an asymptomatic population between the ages of 18 and 35 years; (2) with the exception of the standard Thomas test, the data show no statistical differences in range of motion when comparing the left side with the right side; (3) examiner-added, end-range pressure for assessment of range of motion when compared with the standard gravity-dependent end range of motion used in the Thomas test yields valuable new information; and (4) data provide a basis for population norms for each test--Thomas and iliacus--in gravity-dependent and examiner-produced tissue-feel end ranges.
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.	*Spine.* 2002 May 15;27(10):1056-61. **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.** **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.
Do cerebral potentials to magnetic stimulation of paraspinal muscles reflect changes in palpable muscle	*J Manipulative Physiol Ther.* 2002 Jan;25(1):77-8. OBJECTIVE: Previous studies have shown that cortical-evoked potentials on magnetic stimulation of muscles are influenced by muscle contraction, vibration, and muscle spasm. This

spasm, low back pain, and activity scores? Zhu Y, Haldeman S, Hsieh CY, Wu P, Starr A.	study was carried out to determine whether these potentials correlate with palpatory muscle spasm, patient symptoms, and disability in patients with low back pain. METHODS: A prospective observational study was performed on 13 subjects with a history of low back pain visiting an orthopedic hospital-based clinic. Patients were screened for serious pathologic conditions by an orthopedic surgeon. The patients were then evaluated for the presence of muscle spasm by one of the investigators who was blinded to the results of the evoked potential studies. Patients were asked to complete a low back pain visual analogue scale (VAS) and a Roland-Morris Activity Scale (RMAS). Cortical-evoked potentials were recorded with a magnetic stimulator placed over the lumbar paraspinal muscles with the patient in the prone position. The palpatory examination, VAS, RMAS, and the cortical potentials were repeated after 2 weeks of therapy commonly used to reduce muscle spasm. RESULTS: The patients demonstrated a significant decrease in low back pain VAS and RMAS scores after treatment compared with before treatment. There was a reduction in the amount of palpatory muscle spasm in 11 of 13 cases. The cortical potentials before treatment were attenuated compared with previously reported controls and showed a significant increase before and after treatment in the amplitude of these potentials with multivariate analysis of variance. There was significant correlation between the changes in cortical potentials after treatment and the changes noted in paraspinal muscle spasm and VAS and RMAS scores. CONCLUSIONS: This study confirms the previous report that the amplitude of cerebral-evoked potentials on magnetic stimulation of paraspinal muscles is depressed in the presence of palpable muscle spasm. **The close correlation among these potentials, paraspinal muscle spasm, and clinical symptoms suggests that the measurement of muscle activity may be more important in the assessment of low back pain than is commonly accepted.** **Comment:** This hypothesis has been made in AK since the technique was founded. Through evaluation of the function of certain muscles pre- and post-treatment, therapeutic efficacy for particular problems can be evaluated. Applied kinesiologists theorize that physical, chemical, and mental 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. This study demonstrates the simultaneous presence of muscle spasm and depressed cortical-evoked potentials in patients with low back pain. After 2 weeks of chiropractic spinal therapy the patients were alleviated of their clinical symptoms and increased the synaptic efficacy of Ia afferent activation to the central nervous system.
Exercise-induced muscle damage in humans, Clarkson PM, Hubal MJ.	*Am J Phys Med Rehabil.* 2002 Nov;81(11 Suppl):S52-69. **Abstract:** Exercise-induced muscle injury in humans frequently occurs after unaccustomed exercise, particularly if the exercise involves a large amount of eccentric (muscle lengthening) contractions. Direct measures of exercise-induced muscle damage include cellular and subcellular disturbances, particularly Z-line streaming. Several indirectly assessed markers of muscle damage after exercise include increases in T2 signal intensity via magnetic resonance imaging techniques, prolonged decreases in force production measured during both voluntary and electrically stimulated contractions (particularly at low stimulation frequencies), increases in inflammatory markers both within the injured muscle and in the blood, increased appearance of muscle proteins in the blood, and muscular soreness. Although the exact mechanisms to explain these changes have not been delineated, the initial injury is ascribed to mechanical disruption of the fiber, and subsequent damage is linked to inflammatory processes and to changes in excitation-contraction coupling within the muscle. Performance of one bout of eccentric exercise induces an adaptation such that the muscle is less vulnerable to a subsequent bout of eccentric exercise. Although several theories have been proposed to explain this "repeated bout effect," including altered motor unit recruitment, an increase in sarcomeres in series, a blunted inflammatory response, and a reduction in stress-susceptible fibers, there is no general agreement as to its cause. In addition, there is controversy concerning the presence of sex differences in the response of muscle to damage-inducing exercise. In contrast to the animal literature, which clearly shows that females experience less damage than males, research using human studies

	suggests that there is either no difference between men and women or that women are more prone to exercise-induced muscle damage than are men. **Comment:** The first technique used in AK to change muscle function was firm manipulation of the muscle's origin and insertion. When muscle weakness was found on MMT, small nodules at the origin or insertion were often present in the muscle. A history of trauma to the muscle will usually be present. Significant research on muscle soreness has focused on eccentric muscle contractions. During this type of muscular movement, muscles lengthen, which causes the microtears characteristic of exercise-induced muscle damage. The AK hypothesis that in some cases muscle weakness is due to a microavulsion of the tendon from the periosteum finds substantiation in this study.
Neurophysiological effects of spinal manipulation, Pickar JG.	*Spine J.* 2002 Sep-Oct;2(5):357-71. **BACKGROUND CONTEXT:** Despite clinical evidence for the benefits of spinal manipulation and the apparent wide usage of it, the biological mechanisms underlying the effects of spinal manipulation are not known. Although this does not negate the clinical effects of spinal manipulation, it hinders acceptance by the wider scientific and health-care communities and hinders rational strategies for improving the delivery of spinal manipulation. **PURPOSE:** The purpose of this review article is to examine the neurophysiological basis for the effects of spinal manipulation. **STUDY DESIGN:** A review article discussing primarily basic science literature and clinically oriented basic science studies. **METHODS:** This review article draws primarily from the peer-reviewed literature available on Medline. Several textbook publications and reports are referenced. A theoretical model is presented describing the relationships between spinal manipulation, segmental biomechanics, the nervous system and end-organ physiology. Experimental data for these relationships are presented. **RESULTS:** Biomechanical changes caused by spinal manipulation are thought to have physiological consequences by means of their effects on the inflow of sensory information to the central nervous system. **Muscle spindle afferents and Golgi tendon organ afferents are stimulated by spinal manipulation.** Smaller-diameter sensory nerve fibers are likely activated, although this has not been demonstrated directly. Mechanical and chemical changes in the intervertebral foramen caused by a herniated intervertebral disc can affect the dorsal roots and dorsal root ganglia, but it is not known if spinal manipulation directly affects these changes. Individuals with herniated lumbar discs have shown clinical improvement in response to spinal manipulation. The phenomenon of central facilitation is known to increase the receptive field of central neurons, enabling either subthreshold or innocuous stimuli access to central pain pathways. Numerous studies show that spinal manipulation increases pain tolerance or its threshold. One mechanism underlying the effects of spinal manipulation may, therefore, be the manipulation's ability to alter central sensory processing by removing subthreshold mechanical or chemical stimuli from paraspinal tissues. **Spinal manipulation is also thought to affect reflex neural outputs to both muscle and visceral organs. Substantial evidence demonstrates that spinal manipulation evokes paraspinal muscle reflexes and alters motoneuron excitability.** The effects of spinal manipulation on these somatosomatic reflexes may be quite complex, producing excitatory and inhibitory effects. Whereas substantial information also shows that sensory input, especially noxious input, from paraspinal tissues can reflexively elicit sympathetic nerve activity, knowledge about spinal manipulation's effects on these reflexes and on end-organ function is more limited. **CONCLUSIONS:** A theoretical framework exists from which hypotheses about the neurophysiological effects of spinal manipulation can be developed. **An experimental body of evidence exists indicating that spinal manipulation impacts primary afferent neurons from paraspinal tissues, the motor control system and pain processing.** Experimental work in this area is warranted and should be encouraged to help better understand mechanisms underlying the therapeutic scope of spinal manipulation. **Comment:** This important review of the current scientific literature suggests that spinal manipulation alters group Ia and group II mechanoreceptor discharge and significantly affects the motor control system. Central motor facilitation is a basic, immediate neurophysiological response to chiropractic care. This paper reviews the evidence that reductions in resting muscular

	tone (quantified by surface electromyography in the prone posture) have been documented following spinal adjustments, as have improvements in muscular strength.
Central motor excitability changes after spinal manipulation: A transcranial magnetic stimulation study, Dishman J, Ball K, Burke J.	*J Manipulative Physiol Ther* 2002;25:1-9 **Background:** The physiologic mechanism by which spinal manipulation may reduce pain and muscular spasm is not fully understood. One such mechanistic theory proposed is that spinal manipulation may intervene in the cycle of pain and spasm by affecting the resting excitability of the motoneuron pool in the spinal cord. Previous data from our laboratory indicate that spinal manipulation leads to attenuation of the excitability of the motor neuron pool when assessed by means of peripheral nerve Ia-afferent stimulation (Hoffmann reflex). **Objective:** The purpose of this study was to determine the effects of lumbar spinal manipulation on the excitability of the motor neuron pool as assessed by means of transcranial magnetic stimulation. **Methods:** Motor-evoked potentials were recorded subsequent to transcranial magnetic stimulation. The motor-evoked potential peak-to-peak amplitudes in the right gastrocnemius muscle of healthy volunteers (n = 24) were measured before and after homolateral L5-S1 spinal manipulation (experimental group) or side-posture positioning with no manipulative thrust applied (control group). Immediately after the group-specific procedure, and again at 5 and 10 minutes after the procedure, 10 motor-evoked potential responses were measured at a rate of 0.05 Hz. An optical tracking system (OptoTRAK, Northern Digital Inc, Waterloo, Canada [<0.10 mm root-mean-square]) was used to monitor the 3-dimensional (3-D) position and orientation of the transcranial magnetic stimulation coil, in real time, for each trial. **Results:** The amplitudes of the motor-evoked potentials were significantly facilitated from 20 to 60 seconds relative to the pre baseline value after L5-S1 spinal manipulation, without a concomitant change after the positioning (control) procedure. **Conclusions:** When motor neuron pool excitability is measured directly by central corticospinal activation with transcranial magnetic stimulation techniques, a transient but significant facilitation occurs as a consequence of spinal manipulation. **Thus, a basic neurophysiologic response to spinal manipulation is central motor facilitation.**
Assessment of isokinetic muscle strength in women who are obese, Hulens M, Vansant G, Lysens R, Claessens AL, Muls E. -- Department of Rehabilitation Sciences, Faculty of Physical Education and Physiotherapy, Katholieke Universiteit, Leuven, Belgium. maria.hulens@flok.kuleuven.ac.be	*J Orthop Sports Phys Ther.* 2002 Jul;32(7):347-56. **STUDY DESIGN:** Cross-sectional study of isokinetic trunk and knee muscle strength in women who are obese. **OBJECTIVE:** To provide reference values, to identify variables that affect peripheral muscle strength, and to provide recommendations for isokinetic testing of trunk and knee muscles in women who are obese and morbidly obese. **BACKGROUND:** The assessment of peripheral muscle strength is useful for the quantification of possible loss of strength, for exercise prescription, and for the evaluation of the effect of training programs in obese individuals. **METHODS AND MEASURES:** Isokinetic trunk and leg muscle strength was assessed in 241 women who were obese (18-65 years, body mass index (BMI) > or = 30 kg/m2). Trunk flexion and extension peak torque (PT) was measured using the Cybex TEF dynamometer; trunk rotation (TR) PT was measured using the Cybex TORSO dynamometer; and knee flexion/extension (KFE) PT was measured using the Cybex 350 dynamometer. Body composition was assessed using the bioelectrical impedance method; physical activity was assessed using the Baecke questionnaire; and peak VO2 was assessed using an incremental exercise capacity test on a bicycle ergometer. To identify variables related to muscle strength, Pearson correlations were computed and a stepwise multiple regression analysis was performed. **RESULTS:** Pearson correlation coefficients of all strength measurements at 60 degrees/s revealed low-to-moderate negative associations with age and positive associations with mass, height, fat free mass (FFM), and peak VO2 ($P < 0.05$), except for gravity-uncorrected trunk extension strength, which was not related to mass. The sports index of the Baecke questionnaire was associated with TR PT ($r = 0.20$, $P < 0.01$) and KFE PT ($r = 0.18$, $P < 0.05$). **CONCLUSION:** The weight of the trunk accounts largely for the measured trunk extensor and flexor strength in women who are obese. Contributing variables of isokinetic trunk flexion and extension strength in women who are obese are age, height, and FFM; whereas sports activities and aerobic fitness are contributing factors for trunk rotational and knee extension strength.

	Recommendations for measuring isokinetic muscle strength in individuals who are obese are provided.
Decrease in elbow flexor inhibition after cervical spine manipulation in patients with chronic neck pain, Suter E, McMorland G.	*Clin Biomech (Bristol, Avon).* 2002 Aug;17(7):541-4. **OBJECTIVE:** This study measured functional capacity and subjective pain in patients with chronic neck pain before and after manipulation of the cervical spine. **DESIGN:** Outcomes study on 16 patients with chronic neck pain. **BACKGROUND:** Muscle inhibition, i.e., the inability to fully activate a muscle, has been observed following joint pathologies and in low back pain conditions. Although chronic neck pain has been associated with changes in muscle recruitment and coordination in the shoulder and arms, the possibility of muscle inhibition has not been explored. **METHODS:** Biceps activation during a maximal voluntary elbow flexor contraction was assessed using the interpolated twitch technique and electromyography. Cervical range of motion and pressure pain thresholds were measured using a goniometer and an algometer. Manipulation of the cervical spine was applied at the level of C5/6/7, and functional assessments were repeated. **RESULTS:** Patients showed significant inhibition in their biceps muscles. Cervical range of motion was restricted laterally, and increased pressure pain sensitivity was evident. After cervical spine manipulation, a significant reduction in biceps inhibition and an increase in biceps force occurred. Cervical range of motion and pressure pain thresholds increased significantly. **CONCLUSIONS: Significant dysfunction in biceps activation was evident in patients with chronic neck pain, indicating that this muscle group cannot be used to the full extent. Spinal manipulation decreased muscle inhibition and increased elbow flexor strength at least in the short term. RELEVANCE:** Muscle inhibition in the biceps has not been previously documented in patients with chronic neck pain. Further research is needed to establish whether muscle inhibition is related to clinical symptoms and functional outcome. Spinal manipulation improved muscle function, cervical range of motion and pain sensitivity, and might therefore be beneficial for treating patients with chronic neck pain. **Comment:** The relationship between spinal dysfunction and muscular inhibition is very clearly demonstrated in this paper.
The reliability of upper- and lower-extremity strength testing in a community survey of older adults, Ottenbacher KJ, Branch LG, Ray L, Gonzales VA, Peek MK, Hinman MR. -- Division of Rehabilitation Sciences, Sealy Center on Aging, University of Texas Medical Branch, Galveston, TX 77555-1028, USA. kottenbo@utmb.edu	*Arch Phys Med Rehabil.* 2002 Oct;83(10):1423-7. **OBJECTIVE:** To examine the stability (test-retest reliability) of strength measures in older adults obtained by nontherapist lay examiners by using a hand-held portable muscle testing device (Nicholas Manual Muscle Tester). **DESIGN:** A prospective relational design was used to collect test-retest data for 1 male subject by using 27 lay raters who completed intensive training in manual muscle. **SETTING:** Data were collected from older Mexican-American adults living in the community. **PARTICIPANTS:** Twenty-seven lay raters who completed intensive training in manual muscle testing for a field-based assessment and interview of older adults and 63 Mexican-American subjects completing wave 4 of the Hispanic Established Populations for the Epidemiologic Study of the Elderly. **INTERVENTIONS:** Training involved reviewing a manual describing each testing position followed by approximately 6 hours of instruction and practice supervised by an experienced physical therapist. Lay raters then collected test-retest information on older Mexican-American subjects. **MAIN OUTCOME MEASURE:** Stability (test-retest) for a portable manual muscle testing device. **RESULTS:** Intraclass correlation coefficients (ICCs) were computed for the 27 lay raters examining 1 male subject (2 trials) and 12 lay raters assessing 63 older Mexican-American adults (1 practice and 2 trials recorded). The ICC values for the first 27 lay raters ranged from .74 to.96. The ICC values for the latter 12 lay raters ranged from .87 to.98. No differences were found in ICC values between male or female subjects. **CONCLUSIONS:** Stable and consistent information for upper- and lower-extremity strength was collected from the older adults participating in this study. The results suggest reliable information can be obtained by lay raters using a portable manual muscle testing device if the examiners receive intensive training.
Sensorimotor control of the	*Journal of Electromyography and Kinesiology,* 2002,12;3:219-234.

spine, Holm S, Indahl A, Solomonow M.	(http://www.isek-online.org/) **Abstract:** The spinal viscoelastic structures including disk, capsule and ligaments were reviewed with special focus on their sensory motor functions. Afferent capable of monitoring proprioceptive and kinesthetic information are abundant in the disc, capsule and ligament. Electrical stimulation of the lumbar afferents in the discs, capsules and ligaments seem to elicit reflex contraction of the multifidus and also longissimus muscles. The muscular excitation is pronounced in the level of excitation and with weaker radiation 1 to 2 levels above and below. Similarly, mechanical stimulation of the spinal viscoelastic tissues excites the muscles with higher excitation intensity when more than one tissue (ligaments and discs for example) is stimulated. Overall, it seems that spinal structures are well suited to monitor sensory information as well as to control spinal muscles and probably also provide kinesthetic perception to the sensory cortex. **Comment:** The new and strikingly original feature of AK is that it brings together in a functional, inseparable manner the spinal, the nervous, and the muscle systems. Remarkably, each system demonstrates and maintains the condition of the other.
The effect of different standing and sitting postures on trunk muscle activity in a pain-free population, O'Sullivan PB, Grahamslaw KM, Kendell M, Lapenskie SC, Moller NE, Richards KV.	*Spine.* 2002 Jun 1;27(11):1238-44. **STUDY DESIGN:** A normative, single-group study was conducted. **OBJECTIVE:** To determine whether there is a difference in electromyographic activation of specific lumbopelvic muscles with the adoption of common postures in a pain-free population. **SUMMARY OF BACKGROUND DATA:** Clinical observations indicate that adopting passive postures such as sway standing and slump sitting can exacerbate pain in individuals with low back pain. These individuals often present with poor activation of the lumbopelvic stabilizing musculature. At this writing, little empirical evidence exists to document that function of the trunk and lumbopelvic musculature are related to the adoption of standardized standing and sitting postures. **METHODS:** This study included 20 healthy adults, with equal representation of the genders. Surface electromyography was used to measure activity in the superficial lumbar multifidus, internal oblique, rectus abdominis, external oblique, and thoracic erector spinae muscles for four standardized standing and sitting postures. **RESULTS:** The internal oblique, superficial lumbar multifidus, and thoracic erector spinae muscles showed a significant decrease in activity during sway standing ($P = 0.027$, $P = 0.002$, and $P = 0.003$, respectively) and slump sitting ($P = 0.007$, $P = 0.012$, and $P = 0.003$, respectively), as compared with erect postures. Rectus abdominis activity increased significantly in sway standing, as compared with erect standing ($P = 0.005$). **CONCLUSIONS:** The findings show that the lumbopelvic stabilizing musculature is active in maintaining optimally aligned, erect postures, and that these muscles are less active during the adoption of passive postures. The results of this study lend credence to the practice of postural retraining **when facilitation of the lumbopelvic stabilizing musculature is indicated in the management of specific spinal pain conditions.**
Chiropractic 'name techniques': a review of the literature, Gleberzon BJ.	*European Journal of Chiropractic* 2002; 49: 242-3. **Abstract:** The purpose of this paper is to describe the results of a literature search of several different chiropractic 'name techniques.' This process is an important first step in building an evidentiary foundation upon which clinical decisions should be made, and it further guides research efforts by exposing those areas which are insufficiently investigated. Out of the 111 articles found in this study, 39 were technique descriptions (35%), 29 were case studies or case series (26%), 25 were experimental studies (23%), and only 17 (15%) were clinical trials. Out of the clinical trial, only five were designed with a treatment group/control group and only one study was designed with a treatment group/sham treatment group. None of these clinical trials were designed with a treatment/sham/control group protocol. It is equally problematic that those studies which investigated the intra- and inter-reliability of such diagnostic tests as leg length checks or X-ray mensurations have not linked these tests with any clinical applicability or

	relevance. Thus it is fair to state that the current body of research into name techniques is still in its infancy. Therefore, it is incumbent upon advocates of name techniques to continue to establish an evidentiary base to support the utilization of their diagnostic or therapeutic procedures. **Comment:** Research is one of ICAK's priorities. The *Collected Papers of the International College of Applied Kinesiology* has been published both annually and bi-annually since the founding of the ICAK in 1976, and are available for review on this website. The sharing of the clinical observations and ideas in this yearly publication is the launching of a researching idea, and a step up a path where too few in the health care community have gone. As patient-based outcomes assessment are a growing part of evidence-based health care throughout the healing professions, more studies are needed that evaluate patient responses to therapy. There have been over 2,000 papers in 40 Annual Yearbooks published by members of the ICAK, taking the organization from its infancy toward its maturity.
Chiropractic Name Techniques in Canada: A Continued Look at Demographic Trends and Their Impact on Issues of Jurisprudence, Gleberzon BJ.	*J Can Chiropr Assoc* 2002; 46(4): 241-56. **Abstract:** In a previous article, the author reported on the recommendations gathered from student projects between 1996-1999 investigating their preferences for including certain chiropractic Name technique systems into the curriculum at the Canadian Memorial Chiropractic College (CMCC). These results were found to be congruent with the professional treatment techniques used by Canadian chiropractors. This article reports on date obtained during the 2002 and 2001 academic years, comparing these results to those previously gathered. In addition, because of the implementation of a new curriculum during this time period, there was a unique opportunity to observe whether or not student perceptions differed between those students in the 'old' curricular program , and those students in the 'new' curricular program. The results gathered indicate that students in both curricular programs show an interest in learning Thompson Terminal Point, Activator Methods, Gonstead, and Active Release Therapy techniques in the core curriculum, as an elective, or during continuing educational programs provided by the college. Students continue to show less interest in learning CranioSacral Therapy, Sacro Occipital Technique, Logan Basic, Applied Kinesiology and Chiropractic BioPhysics. Over time, student interest has moved away from Palmer HIO and other upper cervical techniques, and students show a declining interest in being offered instruction in either Network Spinal Analysis or Torque Release Techniques. Since these findings reflect the practice activities of Canadian chiropractors they may have implications not only towards pedagogical decision-making process at CMCC, but may also influence professional standards of care.
Effects of osteopathic manipulative treatment and concentric and eccentric maximal-effort exercise on women with multiple sclerosis: a pilot study. Yates HA, Vardy TC, Kuchera ML, Ripley BD, Johnson JC.	*J Am Osteopath Assoc.* 2002 May;102(5):267-75. **Abstract:** The research objectives of this study were to evaluate the effects of osteopathic manipulative treatment (OMT) combined with maximal-effort exercise (MEE) on strength, coordination, endurance, and fatigue in female patients with multiple sclerosis (MS). Seven female subjects with MS participated in the 12-week study, which included intervention with OMT and MEE twice per week. Standardized tests for progression of MS and fatigue were used. Strength (maximal effort and impulse) was measured with the IsoPump exercise machine (IsoPump USA, Cleveland, Miss) during the three phases of the exercise protocol. Significant changes occurred in all but one measure of strength and on the 25-foot walk ($P < .05$), but not on the block-and-box test. The change in fatigue scores was not significantly different. Findings indicate that OMT combined with MEE significantly increases strength and ambulatory levels while not increasing fatigue in female patients with MS who have low to medium impairment. Qualitative data show that this intervention also produces beneficial effects in activities of daily living.
Patients using chiropractors in North America: who are they, and why are they in chiropractic care? Coulter ID,	*Spine.* 2002 Feb 1;27(3):291-6; discussion 297-8. **SUMMARY OF BACKGROUND DATA AND OBJECTIVES:** Alternative health care was used by an estimated 42% of the U.S. population in 1997, and chiropractors accounted for 31%

Hurwitz EL, Adams AH, Genovese BJ, Hays R, Shekelle PG.	of the total estimated number of visits. Despite this high level of use, there is little empirical information about who uses chiropractic care or why. **METHODS:** The authors surveyed randomly sampled chiropractors (n = 131) at six study sites and systematically sampled chiropractic patients seeking care from participating chiropractors on 1 day (n = 1275). Surveys collected data about the patient's reason for seeking chiropractic care, health status, health attitude and beliefs, and satisfaction. In addition to descriptive statistics, the authors compared data between patients and chiropractors, and between patients and previously published data on health status from other populations, corrected for the clustering of patients within chiropractors. **RESULTS:** More than 70% of patients specified back and neck problems as their health problem for which they sought chiropractic care. Chiropractic patients had significantly worse health status on all SF-36 scales than an age- and gender-matched general population sample. Compared with medical back pain patients, chiropractic back pain patients had significantly worse mental health (6-8 point decrement). Roland-Morris scores for chiropractic back pain patients were similar to values reported for medical back pain patients. The health attitudes and beliefs of chiropractors and their patients were similar. Patients were very satisfied with their care. **CONCLUSION:** These data support the theory that patients seek chiropractic care almost exclusively for musculoskeletal symptoms and that chiropractors and their patients share a similar belief system.
Relationship between levator ani contraction and motor unit activation in the urethral sphincter. Kenton K, Brubaker L.	*Am J Obstet Gynecol.* 2002 Aug;187(2):403-6. **OBJECTIVE:** The purpose of this study was to evaluate the relationship between levator ani contraction and motor unit action potential activation in the striated urethral sphincter. **STUDY DESIGN:** One hundred eight women who underwent preoperative evaluation at our referral center were studied. All women gave a urogynecologic history and underwent physical examination, multichannel urodynamic testing, and urethral sphincter electromyography. **Manual muscle testing was used to grade levator ani contractions as poor, moderate, or strong**; quantitative electromyography software was used to analyze motor unit action potential activation in the urethral sphincter. **RESULTS:** Levator ani contractions were graded as poor in 46% of the women, moderate in 31% of the women, and strong in 23% of the women. **Manual muscle grade was not related to quantitative electromyography values in the urethral sphincter at rest or with voluntary pelvic floor contraction. Poor manual muscle grade was associated with detrusor instability (P =.004) and more advanced stages of prolapse (P =.037).** Levator ani strength was not significantly related to age, genuine stress incontinence, urethrovesical junction hypermobility, menopausal status, or surgical cure rates. **CONCLUSION:** The ability to contract the levator ani does not appear to be related to the ability to activate motor unit action potentials in the urethral sphincter, which suggests that the function of the levator ani in maintaining urinary continence is independent from the role of the urethral sphincter.
Sensible manual muscle strength testing to evaluate and monitor strength of the intrinsic muscles of the hand: a commentary. Brandsma JW, Schreuders TA.	*J Hand Ther. 20*01 Oct-Dec;14(4):273-8. **Abstract:** Hand therapists often assess, evaluate, and monitor the status of, and changes in the strength of, the intrinsic muscles of the hand. Some common indications are peripheral and central neuropathies and nerve lacerations and repairs. The therapist will often use a muscle chart that lists all the muscles innervated by the ulnar and median nerves, and all muscles will be tested. Not all muscles in the hand can be sufficiently isolated to grade their strength, nor is it always necessary to test all muscles innervated by a particular nerve to evaluate the presence or extent of motor function impairment or monitor changes. This paper discusses the tests by which changes in strength of the ulnar and median innervated intrinsic muscles can be assessed and the reasons that certain muscles cannot or need not be tested. Information about the reliability of muscle testing is also given.
Electromyographic reflex response to mechanical force,	*Spine,* 2001;26:1117-24

manually-assisted spinal manipulative therapy, Colloca CJ, Keller TS.	(http://www.journals.elsevierhealth.com/periodicals/ymmt/medline/record/MDLN.11413422) **Study Design:** Surface electromyographic reflex responses associated with mechanical force, manually assisted (MFMA) spinal manipulative therapy were analyzed in this prospective clinical investigation of 20 consecutive patients with low back pain. **Objectives:** To characterize and determine the magnitude of electromyographic reflex responses in human paraspinal muscles during high loading rate mechanical force, manually assisted spinal manipulative therapy of the thoracolumbar spine and sacroiliac joints. **Summary of Background Data:** Spinal manipulative therapy has been investigated for its effectiveness in the treatment of patients with low back pain, but its physiologic mechanisms are not well understood. Noteworthy is the fact that spinal manipulative therapy has been demonstrated to produce consistent reflex responses in the back musculature; however, no study has examined the extent of reflex responses in patients with low back pain. **Methods:** Twenty patients (10 male and 10 female, mean age 43.0 years) underwent standard physical examination on presentation to an outpatient chiropractic clinic. After repeated isometric trunk extension strength tests, short duration (<5 msec), localized posteroanterior manipulative thrusts were delivered to the sacroiliac joints, and L5, L4, L2, T12, and T8 spinous processes and transverse processes. Surface, linear-enveloped electromyographic (sEMG) recordings were obtained from electrodes located bilaterally over the L5 and L3 erector spinae musculature. Force-time and sEMG time histories were recorded simultaneously to quantify the association between spinal manipulative therapy mechanical and electromyographic response. A total of 1600 sEMG recordings were analyzed from 20 spinal manipulative therapy treatments, and comparisons were made between segmental level, segmental contact point (spinous vs. transverse processes), and magnitude of the reflex response (peak-peak [p-p] ratio and relative mean sEMG). Positive sEMG responses were defined as >2.5 p-p baseline sEMG output (>3.5% relative mean sEMG output). SEMG threshold was further assessed for correlation of patient self-reported pain and disability. **Results:** Consistent, but relatively localized, reflex responses occurred in response to the localized, brief duration MFMA thrusts delivered to the thoracolumbar spine and SI joints. The time to peak tension (sEMG magnitude) ranged from 50 to 200 msec, and the reflex response times ranged from 2 to 4 msec, the latter consistent with intraspinal conduction times. Overall, the 20 treatments produced systematic and significantly different L5 and L3 sEMG responses, particularly for thrusts delivered to the lumbosacral spine. Thrusts applied over the transverse processes produced more positive sEMG responses (25.4%) in comparison with thrusts applied over the spinous processes (20.6%). Left side thrusts and right side thrusts over the transverse processes elicited positive contralateral L5 and L3 sEMG responses. When the data were examined across both treatment level and electrode site (L5 or L3, L or R), 95% of patients showed positive sEMG response to MFMA thrusts. Patients with frequent to constant low back pain symptoms tended to have a more marked sEMG response in comparison with patients with occasional to intermittent low back pain. **Conclusions:** This is the first study demonstrating neuromuscular reflex responses associated with MFMA spinal manipulative therapy in patients with low back pain. Noteworthy was the finding that such mechanical stimulation of both the paraspinal musculature (transverse processes) and spinous processes produced consistent, generally localized sEMG responses. Identification of neuromuscular characteristics, together with a comprehensive assessment of patient clinical status, may provide for clarification of the significance of spinal manipulative therapy in eliciting putative conservative therapeutic benefits in patients with pain of musculoskeletal origin.
Sensory motor control of the lower back: implications for rehabilitation, Ebenbichler, G, Oddsson, L, Kollmitzer, J, Erim, Z.	*Med Sci Sports Exer,* 2001;33:1889-98 This paper described a series of studies that have been done investigating the surface electromyography (SEMG) fatigue pattern of the back muscles during submaximal contraction. SEMG changes correlated with erector muscle fatigue, validating the subjective erector muscle endurance tests against the objective SEMG. Given the results of this study, a larger double-blind study of SEMG evaluation compared to manual muscle testing could be done, wherein back muscles strength and endurance time during testing are measured before and after a course of

	chiropractic care.
Cervical mobilisation: concurrent effects on pain, sympathetic nervous system activity and motor activity. Sterling M, Jull G, Wright A.	*Man Ther.* 2001 May;6(2):72-81. **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=<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. **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.
Ischemia causes muscle fatigue, Murthy, G, Hargens, A, Lehman, S, Rempel, D.	*J Orthop Res,* 2001;19:436-440 The purpose of this investigation was to determine whether ischemia, which reduces oxygenation in the extensor carpi radialis (ECR) muscle, causes a reduction in muscle force production. In eight subjects, muscle oxygenation (TO_2) of the right ECR was measured noninvasively and continuously using near infrared spectroscopy (NIRS) while muscle twitch force was elicited by transcutaneous electrical stimulation (1 Hz, 0.1 ms). Baseline measurements of blood volume, muscle oxygenation and twitch force were recorded continuously, then a tourniquet on the upper arm was inflated to one of five different pressure levels: 20, 40, 60 mm Hg (randomized order) and diastolic (69 ± 9.8 mm Hg) and systolic (106 ± 12.8 mm Hg) blood pressures. Each pressure level was maintained for 3–5 min, and was followed by a recovery period sufficient to allow measurements to return to baseline. For each respective tourniquet pressure level, mean TO_2 decreased from resting baseline (100% TO_2) to 99 ± 1.2% (SEM), 96 ± 1.9%, 93 ± 2.8%, 90 ± 2.5%, and 86 ± 2.7%, and mean twitch force decreased from resting baseline (100% force) to 99 ± 0.7% (SEM), 96 ± 2.7%, 93 ± 3.1%, 88 ± 3.2%, and 86 ± 2.6%. Muscle oxygenation and twitch force at 60 mm Hg tourniquet compression and above were significantly lower (P<0.05) than baseline value. Reduced twitch force was correlated in a dose-dependent manner with reduced muscle oxygenation (r=0.78,P<0.001). Although the correlation does not prove causation, the results indicate that ischemia leading to a 7% or greater reduction in muscle oxygenation causes decreased muscle force production in the forearm extensor muscle. Thus, ischemia associated with a modest decline in TO_2 causes muscle fatigue.
Understanding work-related upper extremity disorders: clinical findings in 485 computer users, musicians, and others. Pascarelli EF, Hsu YP.	*J Occup Rehabil.* 2001 Mar;11(1):1-21. **Abstract:** Four hundred eighty five patients whose chief complaints were work related pain and other symptoms received a comprehensive upper-body clinical evaluation to determine the extent of their illness. The group had a mean age of 38.5 years. Sixty-three percent of patients were females. Seventy percent were computer users, 28% were musicians, and 2% were others engaged in repetitive work. The time between the onset of symptoms and our initial visit ranged from 2 weeks to over 17 years. A majority sought care within 30 months with the greatest

	number of them seeking care before 12 months. Fifty nine percent of subjects were still working when seen despite increasing pain and symptoms such as weakness, numbness, tingling, and stiffness. Following a history, a physical assessment utilizing commonly employed clinical tests were performed including evaluation of joint range of motion, hyperlaxity, muscle tenderness, pain, strength, and imbalance. Neurologic tests included Tinel's sign performed in wrist, elbow, tricipital sulcus, and neck and tests for thoracic out syndrome (TOS). Specific tests such as Finkelstein's test for deQuervain's tenosynovitis, Phalen's test for carpal tunnel syndrome and grip strengths were included in the examination protocol. Significant findings included postural misalignment with protracted shoulders (78%), head forward position (71%), neurogenic TOS (70%), cervical radiculopathy (0.03%), evidence of sympathetic dysfunction (20%), and complex regional pain syndrome (RSD) (0.6%). Hyperlaxity of fingers and elbows was found in over 50%, carpal tunnel syndrome in 8%, radial tunnel syndrome in 7%, cubital tunnel in 64%, shoulder impingement in 13%, medial epicondylitis in 60%, lateral epicondylitis in 33%, **and peripheral muscle weakness in 70%.** We conclude that despite initial presentation distally, work-related upper-extremity disorders are a diffuse neuromuscular illness with significant proximal upper-body findings that affect distal function. While neurogenic TOS remains a controversial diagnosis, the substantial number of patients with positive clinical findings in this study lends weight to the concept that posture related neurogenic TOS is a key factor in the cascading series of physical events that characterize this illness. A comprehensive upper-body examination produces findings that cannot be obtained through laboratory tests and surveys alone and lays the ground work for generating hypotheses about the etiology of work related upper-extremity disorders that can be tested in controlled investigations.
Physiology of human lymphatic contractility: a historical perspective, Gashev AA, Zawieja DC.	*Lymphology.* 2001 Sep;34(3):124-34. **Abstract:** The lymphatic system is a transport system that has important roles in fluid/macromolecule homeostasis, lipid absorption, metastasis and immune function. It accomplishes these roles via the generation of a regulated lymph circulation which is dependent upon valves and pumps to overcome the normal fluid pressure gradients. Lymphatic contractility plays crucial roles in the regulation and generation of lymph transport. Whereas our understanding of lymphatic contractility in humans is somewhat limited, a number of studies both in situ and in vitro have provided important insights into the presence and modulation of lymphatic contractility. These studies have clearly demonstrated that lymphatic vessels from a number of different human tissues possess both tonic and phasic changes in contractility. These changes in contractility are presumably involved in the generation and regulation of lymph flow. It has been shown that human lymphatic contractility can be influenced by a number of neural and humoral agents as a means to control lymph transport. However our understanding of the physical and chemical factors which regulate both the spontaneous pumping activity and the vessel tone are more limited. An understanding of the factors which regulate human lymph transport could provide valuable information on human biology that could be of benefit to the treatment and prevention of diseases.
Active therapy for chronic low back pain: part 3. Factors influencing self-rated disability and its change following therapy. Mannion AF, Junge A, Taimela S, Müntener M, Lorenzo K, Dvorak J.	*Spine.* 2001 Apr 15;26(8):920-9. **DESIGN:** Cross-sectional analysis of the factors influencing self-rated disability associated with chronic low back pain and prospective study of the relationship between changes in each of these factors and in disability following active therapy. **OBJECTIVES:** To examine the relative influences of pain, psychological factors, and physiological factors on self-rated disability. **SUMMARY OF BACKGROUND DATA:** In chronic LBP, the interrelationship between physical impairment, pain, and disability is particularly complicated, due to the influence of various psychological factors and the lack of unequivocal methods for assessing impairment. Investigations using new "belief" questionnaires and "sophisticated" performance tests, which have shown promise as discriminating measures of impairment, may assist in clarifying the situation. Previous studies have rarely investigated all these factors simultaneously. **METHODS:** One hundred forty-eight patients with cLBP completed questionnaires and underwent tests of

	mobility, strength, muscle activation, and fatigability, and (in a subgroup) erector spinae size and fiber size/type distribution. All measures were repeated after 3 months active therapy. Relationships between each factor and self-rated disability (Roland and Morris questionnaire) at baseline, and between the changes in each factor and changes in disability following therapy, were examined. **RESULTS:** Stepwise linear regression showed that the most significant predictors of disability at baseline were, in decreasing order of importance: pain; psychological distress; fear-avoidance beliefs; muscle activation levels; lumbar range of motion; gender. Only changes in pain, psychological distress, and fear-avoidance beliefs significantly accounted for the changes in disability following therapy. **CONCLUSION:** A combination of pain, psychological and physiological factors was best able to predict baseline disability, although its decrease following therapy was determined only by reductions in pain and psychological variables. The active therapy program-in addition to improving physical function-appeared capable of modifying important psychological factors, possibly as a result of the positive experience of completing the prescribed exercises without undue harm. **Comment:** Mannion et al suggest that faulty motor control is the most likely source of the approximately 50% of LBP syndromes that are still unexplained. Lewit confirms this by stating that this functional pathology of the motor system is the most common clinical finding in pain patients presenting to orthopedists, rheumatologists, and neurologists, yet it is routinely overlooked in clinical medical practice.
Spinal manipulation causes variable spine kinematic and trunk muscle electromyographic responses, Lehman GJ, McGill SM.	*Clin Biomech* (Bristol, Avon). 2001 May;16(4):293-9. **STUDY DESIGN:** Analytic cohort with a convenience sample in a research clinic. **OBJECTIVES:** To determine the influence of a spinal manipulation on trunk kinematics and associated trunk myoelectric activity. **SUMMARY OF BACKGROUND:** While the mechanism of spinal manipulation is unknown, it has been theorized to influence spinal range of motion and trunk muscle activity. **METHODS:** Trunk kinematics were measured in low back pain patients (n = 14) during simple range of motion tasks in three planes, while trunk muscle electromyogram signals were recorded bilaterally from paraspinal and abdominal musculature. Kinematics and electromyogram signals were assessed pre-post manipulation. Electromyogram activity was also assessed pre-post manipulation during quiet stance. **RESULTS:** While no consistent kinematic or electromyographic changes occurred following manipulation across the population, individual changes were observed. **The largest changes (> 6 degrees) in range of motion occurred in the sagittal plane of three patients experiencing the greatest amount of pain. During quiet stance 17 muscles across all subjects exhibited changes in muscle activity following manipulation.** Sixteen of those changes were decreases in muscle amplitude. **CONCLUSIONS:** This study offers some preliminary data on the short-term effects of manipulation on lumbar range of motion and dynamic electromyogram. The findings suggest that the response to manipulation is variable and dependent on the individual, with no change in some to the largest changes seen in the more pained patients. Relevance. Basic science investigations into the mechanisms and biomechanical influences of spinal manipulation are few. This study attempts to address issues of measureable functional change with manipulative therapy. **Comment:** This study shows that measurable changes in muscle function occur immediately after spinal manipulation.
Prevalence of nonmusculoskeletal complaints in chiropractic practice: report from a practice-based research program, Hawk C, Long CR, Boulanger KT. -- Palmer Center for	*J Manipulative Physiol Ther.* 2001 Mar-Apr;24(3):157-69. **OBJECTIVE:** To identify patient and practice characteristics that might contribute to people's seeking chiropractic care for nonmusculoskeletal complaints. **DESIGN:** This was a cross-sectional study conducted through the methods of practice-based research. **SETTING:** Data were collected in 1998--1999 in chiropractic offices in the United States, Canada, and Australia; data were managed by a practice-based research office operating in a chiropractic research center. **POPULATION:** The subjects were new and established patients of all ages who visited the participating offices during a designated data collection week. **DATA ANALYSIS:** Multiple logistic regression was used to examine factors associated with patients' presenting for

Chiropractic Research, Davenport, Iowa 52803, USA.	nonmusculoskeletal chief complaints. Pearson's chi(2) test was used to examine associations among practice variables and the proportion of patients with nonmusculoskeletal chief complaints. **RESULTS:** A total of 7651 patients of 161 chiropractors in 110 practices in 32 states and 2 Canadian provinces participated; data from 2 Australian practices were included in the totals but not in the analysis. Nonmusculoskeletal complaints accounted for 10.3% of the chief complaints. The following characteristics made patients more likely to present with nonmusculoskeletal chief complaints: being less than 14 years of age (adjusted odds ratio [AOR], 6.9; 95% CI, 5.2--9.1); being female (AOR, 1.5; CI, 1.3--1.8); presenting in a small town/rural location (AOR, 1.9; CI, 1.3--2.7); reporting more than 1 complaint, especially nonmusculoskeletal complaints (AOR, 4.9; CI, 3.9--6.0); having received medical care for the chief complaint (AOR, 3.4; CI, 2.9--4.1); and having first received chiropractic care before 1960 (AOR, 1.7; CI, 1.1--2.4). Practices with the highest proportion of patients with nonmusculoskeletal chief complaints (>17%) were less likely to accept insurance and more likely to be in locations with populations greater than 100,000. They used the most common chiropractic adjustive techniques less frequently and used more nonadjustive procedures, especially diet/nutrition counseling, nutritional supplementation, herbal preparations, naturopathy, and homeopathy. **CONCLUSIONS:** Drawing on practices with the patient and practice characteristics identified in this study to conduct outcomes studies on nonmusculoskeletal conditions is a possible direction for future research. **Comment:** Applied kinesiologists theorize that specific muscles are associated with specific areas of the body. There are organ-muscle, gland-muscle, meridian-muscle, spine-muscle, and reflex-muscle relationships. (The relationships between specific spinal nerves and specific muscles are taught in neurology textbooks.) AK MMT offers a simple, non-invasive method of functional diagnosis that incorporates many other chiropractic, osteopathic, cranial, nutritional, manual medicine, and Traditional Chinese Medicine assessment methods, all of which are based on the traditional and foundational principles of chiropractic health care. AK combines many existing therapies into one inseparable system of health care, making AK a foundation stone for non-crisis care functional medicine.
Comparison of effects of spinal manipulation and massage on motoneuron excitability, Dishman J, Bulbulian R.	*Electromyogr Clin Neurophysiol.* 2001;41:97-106 **Abstract:** The purpose of this study was to compare the magnitude and duration of motoneuron inhibition occurring as a sequel to spinal manipulation or paraspinal and limb massage. The physiologic mechanisms involved in spinal manipulative therapy and massage therapy are largely unknown. One possible hypothesis is based upon the theory that these two distinct and different modalities may attenuate the activity of alpha motoneurons. Both modalities have been reported to produce short-term inhibition of motoneurons. Asymptomatic volunteers were randomly assigned to either a spinal manipulation, massage, or control group. Baseline tibial nerve H-reflex amplitudes were obtained prior to the application of either lumbosacral spinal manipulation or paralumbar and limb massage. Post-interventional H-reflex recordings were recorded immediately following the application of either modality. Spinal manipulation significantly ($p < 0.05$) attenuated alpha motoneuronal activity immediately post-therapy, as measured by the amplitude of the tibial nerve H-reflex. Massage subjects exhibited no significant reduction in motoneuronal activity immediately following administration. Spinal manipulation produced a transient attenuation of alpha motoneuronal excitability. Paraspinal and limb massage did not inhibit the motoneuron pool as measured immediately post-therapy. These findings support the supposition that spinal manipulation procedures lead to short-term inhibitory effects on motoneuron excitability to a greater magnitude than massage.
Relationship between hip muscle imbalance and occurrence of low back pain in collegiate athletes: a prospective study, Nadler SF, Malanga GA, Feinberg JH,	*Am J Phys Med Rehabil.* 2001 Aug;80(8):572-7. **OBJECTIVE:** To assess whether athletes with strength imbalance of the hip musculature would be more likely to require treatment for low back pain (LBP) over the ensuing year. **DESIGN:** The study population included 163 National Collegiate Athletic Association Division I college athletes (100 males and 63 females) undergoing preparticipation sports physicals. Institutional

Prybicien M, Stitik TP, DePrince M.	review board approval was obtained to acquire and analyze hip muscle strength data. A commercially available dynamometer (Chatillon, Lexington, KY) incorporated into a specially designed anchoring station was used for testing the hip extensors and abductors. The maximum force generated for the hip abductors and extensors was used to calculate a percentage difference between the right and left hip extensors and abductors. Treatment of athletes by the athletic trainers for LBP unrelated to blunt trauma over the ensuing year was recorded. **RESULTS:** Of all athletes, 5 of 63 females and 8 of 100 males required treatment for LBP. Logistic regression analysis indicated that for female athletes, the percentage difference between the right and left hip extensors was predictive of whether treatment for LBP was required over the ensuing year (P = 0.05). There was no significant association noted for the percentage difference between the right and left hip abductors in females and for the percentage difference between both the right and left hip abductors and right and left hip extensors in males requiring treatment for LBP. **CONCLUSIONS:** These data support our results from our previous cohort study, **adding validity to the concept of hip muscle imbalance being associated with LBP occurrence in female athletes. This research further supports the need for the assessment and treatment of hip muscle imbalance in individuals with LBP.** **Comment:** The correlation between "inhibited" or "weak" MMT findings and low back pain has been established in much of the research literature. This paper shows that there is a construct validity and reliability in employing MMT testing in patients with low back pain.
Measuring knee extensor muscle strength, Bohannon RW. -- Department of Physical Therapy, School of Allied Health, University of Connecticut, Storrs 06269-2101, USA.	*Am J Phys Med Rehabil.* 2001 Jan;80(1):13-8. **OBJECTIVE:** To compare manual muscle test with hand-held dynamometer measurements of knee extension strength. A secondary analysis of measurements (n = 256 knees) from 128 acute rehabilitation patients was performed. **DESIGN:** Knee extensor muscle testing was conducted according to the technique of Hislop and Montgomery; 0 to 5 grades were converted to an expanded 0 to 12 scale. Dynamometry was used to measure the isometric knee extension force with 'gravity eliminated.' **RESULTS:** Manual muscle test and dynamometer measures were highly correlated (r = 0.768; P < 0.001); the correlation was higher when the quadratic nature of the relationship was taken into account (R = 0.887; P < 0.001). Although the dynamometer forces that were associated with different manual muscle test grades differed overall (F = 67.736; P < 0.001), the forces associated with some of the higher grades did not differ statistically. **CONCLUSIONS:** These findings reinforce the convergent construct validity of the manual muscle test and dynamometry measurements but challenge the discriminant construct validity of manual muscle testing. An alternative manual muscle testing grading scheme is suggested that provides for discriminant validity and retains convergent validity.
Effect of knee joint effusion on quadriceps and soleus motoneuron pool excitability, Hopkins JT, Ingersoll CD, Krause BA, Edwards JE, Cordova ML.	*Med Sci Sports Exerc,* 2001 Jan;33(1):123-6. **PURPOSE:** To examine changes in quadriceps and soleus MN pool activity resulting from knee joint effusion over a 4-h period and assess the relationship between the muscles. **METHODS:** A repeated measures before-after trial design was used for this study. Eight, neurologically sound volunteers (age 23.3+/-2.1 yr, height 171.8+/-15.9 cm, mass 65.5+/-17.7 kg) participated in this study. An area superomedial to the patella was cleaned and anesthetized, and 30 mL of sterile saline was injected into the knee joint capsule to mimic mechanical joint effusion. The Hoffman reflex (H-reflex) was elicited by applying a percutaneous stimulus to the appropriate nerve and recording the response through surface electromyography. Soleus and vastus medialis H-reflex measures were collected from each volunteer before, at 30 min, 90 min, 150 min, and 210 min intervals over a 4-h period after knee effusion. **RESULTS:** All soleus H-reflex measures after effusion (30 min 5.89+/-0.92 V; 90 min 6.16+/-0.48 V; 150 min 6.59+/-0.50 V; 210 min 6.70+/-0.56 V) were increased in relation to the preeffusion measure (5.01+/-0.79 V). All vastus medialis H-reflex measures after effusion (30 min 4.23+/-0.94 V; 90 min 4.15 +/-1.11 V; 150 min 4.16+/-0.57 V; and 210 min 4.99+/-1.23) were decreased in relation to the preeffusion measure (5.88+/-1.44 V; P < or = 0.05). **CONCLUSIONS: Afferent activity from the knee joint capsule resulted in an inhibitory effect on the vastus medialis and a facilitatory effect**

	on the soleus. Facilitation of the soleus in cooperation with other lower extremity musculature could be **a mechanism for compensation of the inhibited quadriceps** to maintain lower kinetic chain function.
Delayed onset of electromyographic activity of vastus medialis obliquus relative to vastus lateralis in subjects with patellofemoral pain syndrome, Cowan SM, Bennell KL, Hodges PW, Crossley KM, McConnell J.	*Arch Phys Med Rehabil.* 2001 Feb;82(2):183-9. **OBJECTIVE:** To determine whether electromyographic (EMG) onsets of vastus medialis obliquus (VMO) and vastus lateralis (VL) are altered in the presence of patellofemoral pain syndrome (PFPS) during the functional task of stair stepping. **DESIGN:** Cross-sectional. **SETTING:** University laboratory. **PATIENTS:** Thirty-three subjects with PFPS and 33 asymptomatic controls. **INTERVENTIONS:** Subjects ascended and descended a set of stairs-2 steps, each 20-cm high-at usual stair-stepping pace. EMG readings of VMO and VL taken on middle stair during step up (concentric contraction) and step down (eccentric contraction). **MAIN OUTCOME MEASURES:** Relative difference in onset of surface EMG activity of VMO compared with VL during a stair-stepping task. EMG onsets were determined by using a computer algorithm and were verified visually. **RESULTS: In the PFPS population, the EMG onset of VL occurred before that of VMO in both the step up and step down phases of the stair-stepping task (p <.05). In contrast, no such differences occurred in the onsets of EMG activity of VMO and VL in either phase of the task for the control subjects**. **CONCLUSION:** This finding supports the hypothesized relationship between changes in the timing of activity of the vasti muscles and PFPS. This finding provides theoretical rationale to support physiotherapy treatment commonly used in the management of PFPS.
Quantitative study of muscle spindles in suboccipital muscles of human fetuses, Kulkarni V, Chandy MJ, Babu KS.	*Neurol India.* 2001 Dec;49(4):355-9. **Abstract:** The proprioceptive inputs from the cervical musculature play an important role in head-eye co-ordination and postural processes. Deep cervical muscles in humans are shown to have high spindle content. The density, distribution and morphology of muscle spindles were studied in superior oblique capitis, inferior oblique capitis and rectus capitis posterior major and minor three small suboccipital muscles. The muscles were obtained, post-mortem from stillborn human foetus. The spindle density was calculated as the ratio of mean spindle content to the mean wet weight of that muscle in grams. The distribution and arrangement of spindles within the muscle and their arrangement was studied. The spindle density of superior oblique muscle was found to be 190, that of inferior oblique was 242 and the rectus capitis posterior contained 98 spindles per gram of muscle. No tendon organs were seen. The serial transverse sections of inferior oblique muscle revealed muscle spindles of varying sizes, length varying between 100-650 microns and, diameter 50-250 microns. A complex parallel arrangement of group of large spindles were seen in the belly of the inferior oblique muscle, while the polar regions contain few small isolated spindles. The relevance of such high spindle receptor content in these tiny muscles is discussed. **Comment:** Postural instability in children may contribute to various learning and behavior problems, including attention deficit disorder and complex developmental disorders. Many children who fall within these categories will demonstrate significant posture and balance dysfunctions when carefully tested. More often than not, the postural deficit is related to a biomechanical dysfunction, which can be addressed with the proper manipulative therapy. More than 40% of the sensors relaying proprioceptive information are found in the cervical region. The suboccipital area is critically important to proprioception, and it is the area most frequently faulted in proprioceptive examination and treatment. Grostic, Sweat, and other upper cervical chiropractic researchers have shown that joint dysfunctions of even less than 1 mm can disturb cerebellar function, muscle function, body posture, leg length inequalities, and nociception.
Attachments from the Spinal Dura to the Ligamentum Nuchae: Incidence, MRI Appearance, and Strength of	*Proceedings of the 2000 International Conference of Spinal Manipulation* 2000;Sept:202-4 **Abstract:** The identification of attachments to the posterior spinal dura from the surrounding

Attachment, Kenin S, Humphreys BK, Hubbard B, Cramer GD	tissues in the cranio-cervical region by Von Lanz in 1929, may provide the key towards a better understanding of underlying mechanisms involved in chronic benign headaches as well as neck pain of unknown etiology. The recent findings of connective tissue attachments to the cervical spinal dura from muscles, ligament, and osseous elements have sparked increasing interest among clinicians and anatomists. However, studies of a large number of specimens or those evaluating the MRI appearance of these attachments have never been published. This study evaluated these attachments in 30 cadaveric spines and then correlated the MRI appearance of the attachments to their anatomic appearance on 4 of the specimens. This study identified a consistent connective tissue complex arising from within the substance of the ligamentum nuchae, between the occiput and axis, giving rise to 3 connective tissue bridges. Two of the connective tissue bridges attached to the posterior spinal dura while the third linked the rectus capitis posterior minor muscle to the ligamentum nuchae. Of significance were: (1) The attachment between the ligamentum nuchae and dura between C1-C2 are quite robust. (2) The attachments between the rectus capitis posterior minor and ligamentum nuchae usually exist. (3) The attachments between the ligamentum nuchae and dura mater can be identified on MRI scans. These attachments may have clinical significance in cervicogenic headache, vertigo, and flexion-extension (whiplash) injuries, making their MRI appearance clinically important.
Conservative lower back treatment reduces inhibition in knee-extensor muscles: a randomized controlled trial, Suter, E., McMorland, G., Herzog, W., Bray, R.	*J Manipulative Physiol Ther,* 2000;23:76-80 (http://www.journals.elsevierhealth.com/periodicals/ymmt/article/PIIS016147540090071X/abstract) **Background:** Knee-joint pathologies, such as anterior knee pain (AKP), are associated with strength deficits and reduced activation of the knee extensors, which is referred to as *muscle inhibition* (MI). MI is thought to prevent full functional recovery, and treatment modalities that help to reduce or eliminate MI appear necessary for successful rehabilitation. Clinical observations suggest that AKP is typically associated with sacroiliac (SI) joint dysfunction. It is unknown whether Sl-joint dysfunction contributes to knee-extensor deficits and whether correction of SI-joint dysfunction alleviates MI. **Objective:** The objective of this study was to assess whether conservative low back treatment reduces lower limb MI. **Study design:** In a randomized, controlled, double-blind study the effects of conservative lower back treatment on knee-extensor strength and MI were evaluated in patients with AKP. **Methods:** Twenty-eight patients with AKP were randomly assigned to either a treatment or a control group. After a lower back functional assessment, the treatment group received a conservative treatment in the form of a chiropractic spinal manipulation aimed at correcting SI-joint dysfunction. The control group underwent a lower back functional assessment but received no joint manipulation. Before and after the manipulation or the lower back functional assessment, knee-extensor moments, MI, and muscle activation during full effort, isometric knee extensions were measured. **Results:** Patients showed substantial MI in both legs. Functional assessment revealed SI-joint dysfunction in all subjects (23 symptomatic and 5 asymptomatic). After the SI-joint manipulation, a significant decrease in MI of 7.5% was observed in the involved legs of the treatment group. MI did not change in the contralateral legs of the treatment group or the involved and contralateral legs of the control group. There were no statistically significant changes in knee-extensor moments and muscle activation in either group. **Conclusions:** The results of this study suggest that SI-joint manipulation reduces knee-extensor MI. Spinal manipulation may possibly be an effective treatment of MI in the lower limb musculature.
Muscle response pattern to sudden trunk loading in healthy individuals and in patients with chronic low back pain, Radebold A, Cholewicki J, Panjabi MM,	*Spine*, 2000 Apr 15;25(8):947-54. **STUDY DESIGN:** A quick-release method in four directions of isometric trunk exertions was used to study the muscle response patterns in 17 patients with chronic low back pain and 17 matched control subjects. **OBJECTIVES:** It was hypothesized that patients with low back pain would react to sudden load release with a delayed muscle response and would exhibit altered

Patel TC.	muscle recruitment patterns. **SUMMARY OF BACKGROUND DATA:** A delay in erector spinae reaction time after sudden loading has been observed in patients with low back pain. Muscle recruitment and timing pattern play an important role in maintaining lumbar spine stability. **METHODS:** Subjects were placed in a semiseated position in an apparatus that provided stable fixation of the pelvis. They exerted isometric contractions in trunk flexion, extension, and lateral bending. Each subject performed three trials at two constant force levels. The resisted force was suddenly released with an electromagnet and electromyogram signals from 12 trunk muscles were recorded. The time delay between the magnet release and the shut-off or switch-on of muscle activity (reaction time) was compared between two groups of subjects using two-factor analysis of variance. **RESULTS:** The number of reacting muscles and reaction times averaged over all trials and directions showed the following results: For healthy control subjects a shut-off of agonistic muscles (with a reaction time of 53 msec) occurred before the switch-on of antagonistic muscles (with a reaction time of 70 msec). Patients exhibited a pattern of co-contraction, with agonists remaining active (3.4 out of 6 muscles switched off) while antagonists switched on (5.3 out of 6 muscles). Patients also had longer muscle reaction times for muscles shutting off (70 msec) and switching on (83 msec) and furthermore, their individual muscle reaction times showed greater variability. **CONCLUSIONS:** Patients with low back pain, in contrast to healthy control subjects, **demonstrated a significantly different muscle response pattern in response to sudden load release**. These differences **may either constitute a predisposing factor to low back injuries or a compensation mechanism to stabilize the lumbar spine**. **Comment:** Dr. Panjabi is the world's most published human biomechanical researcher, with 263 published articles to date. The hypothesis he and the other authors of this paper present places the functionality of muscles, as both a cause and a consequence in chronic back pain patients, at the center of a sequence of events that ultimately results in back pain. The role of the muscular system, as "the stabilizing system of the spine," has been investigated by Dr. Panjabi in numerous other papers.
Cervical muscle dysfunction in the chronic whiplash associated disorder grade II (WAD-II), Nederhand MJ, IJzerman MJ, Hermens HJ, Baten CT, Zilvold G.	*Spine.* 2000 Aug 1;25(15):1938-43. **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.

	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.
Motor control problems in patients with spinal pain: a new direction for therapeutic exercise, Jull GA, Richardson CA.	*J Manipulative Physiol Ther*, 2000 Feb;23(2):115-7. **Abstract:** Recent research into muscle dysfunction in patients with low back pain has led to discoveries of impairments in deep muscles of the trunk and back. **These muscles have a functional role in enhancing spinal segmental support and control. The muscle impairments are not those of strength but rather problems in motor control.** These findings call for a different approach in therapeutic exercise, namely a motor learning exercise protocol. The specific exercise approach has an initial focus on retraining the co-contraction of the deep muscles (i.e., the transversus abdominis and lumbar multifidus). Initial clinical trials point to the effectiveness of the approach in patients with both acute and chronic low back pain in terms of reducing the neuromuscular impairment and in control of pain. **Comment:** This study elegantly demonstrates that sensory and motor function is integrated, and that improper sequencing of muscle groups results in disjointed movement and pain. AK has argued from its founding that postural control is dependent upon the ability of the individual to properly interpret sensory information and execute an appropriate motor response. This study also demonstrates that both acute and chronic low back pain recovers more swiftly with specific treatments to the dysfunctional muscles.
Use of a mental rotation reaction-time paradigm to measure the effects of upper cervical adjustments on cortical processing: a pilot study, Kelly DD, Murphy BA, Backhouse DP.	*J Manipulative Physiol Ther.* 2000 May;23(4):246-51. **OBJECTIVES:** To investigate the potential usefulness of a mental rotation paradigm in providing an objective measure of spinal manipulative therapy. To determine if cortical processing, as indicated by response time to a mental rotation reaction-time task, is altered by an upper cervical toggle recoil adjustment. **DESIGN:** Prospective, double-blind, randomized, controlled trial. **SETTING:** Chiropractic college clinical training facility. **PARTICIPANTS:** Thirty-six chiropractic student volunteers with clinical evidence of upper cervical joint dysfunction. **INTERVENTION:** Participants in the experimental group received a high-velocity, low-amplitude upper cervical adjustment. A non-intervention group was used to control for improvement in the mental rotation task as a result of practice effects. Outcome measures: Reaction time was measured for randomly varying angular orientations of an object appearing either as normal or mirror-reversed on a computer screen. **RESULTS:** The average decrease in mental rotation reaction time for the experimental group was 98 ms, a 14.9% improvement, whereas the average decrease in mental rotation reaction time for the control group was 58 ms, an 8. 0 improvement. The difference scores after the intervention time were significantly greater for the experimental group compared with the control group, as indicated by a one-tailed, 2-sample, equal variance Student t test, ($P < 05$). **CONCLUSION:** The results of this study have demonstrated a significant improvement in a complex reaction-time task after an upper cervical adjustment. These results provide evidence that upper cervical adjustment may affect cortical processing. **Comment:** This study demonstrates another investigation into the potential motor control, proprioceptive response, and functional improvements resulting from chiropractic treatments.
Clinical Evaluation of the Athlete's Shoulder. Baker CL, Merkley MS.	*J Athl Train.* 2000 Jul;35(3):256-260. **OBJECTIVE:** To describe the history and physical examination of the athlete's shoulder. **BACKGROUND:** The complex, highly mobile shoulder joint is very susceptible to athletic injury. A comprehensive history and physical examination lay the groundwork for accurate decision making about the nature of the injury and the appropriate treatment plan.

	DESCRIPTION: In taking the history, inquire about the patient's lifestyle (dominant hand, occupation, sports, activity level) and then focus on the specific complaint. Ask about the location, quality, and nature of the pain and activities that provoke the pain. If stiffness is a factor, a review of systems and the patient's past medical history are important. Discuss any previously undertaken interventions and their effects. The physical examination consists of inspection, range of motion, palpation, **manual muscle testing**, and provocative tests. **CLINICAL ADVANTAGES:** Once the clinical evaluation has been completed, the nature of the injury will, in most cases, be apparent. If necessary, appropriate diagnostic tests are ordered, and then a treatment plan tailored to the athlete and the injury is instituted.
Reflex effects of subluxation: the autonomic nervous system, Budgell, B.S.	*J Manipulative Physiol Ther,* 2000;23(2):104-106 (http://www.journals.elsevierhealth.com/periodicals/ymmt/article/PIIS0161475400900769/abstract) **Background:** The collective experience of the chiropractic profession is that aberrant stimulation at a particular level of the spine may elicit a segmentally organized response, which may manifest itself in dysfunction within organs receiving autonomic innervation at that level. This experience is at odds with classic views of neuroscientists about the potential for somatic stimulation of spinal structures to affect visceral function. **Objective:** To review recent findings from basic physiologic research about the effects of somatic stimulation of spinal structures on autonomic nervous system activity and the function of dependent organs. **Data source:** Findings were drawn from a major recent review of the literature on the influences of somatic stimulation on autonomic function and from recent original physiologic studies concerning somatoautonomic and spinovisceral reflexes. **Conclusions:** Recent neuroscience research supports a neurophysiologic rationale for the concept that aberrant stimulation of spinal or paraspinal structures may lead to segmentally organized reflex responses of the autonomic nervous system, which in turn may alter visceral function. **Comment:** Within the spinal cord is the anterior and posterior horn. These horns are divided into five different lamina. The spinal tracts go up and down the spinal cord within these lamina. Lamina 2 holds the spinal tracts that supply and control the visceral organs. Lamina 5 holds the spinal tracts that control the muscles and the skin, carrying the nerve impulses that come from the muscles and skin. Neuro-anatomists have discovered a neuron that connects lamina 2 to lamina 5; it is called the alpha motor neuron. The alpha motor neuron connecting lamina 2 and 5 means that stimulation to the skin or a muscle will simultaneously affect the organs and vice versa. This is neurological, anatomical proof that the muscles, organs and skin, are connected together by the alpha motor neuron. AK physicians have found that they cannot treat one part of the body without affecting another part of the body, which validates what chiropractors and applied kinesiologists do. The MMT makes these types of connections (muscle-organ, muscle-gland, muscle-joint) evident to the patient.
Abnormalities of the soleus H-reflex in lumbar spondylolisthesis: a possible early sign of bilateral S1 root dysfunction, Mazzocchio R, Scarfo GB, Cartolari R, Bolognini A, Mariottini A, Muzii VF, Palma L.	*J Spinal Disord.* 2000 Dec;13(6):487-95. **Abstract:** Using routine electrodiagnostic procedures, the authors searched for physiologic evidence of nerve root compromise in patients with chronic mechanical perturbation to the lumbar spine. They examined 37 patients with spondylolisthesis and various degrees of degenerative changes in the lumbar canal. Clinical and neurophysiologic findings were compared with data obtained from 36 healthy persons. The soleus H-reflex appeared to be a sensitive indicator of sensory fiber compromise at the S1 root level, because changes correlated well with the focal sensory signs and preceded clinical and electromyographic signs of motor root involvement. When these occurred, the clinical findings were consistent with a more severe nerve root deficit and with radiographic evidence of neural compression. The greater sensitivity of the soleus H-reflex may be related to the pathophysiologic events that occur at the lesion site.
Spinal reflex attenuation	*Spine*, 2000 Oct 1;25(19):2519-24;discussion 2525.

associated with spinal manipulation, Dishman JD, Bulbulian R.	STUDY DESIGN: This study evaluated the effect of lumbosacral spinal manipulation with thrust and spinal mobilization without thrust on the excitability of the alpha motoneuronal pool in human subjects without low back pain. OBJECTIVES: To investigate the effect of high velocity, low amplitude thrust, or mobilization without thrust on the excitability of the alpha motoneuron pool, and to elucidate potential mechanisms in which manual procedures may affect back muscle activity. SUMMARY OF BACKGROUND DATA: The physiologic mechanisms of spinal manipulation are largely unknown. It has been proposed that spinal manipulation may reduce back muscle electromyographic activity in patients with low back pain. Although positive outcomes of spinal manipulation intervention for low back pain have been reported in clinical trials, the mechanisms involved in the amelioration of symptoms are unknown. METHODS: In this study, 17 nonpatient human subjects were used to investigate the effect of spinal manipulation and mobilization on the amplitude of the tibial nerve Hoffmann reflex recorded from the gastrocnemius muscle. Reflexes were recorded before and after manual spinal procedures. RESULTS: Both spinal manipulation with thrust and mobilization without thrust significantly attenuated alpha motoneuronal activity, as measured by the amplitude of the gastrocnemius Hoffmann reflex. This suppression of motoneuronal activity was significant ($P < 0.05$) but transient, with a return to baseline values exhibited 30 seconds after intervention. CONCLUSIONS: Both spinal manipulation with thrust and mobilization without thrust procedures produce a profound but transient attenuation of alpha motoneuronal excitability. **These findings substantiate the theory that manual spinal therapy procedures may lead to short-term inhibitory effects on the human motor system.** **Comment:** This study demonstrates that there is an immediate effect upon the motor system after spinal manipulative therapy. This factor has been consistently demonstrated in AK, and measuring the effect upon the motor system is made after every manipulative treatment. Clinical conditions involving hypotonicity, spasticity or hypertonicity are attributed to pathophysiologic abnormalities in the motor neuron system, and this study measures this state.
Integrated jaw and neck function in man. Studies of mandibular and head-neck movements during jaw opening-closing tasks, Zafar H.	*Swed Dent J Suppl,* 2000;(143):1-41. **Abstract:** This investigation was undertaken to test the hypothesis of a functional relationship between the human temporomandibular and craniocervical regions. Mandibular and head-neck movements were simultaneously recorded in healthy young adults using a wireless optoelectronic system for three dimensional movement recording. The subjects were seated in an upright position without head support and were instructed to perform maximal jaw opening-closing movements at fast and slow speed. As a basis, a study was undertaken to develop a method for recording and analysis of mandibular and head-neck movements during natural jaw function. A consistent finding was parallel and coordinated head-neck movements during both fast and slow jaw opening-closing movements. The head in general started to move simultaneously with or before the mandible at the initiation of jaw opening. Most often, the head attained maximum velocity after the mandible. A high degree of spatiotemporal consistency of mandibular and head-neck movement trajectories was found in successive recording sessions. The head movement amplitude and the temporal coordination between mandibular and head-neck movements were speed related but not the movement trajectory patterns. Examination of individuals suffering from temporomandibular disorders and whiplash associated disorders (WAD) showed, compared with healthy subjects, smaller amplitudes, a diverse pattern of temporal coordination but a similar high degree of spatiotemporal consistency for mandibular and head-neck movements. In conclusion, the results suggest the following: A functional linkage exists between the human temporomandibular and craniocervical regions. Head movements are an integral part of natural jaw opening-closing. "Functional jaw movements" comprise concomitant mandibular and head-neck movements which involve the temporomandibular, the atlanto-occipital and the cervical spine joints, caused by jointly activated jaw and neck muscles. Jaw and neck muscle actions are elicited and synchronized by neural commands in common for both the jaw and the neck motor systems. These commands are preprogrammed, particularly at fast speed. In the light of previous observations of concurrent jaw and head movements during

	foetal yawning, it is suggested that these motor programs are innate. Neural processes underlying integrated jaw and neck function are invariant both in short- and long-term perspectives. Integrated jaw and neck function seems to be crucial for maintaining optimal orientation of the gape in natural jaw function. Injury to the head-neck, leading to WAD may derange integrated jaw-neck motor control and compromise natural jaw function. **Comment:** In AK examination and treatment, the complexity of the TMJ apparatus is recognized. The TMJ is part of a complex system including the bones of the skull and cervical spine, the mandible and hyoid bone, the related muscle attachments and other soft tissues, and neurologic and vascular components. This complex is often referred to as the stomatognathic system. The use of AK methods, especially challenge and therapy localization, greatly assists the practitioner in finding concealed or hidden TMJ problems.
The craniocervical connection: a retrospective analysis of 300 whiplash patients with cervical and temporomandibular disorders, Friedman MH, Weisberg J.	*Cranio.* 2000 Jul;18(3):163-7. **Abstract:** Because the concept of whiplash as a causative factor for temporomandibular disorders (TMD) is highly controversial, we decided to do a retrospective analysis of patients treated in our office who had sustained whiplash injuries and were treated for cervical and temporomandibular disorders. The records of 300 patients with TMD preceded by a motor vehicle accident were examined retrospectively. The most common presenting symptoms, in order, were: jaw pain, neck pain, post-traumatic headache, jaw fatigue, and severe temporomandibular joint (TMJ) clicking. The most common TMD diagnoses were: masseter trigger points, closing jaw muscle hyperactivity, TMJ synovitis, opening jaw muscle hyperactivity, and advanced TMJ disk derangement. Based primarily on the physical examination, we concluded that the TMJ and surrounding musculature should be examined similarly to other joints, with no preconceived notion that TMD pathology after whiplash is unlikely.
EMG and strength correlates of selected shoulder muscles during rotations of the glenohumeral joint, David G, Magarey ME, Jones MA, Dvir Z, Turker KS, Sharpe M.	*Clin Biomech (Bristol, Avon).* 2000 Feb;15(2):95-102. **OBJECTIVE:** To identify activation patterns of several muscles acting on the shoulder joint during isokinetic internal and external rotation. **DESIGN:** Combined EMG and isokinetic strength analysis in healthy subjects. **BACKGROUND:** EMG studies of the shoulder region revealed intricate muscular activation patterns during elevation of the arm but no parallel studies regarding pure rotations of the joint could be located. **METHODS:** Fifteen (n=30 shoulders) young, asymptomatic male subjects participated in the study. Strength production during isokinetic concentric and eccentric internal and external rotations at 60 and 180 degrees /s was correlated with the EMG activity of the rotator cuff, biceps, deltoid and pectoralis major. Analysis of the smoothed EMG related to the timing of onset of the signal and to the normalized activity at the angle of the peak moment. Determination of the association between the EMG and the moment was based on strength ratios. **RESULTS:** Findings indicated that for both types of rotations, the rotator cuff and biceps were active 0.092+/-0.038-0.215+/-0.045 s prior to the initiation of the actual movement and 0.112-0.034 s prior to onset of deltoid and pectoralis major activity. These differences were significant in all of the eight conditions ($P<0.05$). In terms of the strength ratios, strong association was found between electrical activity and moment production in the subscapularis and infraspinatus ($r(2)=0.95$ and 0. 72, respectively) at the low and high angular velocities. **CONCLUSIONS:** Prior to actual rotation of the shoulder joint, normal recruitment of the rotator cuff and biceps is characterized by a non-specific presetting phase which is mainly directed at enhancing the joint 'stiffness' and hence its stability. Once movement is in progress, the EMG patterns of these muscles become movement specific and are correlated with the resultant moment. **RELEVANCE:** Muscular dysfunction relating to delayed onset activity or altered activation patterns, due to pain, perturbed mechanics or disturbed neural activation have been implicated as concomitant factors in other joint associated pathologies. Through highlighting the role of the rotator cuff in shoulder joint rotations, this study lends further support to the argument that a parallel situation may prevail with respect to shoulder joint dysfunction. This could lead to the development of rehabilitation protocols aimed specifically at

	redressing such dysfunction.
Muscle force measured using "break" testing with a hand-held myometer in normal subjects aged 20 to 69 years, Phillips BA, Lo SK, Mastaglia FL. -- Centre for Neuromuscular and Neurological Disorders, University of Western Australia, Australian Neuromuscular Research Institute, Perth.	*Arch Phys Med Rehabil.* 2000 Oct;81(10):1442-3. **OBJECTIVE:** To measure the strength of 17 muscle groups in the upper and lower extremities in a large group of healthy subjects using "break" testing with a hand-held myometer, and to examine the intrasession and intersession reliability of the testing protocol. **SUBJECTS AND INSTRUMENTATION:** A convenience sample of 20 men and 20 women in each decade of age from 20 to 69 years (n = 200) was tested using a Penny & Giles hand-held myometer. **RESULTS:** Reliability coefficients were >.85 for both intrasession and intersession reliability, except for the ankle dorsiflexors. Men exerted a significantly greater force than women for all muscle groups. Age, weight, and side of testing were significant predictors of force in the majority of muscle groups. The fifth percentile values, as the lower limit of normal, are reported separately for gender and side of testing for each decade of age. **CONCLUSION:** Using the testing protocol specified in this study, data from patients with various neuromuscular diseases may be compared with the appropriate gender- and age-matched normal data to accurately identify the presence of weakness.
Hand-held dynamometry reliability in persons with neuropathic weakness, Kilmer DD, McCrory MA, Wright NC, Rosko RA, Kim HR, Aitkens SG. -- Department of Physical Medicine and Rehabilitation, School of Medicine, University of California, Davis, USA.	*Arch Phys Med Rehabil.* 2000 Nov;81(11):1538-9. **OBJECTIVE:** To determine test-retest reliability of hand-held dynamometry (HHD) in measuring strength of persons with neuropathic weakness. **DESIGN:** Intratester and intertester reliability of HHD-measured strength over a 7- to 10-day period. In addition, HHD knee strength was compared with criterion standard of fixed dynamometry (FD). **SETTING:** Human performance laboratory of a university. PARTICIPANTS: Convenience sample of ambulatory outpatients with Hereditary Motor and Sensory Neuropathy, Type I (HMSN) (n = 10) and able-bodied controls (CTL) (n = 11). **MAIN OUTCOME MEASURE:** Maximal isometric torque. **RESULTS:** Intratester intraclass correlation coefficients (ICCs) were high, generally ranging from .82 to .96 for HHD- and FD-measured strength for both HMSN and CTL groups. There were no significant differences between sessions for HHD-measured strength, while FD-measured strength was only significantly different for knee extension ($p < .01$). Intertester reliability was generally good for both HHD- and FD-measured strength, with ICCs ranging from .72 to .97 for HMSN and CTL groups. Exceptions were knee extensors and ankle dorsiflexors for the CTL group. Knee extensor strength was significantly lower measured by HHD compared with FD ($p < .01$), but knee flexor strength was similar for the two methods. **CONCLUSION:** HHD appears to be a reliable method to measure maximal isometric strength in persons with neurogenic weakness, and may be useful to quickly and objectively evaluate strength in the clinical setting.
The role of the motor system in spinal pain: implications for rehabilitation of the athlete following lower back pain, Hodges PW.	*J Sci Med Sport.* 2000 Sep;3(3):243-53. **Abstract:** The purpose of this review is to consider the role of the motor system in spinal pain. It is well accepted that spinal stability is dependent on the contribution of the muscular system. However, the ability of this system to satisfy the requirements of stability is dependent on its controller--the central nervous system (CNS). The CNS must predict the outcome of movements to plan appropriate strategies of muscle activity to meet the demands of internal and external forces, and initiate appropriate responses to unexpected disturbances. In addition, this complex control of stability must occur in conjunction with control of the trunk muscles for other functions, such as respiration. For the CNS to cope with athletic performance the coordination of these parameters must be streamlined. Yet evidence suggests that when spinal pain is present the strategies used by the CNS to control trunk muscles may be altered. The mechanism for these changes is poorly understood but may be due to changes at many levels of the CNS. For rehabilitation of the athlete with spinal pain it is critical that the motor control of stability is optimized. Furthermore, this must be coordinated with the multiple other functions of trunk muscles, including respiration.

	Comment: This paper reviews precisely many of the central tenets of AK therapy.
Neuromuscular findings in thyroid dysfunction: a prospective clinical and electrodiagnostic study. Duyff RF, Van den Bosch J, Laman DM, van Loon BJ, Linssen WH.	*J Neurol Neurosurg Psychiatry.* 2000 Jun;68(6):750-5. **OBJECTIVES:** To evaluate neuromuscular signs and symptoms in patients with newly diagnosed hypothyroidism and hyperthyroidism. **METHODS:** A prospective cohort study was performed in adult patients with newly diagnosed thyroid dysfunction. Patients were evaluated clinically with hand held dynamometry and with electrodiagnosis. The clinical features of weakness and sensory signs and the biochemical data were evaluated during treatment. **RESULTS:** In hypothyroid patients 79% had neuromuscular complaints, **38% had clinical weakness (manual muscle strength testing) in one or more muscle groups**, 42% had signs of sensorimotor axonal neuropathy, and 29% had carpal tunnel syndrome. Serum creatine kinase did not correlate with weakness. After 1 year of treatment 13% of the patients still had weakness. In hyperthyroid patients 67% had neuromuscular symptoms**, 62% had clinical weakness in at least one muscle group that correlated with FT4 concentrations**, but not with serum CK. Nineteen per cent of the patients had sensory-motor axonal neuropathy and 0% had carpal tunnel syndrome. The neuromuscular signs developed rapidly, early in the course of the disorder and were severe, but resolved rapidly and completely during treatment (average time 3.6 months). **CONCLUSIONS:** Neuromuscular symptoms and signs were present in most patients. About 40% of the hypothyroid patients and 20% of the hyperthyroid patients had predominantly sensory signs of a sensorimotor axonal neuropathy early in the course of thyroid disease. **Weakness in hyperthyroidism evolved rapidly at an early stage of the disorder and resolved completely during treatment, suggesting a functional muscle disorder.** Hand held dynamometry is sensitive for the detection of weakness and for the clinical evaluation of treatment effects. Weakness in hypothyroidism is more difficult to treat, suggesting myopathy.
Effects of acupuncture, cervical manipulation and NSAID therapy on dizziness and impaired head repositioning of suspected cervical origin: a pilot study, Heikkila H, Johansson M, Wenngren BI.	*Man Ther.* 2000 Aug;5(3):151-7. **Abstract:** In a single-subject experiment undertaken on 14 consecutive patients, the effects of acupuncture, cervical manipulation, no therapy, and NSAID-percutan application on kinesthetic sensibility, dizziness/vertigo and pain were studied in patients with dizziness/vertigo of suspected cervical origin. The ability to perceive position of the head with respect to the trunk was studied. The effects of different forms of therapy-and none-on dizziness and neck pain were compared, using a 100 mm visual analogue scale (VAS). Active head relocation by subjects with dizziness was significantly less precise than in the control group. Manipulation was the only treatment to diminish the duration of dizziness/vertigo complaints during the past 7 days and increased the cervical range of motion. Both acupuncture and manipulation reduced dizziness/vertigo on the VAS scale and had positive effects on active head repositioning. Ketoprofen percutan application and acupuncture both alleviated pain. The results of this study would suggest that spinal manipulation may impact most efficiently on the complex process of proprioception and dizziness of cervical origin.
The pain of being sick: implications of immune-to-brain communication for understanding pain, Watkins LR, Maier SF.	*Annu Rev Psychol.* 2000;51:29-57. **Abstract:** This review focuses on the powerful pain facilitatory effects produced by the immune system. Immune cells, activated in response to infection, inflammation, or trauma, release proteins called proinflammatory cytokines. These proinflammatory cytokines signal the central nervous system, thereby creating exaggerated pain as well as an entire constellation of physiological, behavioral, and hormonal changes. These changes are collectively referred to as the sickness response. Release of proinflammatory cytokines by immune cells in the body leads, in turn, to release of proinflammatory cytokines by glia within the brain and spinal cord. Evidence is reviewed supporting the idea that proinflammatory cytokines exert powerful pain facilitatory effects following their release in the body, in the brain, and in the spinal cord. Such exaggerated pain states naturally occur in situations involving infection, inflammation, or trauma of the skin, of peripheral nerves, and of the central nervous system itself. Implications for human

	pain conditions are discussed. **Comment:** In AK it has been recognized for many years that inflammatory processes contribute to clinical syndromes in patients. The adrenal glands (which control pro- and anti-inflammatory processes in the body) have been an important component of AK diagnosis and treatment, as well as other anti-inflammatory treatment methods also (nutritional, dietary, meridian, structural, and others).
Nociceptive fingertip stimulation inhibits synergistic motoneuron pools in the human upper limb, Leis AA, Stokic DS, Fuhr P, Kofler M, Kronenberg MF, Wissel J, Glocker FX, Seifert C, Stetkarova I.	*Neurology.* 2000 Nov 14;55(9):1305-9. **BACKGROUND:** Activation of distinct muscle groups organized in a stereotyped manner ("muscle synergies") is thought to underlie the production of movement by the vertebrate spinal cord. This results in movement with minimum effort and maximum efficiency. The question of how the vertebrate nervous system inhibits ongoing muscle activity is central to the study of the neural control of movement. **OBJECTIVE:** To investigate the strategy used by the human spinal cord to rapidly inhibit muscle activation in the upper limb. **METHODS:** The authors performed a series of experiments in 10 healthy subjects to assess the effect of nociceptive cutaneous stimulation on voluntarily contracting upper limb muscles. They recorded the electromyogram (EMG) with surface electrodes placed over various upper limb muscles. **RESULTS:** The authors found evidence of a simple inhibitory strategy that 1) was dependent on the intensity of the stimulus, 2) was maximally evoked when stimulation was applied to the fingertips, 3) preceded the earliest onset of voluntary muscle relaxation, and 4) produced inhibition of EMG activity in specific upper limb muscle groups. Nociceptive fingertip stimulation preferentially inhibited contraction of synergistic muscles involved in reaching and grasping (intrinsic hand muscles, forearm flexors, triceps) while having little effect on biceps or deltoid. **CONCLUSIONS:** Neural circuitry within the human spinal cord is organized to inhibit movement by rapidly deactivating muscles that constitute distinct muscle synergies. This strategy of selective and concurrent deactivation of the same basic elements that produce synergistic movement greatly simplifies motor control. **Comment:** This paper describes nociception-induced motor neuron reflex inhibition at the dorsal horn of the spinal cord. The relationship between somatic injury and muscle weakness is demonstrated and explained here.
Short latency inhibition of human hand motor cortex by somatosensory input from the hand, Tokimura H, Di Lazzaro V, Tokimura Y, Oliviero A, Profice P, Insola A, Mazzone P, Tonali P, Rothwell JC.	*J Physiol.* 2000 Mar 1;523 Pt 2:503-13 **Abstract:** EMG responses evoked in hand muscles by transcranial stimulation over the motor cortex were conditioned by a single motor threshold electrical stimulus to the median nerve at the wrist in a total of ten healthy subjects and in five patients who had electrodes implanted chronically into the cervical epidural space. 2. The median nerve stimulus suppressed responses evoked by transcranial magnetic stimulation (TMS) in relaxed or active muscle. The minimum interval between the stimuli at which this occurred was 19 ms. A similar effect was seen if electrical stimulation was applied to the digital nerves of the first two fingers. 3. Median or digital nerve stimulation could suppress the responses evoked in active muscle by transcranial electrical stimulation over the motor cortex, but the effect was much less than with magnetic stimulation. 4. During contraction without TMS, both types of conditioning stimuli evoked a cutaneomuscular reflex that began with a short period of inhibition. This started about 5 ms after the inhibition of responses evoked by TMS. 5. Recordings in the patients showed that median nerve stimulation reduced the size and number of descending corticospinal volleys evoked by magnetic stimulation. 6. **We conclude that mixed or cutaneous input from the hand can suppress the excitability of the motor cortex at short latency. This suppression may contribute to the initial inhibition of the cutaneomuscular reflex. Reduced spinal excitability in this period could account for the mild inhibition of responses to electrical brain stimulation.** **Comment:** This study demonstrates also a small part of the potentiality of the AK technique called Therapy Localization or TL. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and they may be a part of the mechanism for what is found clinically with TL testing.

The role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain, Brumagne S, Cordo P, Lysens R, Verschueren S, Swinnen S.	*Spine.* 2000 Apr 15;25(8):989-94. **STUDY DESIGN:** A two-group experimental design with repeated measures on one factor was used. **OBJECTIVES:** To investigate the role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain. **SUMMARY OF BACKGROUND DATA:** Proprioceptive deficits have been identified in patients with low back pain. The underlying mechanisms, however, are not well documented. **METHODS:** Lumbosacral position sense was determined before, during, and after lumbar paraspinal muscle vibration in 23 young patients with low back pain and in 21 control subjects. Position sense was estimated by calculating the mean absolute error, constant error, and variable error between six criterion and reproduction sacral tilt angles. **RESULTS:** Repositioning accuracy was significantly lower in the patient group than in healthy individuals (absolute error difference between groups = 2.7 degrees, $P < 0.0001$). Multifidus muscle vibration induced a significant muscle-lengthening illusion that resulted in an undershooting of the target position in healthy individuals (constant error = -3.1 degrees, $P < 0.0001$). Conversely, the position sense scores of the patient group did not display an increase in negative directional error but a significant improvement in position sense during muscle vibration ($P < 0.05$). No significant differences in absolute error were found between the first and last trial in the healthy individuals ($P >/= 0.05$) and in the patient group ($P > 0.05$). **CONCLUSIONS: Patients with low back pain have a less refined position sense than healthy individuals, possibly because of an altered paraspinal muscle spindle afference and central processing of this sensory input. Furthermore, muscle vibration can be an interesting expedient for improving proprioception and enhancing local muscle control.** **Comment:** The treatment of myofascial gelosis and fascial tension through percussion (as taught by Dr. Robert Fulford and applied in AK by Dr. Goodheart) has relevance to patients with low back pain who suffer from position sense deficits as described in this paper.
Decrease in quadriceps inhibition after sacroiliac joint manipulation in patients with anterior knee pain, Suter, E., McMorland G, Herzog W, Bray R.	*J Manipulative Physiol Ther*, 1999;22:149-153 (http://www.journals.elsevierhealth.com/periodicals/ymmt/article/PIIS0161475499701284/abstract) **Background:** Evidence exists that conservative rehabilitation protocols fail to achieve full recovery of muscle strength and function after joint injuries. The lack of success has been attributed to the high amount of muscle inhibition found in patients with pathologic conditions of the knee joint. Clinical evaluation shows that anterior knee pain is typically associated with sacroiliac joint dysfunction, which may contribute to the muscle inhibition observed in this patient group. **Objective:** To assess whether sacroiliac joint manipulation alters muscle inhibition and strength of the knee extensor muscles in patients with anterior knee pain. **Design and Setting:** The effects of sacroiliac joint manipulation were evaluated in patients with anterior knee pain. The manipulation consisted of a high-velocity low-amplitude thrust in the side-lying position aimed at correcting sacroiliac joint dysfunction. Before and after the manipulation, torque, muscle inhibition, and muscle activation for the knee extensor muscles were measured during isometric contractions using a Cybex dynamometer, muscle stimulation, and electromyography, respectively. **Participants:** Eighteen patients (mean age, 30.5 ± 13.0 years) with either unilateral ($n = 14$) or bilateral ($n = 4$) anterior knee pain. **Results:** Patients showed substantial muscle inhibition in the involved and the contralateral legs as estimated by the interpolated twitch technique. After the manipulation, a decrease in muscle inhibition and increases in knee extensor torques and muscle activation were observed, particularly in the involved leg. In patients with bilateral anterior knee pain, muscle inhibition was decreased in both legs after sacroiliac joint adjustment. **Conclusions:** Spinal manipulation might offer an interesting alternative treatment for patients with anterior knee pain and muscle inhibition. Because this clinical outcome study was of descriptive nature rather than a controlled design, biases might have occurred. Thus the results have to be verified in a randomized, controlled,

	double-blinded trial before firm conclusions can be drawn or recommendations can be made.
Cervical root compression monitoring by flexor carpi radialis H-reflex in healthy subjects, Sabbahi M, Abdulwahab S.	*Spine*, 1999 Jan 15;24(2):137-41. STUDY DESIGN: One-group, pretest-postest experimental research with repeated measures. OBJECTIVE: To determine the effect of head postural modification on the flexor carpi radialis H-reflex in healthy subjects. SUMMARY OF BACKGROUND DATA: H-reflex testing has been reported to be useful in evaluating and treating patients with lumbosacral and cervical radiculopathy. The idea behind this technique is that postural modification can cause further H-reflex inhibition, indicating more compression of the impinged nerve root, or recovery, indicating decompression of the root. Such assumptions cannot be supported unless the influence of normal head postural modification on the H-reflex in healthy subjects is studied. METHODS: Twenty-two healthy subjects participated in this study (14 men, 8 women; mean age, 39 +/- 9 years). The median nerve of the subjects at the cubital fossa was electrically stimulated (0.5 msec; 0.2 pulses per second [pps] at H-max), whereas the flexor carpi radialis muscle H-reflex was recorded by electromyography. The H-reflexes were recorded after the subject randomly maintained the end range of head-forward flexion, backward extension, rotation to the right and the left, lateral bending to the right and the left, retraction and protraction. These were compared with the H-reflex recorded during comfortable neutral positions. Data were recorded after the subject maintained the position for 30 seconds, to avoid the effect of dynamic postural modification on the H-reflex. Four traces were recorded in each position. During recording, the H-reflex was monitored by the M-response to avoid any changes in the stimulation-recording condition. RESULTS: Repeated multivariate analysis of variance was used to evaluate the significance of the difference among the H-reflex, amplitude, and latency, in various head positions. The H-reflex amplitude showed statistically significant changes ($P < 0.001$) with head postural modification. All head positions, except flexion, facilitated the H-reflex. Extension, lateral bending, and rotation toward the side of the recording produced higher reflex facilitation than the other positions. These results indicate that H-reflex changes may be caused by spinal root compression-decompression mechanisms. It may also indicate that relative spinal root decompression occurs in most head-neck postures except forward flexion. CONCLUSIONS: Head postural modification significantly influences the H-reflex amplitude but not the latency. This indicates that the H-reflex is a more sensitive predictor of normal physiologic changes than are latencies. The H-reflex modulation in various head positions may be-caused by relative spinal root compression-decompression mechanisms. **Comment:** In AK, the cervical compaction test was developed to monitor this kind of phenomenon. With compression upon the top of the skull, MMT will reveal weaknesses when cervical spine subluxations, and especially cervical disc syndromes are present. This study measures this dynamic.
Electromyographic responses of back and limb muscles associated with spinal manipulative therapy, Herzog, W., Scheele, D., Conway, P.J.	*Spine*, 1999;24:146-152 (http://www.spinejournal.com/pt/re/spine/abstract.00007632-199901150-00012.htm) **Study Design:** Ten young, asymptomatic male subjects underwent 11 clinically relevant spinal manipulative treatments along the length of the spine to test the magnitude and extent of reflex responses associated with the treatments. **Objectives:** To determine the magnitude and extent of reflex responses elicited by spinal manipulative treatments. **Summary of Background Data:** Spinal manipulative treatments have been associated with a reflexogenic relief of pain and a loss of hypertonicity in muscles within the treatment area. However, there is no study in which results show the probability of occurrence or the extent of reflex responses during spinal manipulative treatments. **Methods:** Asymptomatic subjects received spinal manipulative treatments on the cervical, thoracic, and lumbar levels and on the sacroiliac joint. Reflex activities were measured using 16 pairs of bipolar surface electrodes placed on the back and proximal limb musculature. The percentage of occurrence and the extent of reflex responses in the back and proximal limb musculature were determined. **Results:** Each

	treatment produced consistent reflex responses in a target-specific area. The reflex responses occurred within 50-200 msec after the onset of the treatment thrust and lasted for approximately 100-400 msec. The responses were probably of multireceptor origin and were elicited asynchronously. **Conclusions:** This is the first study in which results show a consistent reflex response associated with spinal manipulative treatments. Because reflex pathways are evoked systematically during spinal manipulative treatment, there is a distinct possibility that these responses may cause some of the clinically observed beneficial effects, such as a reduction in pain and a decrease in hypertonicity of muscles.
Further clinical clarification of the muscle dysfunction in cervical headache, Jull G, Barrett C, Magee R, Ho P.	*Cephalalgia,* 1999 Apr;19(3):179-85. **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.
Orthostatic intolerance and chronic fatigue syndrome associated with Ehlers-Danlos syndrome, Rowe PC, Barron DF, Calkins H, Maumenee IH, Tong PY, Geraghty MT	*J Pediatr,* 1999 Oct;135(4):494-9. **OBJECTIVE:** To report chronic fatigue syndrome (CFS) associated with both Ehlers-Danlos syndrome (EDS) and orthostatic intolerance. **STUDY DESIGN:** Case series of adolescents referred to a tertiary clinic for the evaluation of CFS. All subjects had 2-dimensional echocardiography, tests of orthostatic tolerance, and examinations by both a geneticist and an ophthalmologist. **RESULTS:** Twelve patients (11 female), median age 15.5 years, met diagnostic criteria for CFS and EDS, and all had either postural tachycardia or neurally mediated hypotension in response to orthostatic stress. Six had classical-type EDS and 6 had hypermobile-type EDS. **CONCLUSIONS:** Among patients with CFS and orthostatic intolerance, a subset also has EDS. We propose that the occurrence of these syndromes together can be attributed to the abnormal connective tissue in dependent blood vessels of those with EDS, which permits veins to distend excessively in response to ordinary hydrostatic pressures. This in turn leads to increased venous pooling and its hemodynamic and symptomatic consequences. These observations suggest that a careful search for hypermobility and connective tissue abnormalities should be part of the evaluation of patients with CFS and orthostatic intolerance syndromes. **Comment:** The biomedical literature on orthostatic hypotension (a positive Ragland's sign) is very extensive, and has been a part of standard AK evaluation of patients since 1965 when Dr. Goodheart first pointed out the significance of Adrenal Stress Disorder among chiropractic patients. Most chronic health disorders involving any of the three aspects of the triad of health (structural, chemical, mental) will demonstrate some involvement of the adrenal glands, and complete recovery from a chronic health disorder may require treatment of the adrenal stress disorder that may be present.
Manual Muscle Testing combined with Specific Head	*J Vertebral Subluxation Res,*1999;3(2):1-7.

Positioning, and other Articular Challenges, as an Assessment of Vertebral Subluxation of the Upper Cervical Spine: A Descriptive Paper, Dobson GJ.	**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 abberant 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 abberant joint mechanics affect these mechanoreceptors, the application of the head postioning 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.
Sacroiliac joint involvement in activation of the porcine spinal and gluteal musculature, Indahl, A., Kaigle, A., Reikeras, O., Holm, S.H.	*J Spinal Disord,* 1999;12:325-30 **Abstract:** This experiment involved stimulation of the sacroiliac joint that was found to cause neuromuscular responses in the gluteus maximus, quadratus lumborum, and multifidus muscles. This muscular activation was found to assist in the control of locomotion and body posture and to provide stability to the sacroiliac joint and lumbar spine. Thus, sensitization of sacroiliac joint nociceptive afferents were suggested to not only contribute to mechanical low back pain, but plays a role also in sacroiliac joint biomechanics via reflexogenic activation of the trunk and gluteal muscles. **Comment:** Given the results of this study, a larger double-blind study evaluating sacroiliac joint biomechanics in relationship applied kinesiology diagnostic procedures for the sacroiliac joint could be done, wherein back muscles strength tests are measured before and after a course of chiropractic care for the sacroiliac joints.
Shoulder muscle co-ordination during chronic and acute experimental neck-shoulder pain. An occupational pain study, Madeleine P, Lundager B, Voigt M, Arendt-Nielsen L.	*Eur J Appl Physiol Occup Physiol.* 1999 Jan;79(2):127-40. **Abstract:** Little is known about the mechanisms leading to chronic neck-shoulder musculoskeletal disorders (MSD). The aim of the present study was to investigate and compare motor function during controlled, low load, repetitive work together with chronic or acute experimental neck-shoulder pain. The clinical study was performed on workers with (n = 12) and without (n = 6) chronic neck-shoulder pain. In the experimental study, experimental muscle pain was induced in healthy subjects by intra-muscular injection of hypertonic saline into the trapezius muscle (n = 10). The assessed parameters related to motor performance were: work task event duration, cutting forces, surface electromyogram (EMG) activity in four shoulder muscles, displacement of the center of pressure, and arm and trunk 3D movements. For controlled cutting force levels, chronic and acute experimental pain provoked a series of changes: a decreased working rhythm and a protective reorganization of muscle synergy (experimental study), higher EMG frequency contents which may indicate altered motor unit recruitment, and greater postural activity and a tendency towards increased arm and trunk movements. These pain-related changes can play a role in the development of MSD. The present clinical and experimental study demonstrated similar interactions between motor co-ordination and neck-shoulder pain in occupational settings. We therefore suggest that this experimental model can be used to study mechanisms related to MSD. Information on such modulatory processes may help in the design of new strategies aimed at reducing the development of MSD.
Trunk muscle weakness as a risk factor for low back pain. A 5-year prospective study. Lee JH, Hoshino Y,	*Spine.* 1999 Jan 1;24(1):54-7. **STUDY DESIGN:** A 5-year prospective study. **OBJECTIVES: To investigate trunk muscle weakness as a risk factor for low back pain in asymptomatic volunteers. SUMMARY OF**

Nakamura K, Kariya Y, Saita K, Ito K.	**BACKGROUND DATA:** Muscle strength has not been sufficiently studied as a risk factor for low back pain. **METHODS:** The study participants included 30 male and 37 female volunteers (mean age, 17 +/- 2 years), who neither reported nor had ever been treated for low back pain. Trunk muscle strength was measured isokinetically (60 degrees/sec), using the trunk extension and flexion and torso rotation units. The peak torques of the volunteers' extension, flexion, rightward rotation, and leftward rotation were measured, and the agonist/antagonist ratios were calculated as extension/flexion and left rotation/right rotation ratio. The volunteers then were followed prospectively for 5 years to determine the incidence of low back pain and were classified into a non-low back pain group (volunteers with no low back pain during the 5-year follow-up period) and a low back pain group (volunteers who experienced low back pain during this period). **RESULTS:** The low back pain group consisted of 8 male and 10 female volunteers. There were no significant differences between the non-low back pain group and the low back pain group regarding age, height, weight, the peak torque values, or the left rotation/right rotation ratio. **However, the extension/flexion ratio of the low back pain group (men, 0.96 +/- 0.27; women, 0.77 +/- 0.19) demonstrated significantly lower values than that of the non-low back pain group (1.23 +/- 0.28 and 1.00 +/- 0.16 for men and women, respectively, P < 0.05). CONCLUSIONS:** An imbalance in trunk muscle strength, i.e., lower extensor muscle strength than flexor muscle strength, might be one risk factor for low back pain.
Thoracic position effect on shoulder range of motion, strength, and three-dimensional scapular kinematics, Kebaetse M, McClure P, Pratt NA.	*Arch Phys Med Rehabil.* 1999 Aug;80(8):945-50 **OBJECTIVES:** To determine the effect of thoracic posture on scapular movement patterns, active range of motion (ROM) in scapular plane abduction, and isometric scapular plane abduction muscle force. **STUDY DESIGN AND METHOD:** Repeated measures design. There were 34 healthy subjects (mean age, 30.2 yrs). Each subject was positioned and stabilized while sitting in both erect and slouched trunk postures. In each sitting posture a three-dimensional electromechanical digitizer was used to measure thoracic flexion and scapular position and orientation in three planes. Measurements were taken with the arm (1) at the side, (2) abducted to horizontal in the scapular plane, and (3) at maximum scapular plane abduction. In each posture, isometric abduction muscle force was measured with the arm at the side and abducted to horizontal in the scapular plane. **RESULTS:** In the slouched posture, the scapula was significantly more elevated in the interval between 0 to 90 degrees abduction. In the interval between 90 degrees and maximum abduction, the slouched posture resulted in significantly less scapular posterior tilting. There was significantly less active shoulder abduction ROM in the slouched posture (mean difference = 23.6 degrees +/- 10.7 degrees). Muscle force was not different between slouched and erect postures with the arm at the side, but with the arm horizontal muscle force was decreased 16.2% in the slouched position. **CONCLUSION: Thoracic spine position significantly affects scapular kinematics during scapular plane abduction, and the slouched posture is associated with decreased muscle force.**
Hand-grip strength predicts incident disability in non-disabled older men, Giampaoli S, Ferrucci L, Cecchi F, Lo Noce C, Poce A, Dima F, Santaquilani A, Vescio MF, Menotti A.	*Age Ageing.* 1999 May;28(3):283-8. **OBJECTIVES:** To verify if hand-grip performance in older men is a predictor of disability. **DESIGN:** Population-based prospective study. **SETTING:** A sample from the Italian rural cohorts of the FINE study (Finland, Italy, Netherlands Elderly), representative of the general population of elderly men surveyed in 1991 and 1995. **PARTICIPANTS:** 140 men aged 71-91 years who reported no disability in performing activities of daily living (ADLs), instrumental activity of daily living (IADLs) and mobility activities at baseline examination and provided information on their functional status at follow-up 4 years later. **MEASUREMENTS:** Disability was defined as needing help in performing ADLs, IADLs and mobility. Hand-grip strength was evaluated at baseline by a mechanical dynamometer. **RESULTS:** After adjusting for potential confounding variables, a lower concentration of high-density lipoprotein cholesterol was the only factor predicting disability in men aged 76 years or younger and only reduced hand-grip strength predicted incident disability in men 77 years or older. **CONCLUSION:** Poor hand strength as measured by hand-grip is a predictor of disability in older people. The hand-grip test is an easy

	and inexpensive screening tool to identify elderly people at risk of disability. **Comment: This study demonstrates that muscular strength is a predictor of disability in older people.**
Upper extremity nerve involvement in Swedish female machine milkers. Stål M, Hagert CG, Moritz U.	*Am J Ind Med.* 1998 Jun;33(6):551-9. **Abstract:** Entrapment of the median nerve in the proximal forearm, the so-called pronator syndrome, is considered a rather rare condition but it is four times more common in women than in men. In this study, 23 of 30 female machine milkers with symptoms in the forearm and hand were clinically diagnosed as having the pronator syndrome. The diagnosis of median nerve involvement was based on the clinical history and on physical examination by a hand surgeon. All 23 milkers complained of aching in the volar part of the forearm and had a sensation of numbness, tingling, and **decreased muscle strength in their hands, mostly in the hands which usually were statically loaded with heavy equipment.** Objectively, all had an experience of tenderness over the pronator teres muscle. **Furthermore, they showed reduced muscle strength, especially in the following muscles: pronator teres (PT), flexor carpi radialis (FCR), flexor pollicis longus (FPL), and flexor digitorum profundus II (FDP II).** To validate the manual muscle testing, Mannerfeldt's intrinsicmeter was used to quantify the clinically observed weakness. Eight of the 23 milkers with pronator syndrome were surgically released from neuropathy and were almost symptom-free at follow-up after six months. One patient had a slight sensation of numbness and had to be given surgical carpal tunnel release later on. The external exposure of the arm during the application of the milking cluster probably causes muscle and fascial tensions that induce compression of the nerve. Further studies are needed to establish the level of the internal exposure. **Comment:** This important study demonstrates a clear association between individual muscle strength weaknesses confined to forearm muscles innervated by the median nerve that proved to be a reliable sign of median nerve compression at the elbow level, the so-called pronator syndrome.
EMG recordings of abdominal and back muscles in various standing postures: validation of a biomechanical model on sacroiliac joint stability, Snijders, C.J., Ribbers, M.T., de Bakker, H.V., Stoeckart, R., Stam, H.J.	*J Electromyogr Kinesiol,* 1998;8:205-14 **Abstract:** In a biomechanical model we described that for stability of the flat sacroiliac joints (SIJ) muscle forces are required which press the sacrum between the two hip bones (self-bracing). Shear loading of these joints is caused by gravity and longitudinally oriented muscles. Protection against shearing can come from transversely oriented muscles like the internal oblique (OI) abdominal muscles. For validation we used standing postures with significantly more or less OI activity compared to activity in a standardized erect standing reference posture. OI activity decreased significantly when (a) resting on one leg (the contralateral), as can be observed at bus stops, (b) tilting the pelvic backward and (c) applying a pelvic belt. We explain this decrease of OI activity by, respectively, decrease of gravity load, decrease of load from the psoas major muscles, and a substitute of self-bracing. The outcome of this study is in line with the biomechanical model on SIJ stability. Clinical relevance of this study regards aspecific low back pain and is found in the effect of the use of a pelvic belt, of a trunk position as adopted when wearing a small rucksack and of the benefit of exercising trunk muscles in extension and torsion.
The intra-examiner reliability of manual muscle testing of the hip and shoulder with a modified sphygmomanometer: a preliminary study of normal, Perossa DR, Dziak M, Vernon HT, Hayashita K.	*J Can Chiropr Assoc,* Jun 1998;42:2. **Abstract:** The purpose of this study was to investigate the intrarater reliability of manual muscle assessment of the hip and shoulder using a modified sphygmomanometer. In addition, it was intended to establish a preliminary database of values from normal, healthy male and female volunteers. Eighty subjects participated in the test sessions, 40 males and 40 females between the ages of 19-22. Forty subjects participated in each of the hip and shoulder test sessions. Each examiner tested different paired movements on the subjects in one single session for the two separate joints. The tested movements consisted of hip extension, flexion and abduction and shoulder abduction, extension, flexion, internal and external rotation. All movements were tested

	by the patient-initiated method. Each movement was repeated twice, with a 30-35 second rest interval between the trials. The results showed that the intratester reliability coefficients for the hip ranged from 0.94-0.97, while, for the shoulder, the range was 0.86-0.97. Norms are expressed as mean (SD) values. These data conformed to previously established expectations, in that side-to-side differences were less than 10% and test values for males were larger than females in all tests. It was concluded that manual muscle assessment using a modified sphygmomanometer has acceptable intra-examiner reliability for the hip and shoulder when using the patient-initiated method.
The Anatomical Basis for the Effectiveness of Chiropractic Spinal Manipulation in Treating Headache, Hack G	*Proceedings of the 1998 International Conference on Spinal Manipulation*: Vancouver, British Columbia, Canada July 16-19;1998:114-15 **Abstract:** While the notion that headache may arise from neck structures is new to some medical practitioners, it is a concept widely accepted by the chiropractic profession. Chiropractors regularly perform manipulative procedures involving the cervical spine to relieve headache. Interestingly, an increasing body of literature relates headaches to pathology affecting the cervical spine and a number of clinical trials have demonstrated that chiropractic spinal manipulation directed at the neck I valuable for managing headaches. One possible anatomical basis could be a recently identified muscle-dura (myodural) bridge located at the craniocervical junction.
Cervicocephalic kinesthetic sensibility, active range of cervical motion, and oculomotor function in patients with whiplash injury, Heikkila HV,Wenngren BI.	*Arch Phys Med Rehabil.* 1998 Sep;79(9):1089-94 **OBJECTIVE:** To investigate cervicocephalic kinesthetic sensibility, active range of cervical motion, and oculomotor function in patients with whiplash injury. **DESIGN:** A 2-year review of consecutive patients admitted to the emergency unit after whiplash injury. **SETTING:** An otorhinolaryngology department. **PATIENTS AND SUBJECTS:** Twenty-seven consecutive patients with diagnosed whiplash injury (14 men and 13 women, mean age, 33.8yrs [range, 18 to 66yrs]). The controls were healthy subjects without a history of whiplash injury. **MAIN OUTCOME MEASURES**: Oculomotor function was tested at 2 months and at 2 years after whiplash injury. The ability to appreciate both movement and head position was studied. Active range of cervical motion was measured. Subjective intensity of neck pain and major medical symptoms were recorded. **RESULTS:** Active head repositioning was significantly less precise in the whiplash subjects than in the control group. **Failures in oculomotor functions were observed in 62% of subjects.** Significant correlations occurred between smooth pursuit tests and active cervical range of motion. Correlations also were established between the oculomotor test and the kinesthetic sensibility test. **CONCLUSION: The results suggest that restricted cervical movements and changes in the quality of proprioceptive information from the cervical spine region affect voluntary eye movements.** A flexion/extension injury to the neck may result in dysfunction of the proprioceptive system. **Oculomotor dysfunction after neck trauma might be related to cervical afferent input disturbances.** **Comment:** Several recent reviews and articles on eye muscle proprioception agree that there is abundant evidence that the brain utilizes information from the eye muscle proprioceptors for balance and postural control. In applied kinesiology chiropractic methodology, a means for testing the integration of the muscles in the body with the visual reflexes has been termed ***ocular lock*.** It demonstrates the failure of the eyes to work together on a binocular basis through the cardinal fields of gaze. This is usually not gross pathology of cranial nerves III, IV, and VI; rather it is poor functional organization. Mechanical irritation of cranial nerves III, IV, or VI (usually VI) may be responsible for disturbed binocular function leading to discordant sensory inputs from the visual righting reflex. When the eyes are turned in a specific direction, a previously strong indicator muscle will weaken when the ocular lock test is positive, and there is probably disturbance in the visual righting, vestibulo-ocular, or opto-kinetic reflexes. The relevance of the eyes to movement disorders, especially after whiplash trauma, is described in this report.
Dialogue between the CNS	*Immunol Today*, 1998 Sep;19(9):409-13.

and the immune system in lymphoid organs, Straub RH, Westermann J, Scholmerich J, Falk W	**Abstract:** It is well known that the CNS influences the responses of the immune system via humoral substances such as cortisol. Here, Rainer Straub and colleagues discuss aspects of the local interaction between nerves and immune cells in lymphoid organs. They provide evidence for chemically mediated transmission between nerves and immune cells in the spleen that is modified by the microenvironment. **Comment:** The close association of autonomic nerve terminals with macrophages and lymphocytes facilitates a chemically mediated transmission between nerves and immune cells. This study strongly suggests that spinovisceral reflex effects might include alterations in the functional activity of cells in the immune and/or inflammatory responses. It is demonstrable with MMT that there is a relationship between the immune system and the muscular, adrenal, and nervous systems. The doctor and the patient can detect this interplay during MMT, and therapy for immune dysfunction resulting from nervous system dysfunction appropriately employed.
The effect of upper cervical or sacroiliac manipulation on hip flexion range of motion, Pollard H, Ward G.	*J Manipulative Physiol Ther.* 1998 Nov-Dec;21(9):611-6. **OBJECTIVES:** To compare the effectiveness of an upper cervical manipulation and a manipulation of the sacroiliac joint for increasing hip range of motion. DESIGN: Clinical cohort study. **SETTING:** Macquarie University Centre for Chiropractic Outpatient Clinic. **SAMPLE:** Fifty-two randomly chosen university students aged 18 to 34 yr. **METHOD:** A reliable hand-held dynamometer was used to determine the end point of range of motion before and after the application of a treatment. Three groups of subjects were created: cervical manipulation, sacroiliac manipulation and sham/placebo. Range of motion of the hip in flexion (SLR) was used as the independent variable. **RESULTS:** The two manipulative treatments resulted in increased flexion range of motion at the hip. Statistical analysis revealed that only the upper cervical manipulation procedure increased hip flexion range of motion significantly. **CONCLUSION: The results suggest that manual therapy of the neck may affect hip range of motion in normal adults. Findings such as these may indicate the existence of a link between the cervical spine and the lower extremity.** **Comment:** In fact, AK research and experience has shown this relationship since its beginning. Upper cervical subluxations and fixations have been specifically correlated with weakness of the iliopsoas and gluteus maximus muscles. And muscle weakness is frequently the cause of a decreased ROM on testing the extremities, low back and neck.
High cervical stress and apnoea, Koch LE, Biedermann H, Saternus KS.	*Forensic Sci Int.* 1998 Oct 12;97(1):1-9. **Abstract:** The aim of this study was to investigate vegetative reactions in infants after mechanical irritation of the suboccipital region. The investigation is based on 199 infants who were observed while being treated with a suboccipital impulse (manual therapy). The results revealed vegetative reactions in more than half of all cases (52.8%, n = 105). The frequency of such vegetative reactions observed was at follows: flush 48.7% (n = 97), apnoea 22.1% (n = 44), hyperextension 13% (n = 26), and sweating 7.5% (n = 15). It is pointed out that approximately 25% of all the infants examined reacted by apnoea due to a mechanical irritation of the suboccipital region. This symptom was part of an extensive vegetative reaction. This method of inducing an apnoea has not yet been described; from this it follows that there are close relations to sudden infant death.
Rearfoot-forefoot orientation and traumatic risk for runners, Busseuil C, Freychat P, Guedj EB, Lacour JR.	*Foot Ankle Int.* 1998 Jan;19(1):32-7. **Abstract:** Factors making runners more susceptible to injuries were identified with a comparative study between a healthy control group (216) and runners (66) suffering from overuse pathology. On static and dynamic footprint, the angles alpha0 (static) and alpha1 (dynamic) between heel and forefoot have been measured. Analysis showed that the injured subjects have a more pronated foot than control group subjects. These results suggest that the pronating foot configuration would be an injury risk factor.

	Comment: The importance of proper foot function to the gait cycle has been described previously. Specifically, the researchers looked at runners who needed treatment for iliotibial band syndrome, Achilles tendonitis, stress fracture of the tibia, tibial periostitis and plantar fascitis. The significant correlation between these problems and runners with foot dysfunction shows the importance of thorough investigation of the feet in runners with injuries. The many factors that come into play for normal foot function are purposely incorporated into AK examination of the feet.
Effects of experimental muscle pain on muscle activity and co-ordination during static and dynamic motor function. Graven-Nielsen T, Svensson P, Arendt-Nielsen L.	*Electroencephalogr Clin Neurophysiol.* 1997 Apr;105(2):156-64. **Abstract:** The relation between muscle pain, muscle activity, and muscle co-ordination is still controversial. The present human study investigates the influence of experimental muscle pain on resting, static, and dynamic muscle activity. In the resting and static experiments, the electromyography (EMG) activity and the contraction force of m. tibialis anterior were assessed before and after injection of 0.5 ml hypertonic saline (5%) into the same muscle. In the dynamic experiment, injections of 0.5 ml hypertonic saline (5%) were performed into either m. tibialis anterior (TA) or m. gastrocnemius (GA) and the muscle activity and co-ordination were investigated during gait on a treadmill by EMG recordings from m. TA and m. GA. At rest no evidence of EMG hyperactivity was found during muscle pain. **The maximal voluntary contraction (MVC) during muscle pain was significantly lower than the control condition ($P < 0.05$).** During a static contraction at 80% of the pre-pain MVC muscle pain caused a significant reduction in endurance time ($P < 0.043$). During dynamic contractions, **muscle pain resulted in a significant decrease of the EMG activity in the muscle**, agonistic to the painful muscle ($P < 0.05$), and a significant increase of the EMG activity of the muscle, antagonistic to the painful muscle ($P < 0.05$). Muscle pain seems to cause a general protection of painful muscles during both static and dynamic contractions. The increased EMG activity of the muscle antagonistic to the painful muscle is probably a functional adaptation of muscle co-ordination in order to limit movements. Modulation of muscle activity by muscle pain could be controlled via inhibition of muscles agonistic to the movement and/or excitation of muscles antagonistic to the movement. **The present results are in accordance with the pain-adaptation model** (Lund, J.P., Stohler, C.S. and Widmer, C.G. In: H. Vaerøy and H. Merskey (Eds.), Progress in Fibromyalgia and Myofascial Pain. Elsevier, Amsterdam, 1993, pp. 311-327.) **which predicts increased activity of antagonistic muscle and decreased activity of agonistic muscle during experimental and clinical muscle pain.**
Quadriceps weakness and osteoarthritis of the knee. Slemenda C, Brandt KD, Heilman DK, Mazzuca S, Braunstein EM, Katz BP, Wolinsky FD.	*Ann Intern Med.* 1997 Jul 15;127(2):97-104. BACKGROUND: The quadriceps weakness commonly associated with osteoarthritis of the knee is widely believed to result from disuse atrophy secondary to pain in the involved joint. **However, quadriceps weakness may be an etiologic factor in the development of osteoarthritis. OBJECTIVE:** To explore the relation between lower-extremity weakness and osteoarthritis of the knee. DESIGN: Cross-sectional prevalence study. **SETTING:** Population-based, with recruitment by random-digit dialing. **PARTICIPANTS:** 462 volunteers 65 years of age or older. **MEASUREMENTS:** Radiographs of the knee were graded for the presence of osteoarthritis. Knee pain and function were assessed with the Western Ontario and McMaster Universities Arthritis Index, the strength of leg flexors and extensors was assessed with isokinetic dynamometry, and lower-extremity lean tissue mass was assessed with dual-energy x-ray absorptiometry. **RESULTS: Among participants with osteoarthritis, quadriceps weakness, but not hamstring weakness, was common. The ratio of extensor strength to body weight was approximately 20% lower in those with than in those without radiographic osteoarthritis. Notably, among women with tibiofemoral osteoarthritis, extensor weakness was present in the absence of knee pain and was seen in participants with normal lower-extremity lean mass** (extensor strength, 30.1 lb-ft for those with osteoarthritis and 34.8 lb-ft for those without osteoarthritis; $P < 0.001$). After adjustment for body weight, age, and sex, **lesser quadriceps strength remained predictive of both**

	radiographic and symptomatic osteoarthritis of the knee (odds ratio for prevalence of osteoarthritis per 10 lb-ft loss of strength, 0.8 [95% CI, 0.71 to 0.90] for radiographic osteoarthritis and 0.71 [CI, 0.51 to 0.87] for symptomatic osteoarthritis). **CONCLUSION: Quadriceps weakness may be present in patients who have osteoarthritis but do not have knee pain or muscle atrophy; this suggests that the weakness may be due to muscle dysfunction. The data are consistent with the possibility that quadriceps weakness is a primary risk factor for knee pain, disability, and progression of joint damage in persons with osteoarthritis of the knee.** **Comment:** This study is very important and suggests that the validity of MMT in cases of knee pain and osteoarthritis is sound. In this study, quadriceps muscle weakness preceded osteoarthritis of the knee and may be pathogenic. They state that quadriceps action serves as a brake, retarding the rate of the descent of the leg at the end of the swing phase of gait. Quadriceps weakness could accelerate damage to articular cartilage in the knee. Patients with painless osteoarthritis that may appear on X-ray probably should be tested for muscle weakness and given treatment to correct this as prevention. At the very least, everyone with knee pain should have their quadriceps muscles tested for strength.
The Role of the Chiropractic Adjustment in the Care and Treatment of 332 Children with Otitis Media, Fallon, J.	*Journal of Clinical Chiropractic Pediatrics*, 1997 Oct; 2(2) :167-83 **Objective:** To conduct a pilot study of chiropractic adjustive care on children with otitis media using tympanography as an objectifying measure, and to propose possible mechanisms whereby subluxation is implicated in the pathophysiology of otitis media. **Design:** Case series **Setting:** Subjects presented in a private clinical practice in New Rochelle, New York. The subjects were referred by various sources including pediatricians, other MDs, chiropractors and parents. **Participants:** 332 children who presented consecutively with previously diagnosed otitis media, ages 27 days to 5 years. Main **Outcome Measures:** A survey of the parent/guardian was used to determine historical data with respect to previous otitis media bouts, age of onset of initial otitis media, feeding history, history of antimicrobial therapy, referral patterns, and birth history. Otoscopic and tympanographic data was collected as well as data concerning the number of adjustments administered to produce resolution of the otitis media. Data with respect to recurrence rates over six months was also collected. **Results:** The average number of adjustments administered by types of otitis media were as follows: acute otitis media (n=127) 4.0±1.03, chronic/serous otitis media (n=104) 5.1±1.53, for the mixed type of bilateral otitis media (n=10) 5.3±1.35 and where no otitis was initially detected on otoscopic and tympanographic exam (but with history of multiple bouts) (n=74) 5.88±1.87. The number of days it took to normalize the otoscopic examination was for acute 6.67±1.9 chronic/serous 8.57±1.96, and 10.18±3.39, and mixed 10.9±2.02. The overall recurrence rate over a six month period from initial presentation in the office was for acute 11.02%, chronic/serous 16.34%, for mixed 30% and for none present 17.56%. **Conclusion:** To our knowledge this is the first time that tympanography has been used as an objectifying tool with respect to the efficacy of the chiropractic adjustment in the treatment of children with otitis media. As tympanography has been used extensively in the medical assessment of children with otitis media, it also serves as a bridge from which the chiropractic field and the medical field can begin to communicate with respect to otitis media. The results indicate that there is a strong correlation between the chiropractic adjustment and the resolution of otitis media for the children in this study. Normal cranial molding, which is essential for the proper juxtaposition of the cranial bones, often does not occur in the case of a birth malposition, as well as in the case of the child born with the aid of a C- section. This pilot study can now serve as a starting point from which the chiropractic profession can begin to examine its role in the treatment of children with otitis media. Large-scale clinical trials need to be undertaken in the field using tympanography as an objectifying measure. In addition, the role of the occipital adjustment needs to be examined. This study begins the process of examining the role of the vertebral cranial subluxation complex in the pathogenesis of otitis media, and the efficacy of the chiropractic adjustment in its resolution.
Reduced muscle function in	*Scand J Rehabil Med*.1997 Dec;29(4):213-21

patients with osteoarthritis, Fisher NM, Pendergast DR. -- Department of Rehabilitation Medicine, State University of New York at Buffalo, USA.	**Abstract:** The purpose of this study was to determine whether subjects with knee osteoarthritis (OA) had reduced muscle strength at various muscle lengths, endurance, contraction velocity and functional capacity, compared with control subjects and whether the decrease was related to functional capacity. Forty-five men and 45 women with knee OA were compared with a control group (41 males, 63 females) of similar age for functional capacity, maximal isometric strength (in vivo length-tension relationship) and endurance (in vivo force-time relationship) of knee flexion and extension and maximal angular velocity (in vivo force-velocity relationship) of knee extension. The OA subjects had increased difficulty (2.03 +/- 0.53) and pain (1.65 +/- 0.29) for activities of daily living (ADLs) and significantly lower strength for extension (72%) and flexion (56%), endurance for the quadriceps (203%) and hamstrings (214%) and velocity (128%). The reductions were greater at longer muscle lengths. These data demonstrate that patients with knee OA have reduced muscle function and functional capacity compared to controls.
Muscle inhibition following knee injury and disease, Herzog W, Suter E.	*Sportverletz Sportschaden,* 1997 Sep;11(3):74-8. **Abstract:** It has been observed that knee extensor muscles cannot be fully activated during voluntary contractions following knee injuries. This muscle inhibition has an unknown origin and appears to hinder full rehabilitation of the affected joint. We have investigated muscle inhibition during and following knee injuries in non-athletic and athletic patients and compared their results to non-athletic, unaffected volunteer subjects. There appears to be a small amount of muscle inhibition in the knee extensors of normal subjects; this inhibition increases dramatically following knee injury, and appears to go back to normal levels following surgical intervention, aggressive physiotherapy, or a sufficient amount of time. Depending on the intervention, strength deficits of the affected compared to the unaffected knee extensor muscles may persist. Aggressive physiotherapy can eliminate strength deficits following knee injury through an increased ability to recruit the knee extensors in patients more completely compared to normal subjects. **Comment:** The correlation between joint injury to the knee and muscle inhibition found upon muscle testing is very clearly described here. This is a central tenet of AK, i.e. that joint injuries will produce muscle weakness that can be specifically diagnosed and treated. On a clinical basis, AK physicians find this consistently when testing patients with knee injuries. Manual therapy is shown in this paper to improve the strength of muscles supporting the knee, and led to an improvement in function and a decrease in pain for these patients.
Athletic performance and physiological measures in baseball players following upper cervical chiropractic care: a pilot study, Schwartzbauer J, Kolber J, et al.	*J Vertebral Subluxation Res,* 1997;1(4):33-39. **Abstract:** This study analyzed the athletic performance in baseball players following upper cervical chiropractic care. Twenty-one male university baseball players free from physical injury completed the study, nine in the chiropractic group and twelve in the control group. The control group did not receive chiropractic care. The subluxations were determined from radiographic analysis and the Palmer toggle-recoil adjustment in side posture with a drop head piece was employed. The results showed significant improvement ($p < 0.05$) at fourteen weeks of care in muscle strength (repetitive shoulder abduction), long jump distance, and capillary counts in the group receiving adjustments.
Stabilizing function of trunk flexor-extensor muscles around a neutral spine posture, Cholewicki J, Panjabi MM, Khachatryan A	*Spine,* 1997 Oct 1;22(19):2207-12. **STUDY DESIGN:** This study examined the coactivation of trunk flexor and extensor muscles in healthy individuals. The experimental electromyographic data and the theoretical calculations were analyzed in the context of mechanical stability of the lumbar spine. **OBJECTIVES:** To test a set of hypotheses pertaining to healthy individuals: 1) that the trunk flexor-extensor muscle coactivation is present around a neutral spine posture, 2) that the coactivation is increased when the subject carries a load; and 3) that the coactivation provides the needed mechanical stability to the lumbar spine. **SUMMARY OF BACKGROUND DATA:** Theoretically, antagonistic trunk

	muscle coactivation is necessary to provide mechanical stability to the human lumbar spine around its neutral posture. No experimental evidence exists, however, to support this hypothesis. **METHODS:** Ten individuals executed slow trunk flexion-extension tasks, while six muscles on the right side were monitored with surface electromyography: external oblique, internal oblique, rectus abdominus, multifidus, lumbar erector spinae, and thoracic erector spinae. Simple, but realistic, calculations of spine stability also were performed and compared with experimental results. **RESULTS:** Average antagonistic flexor-extensor muscle coactivation levels around the neutral spine posture as detected with electromyography were 1.7 +/- 0.8% of maximum voluntary contraction for no external load trials and 2.9 +/- 1.4% of maximum voluntary contraction for the trials with added 32-kg mass to the torso. The inverted pendulum model based on static moment equilibrium criteria predicted no antagonistic coactivation. The same model based on the mechanical stability criteria predicted 1.0% of maximum voluntary contraction coactivation of flexors and extensors with zero load and 3.1% of maximum voluntary contraction with a 32-kg mass. The stability model also was run with zero passive spine stiffness to simulate an injury. Under such conditions, the model predicted 3.4% and 5.5% of maximum voluntary contraction of antagonistic muscle coactivation for no extra load and the added 32 kg, respectively. **CONCLUSIONS:** This study demonstrated that antagonistic trunk flexor-extensor muscle coactivation was present around the neutral spine posture in healthy individuals. This coactivation increased with added mass to the torso. Using a biomechanical model, the coactivation was explained entirely on the basis of the need for the neuromuscular system to provide the mechanical stability to the lumbar spine. **Comment:** AK demonstrates that muscle imbalance is most often primary to structural and postural deviations, from vertebral subluxations to obvious postural imbalances. Early in AK it was recognized that the short or hypertonic muscle is frequently secondary to poor function of its antagonist muscle. On MMT the antagonist muscle tests weak, indicating that the coactivation necessary for pain free function and, as in this study, neutral spine posture.
Muscle function and gait in patients with knee osteoarthritis before and after muscle rehabilitation, Fisher NM, White SC, Smolinski RJ, Pendergast DR.	*Disabil and Rehabil.*1997 Feb;19(2):47-55. **Abstract:** Patients with knee osteoarthritis (OA) have reduced functional capacity and muscle function that improves significantly after quantitative progressive exercise rehabilitation (QPER). The effects of these changes on the biomechanics of walking have not been quantified. Our goal was to quantify the effects of knee OA on gait before and after QPER. Bilateral kinematic and kinetic analyses were performed using a standard link-segment analysis on seven women (60.9 +/- 9.4 years) with knee OA. All functional capacity, muscle function and gait variables were initially reduced compared to age-matched controls. Muscle strength, endurance and contraction speed were significantly improved (55%, 42% and 34%, respectively) after 2 months of QPER ($p < 0.05$), as were function (13%), walking time (21%), difficulty (33%) and pain (13%). There were no significant changes in the gait variables after QPER. To use the QPER improvements to the best advantage, gait retraining may be necessary to "re-programme' the locomotor pattern.
Spinal manipulation results in immediate H-reflex changes in patients with unilateral disc herniations, Floman Y, Liram N, Gilai AN.	*Eur Spine J.* 1997;6(6):398-401. **Abstract:** The aim of this clinical investigation was to determine whether the abnormal H-reflex complex present in patients with S1 nerve root compression due to lumbosacral disc herniation is improved by single-session lumbar manipulation. Twenty-four patients with unilateral disc herniation at the L5-S1 level underwent spinal H-reflex electro-physiological evaluation. This was carried out before and after single-session lumbar manipulation in the side-lying position. Eligibility criteria for inclusion in the study were: predominant sciatica, no motor or sphincteric involvement, unilateral disc herniation at the L5-S1 level on CT or MR imaging, age between 20 and 50 years. H-reflex responses were recorded bilaterally from the gastrosoleus muscle following stimulation of tibial sensory fibers in the popliteal fossa. H-reflex amplitude in millivolts (HR-A) and H-reflex latency in milliseconds (HR-L) were measured from the spinal reflex response. Pre- and post-manipulation measurements were compared between the affected side and the healthy side. Statistical evaluation was performed by the Wilcoxon matched-pairs

	test (SPSS). Thirteen patients displayed abnormal H-reflex parameters prior to lumbar manipulation, indicating an S1 nerve root lesion. The mean amplitude was found to be significantly lower on the side of disc herniation than on the normal, healthy side (P = 0.0037). Following manipulation, the abnormal HR-A increased significantly on the affected side while the normal HR-A on the healthy side remained unchanged (P = 0.0045). There was a significant difference between latencies on the affected side and those on the healthy side (P = 0.003). Following manipulation there was a trend toward decreased HR-L. However, this trend did not reach statistical significance (P = 0.3877). Eight patients displayed no H-reflex abnormalities before or after manipulation. Their respective HR-A and HR-L values did not change significantly following manipulation. Three additional patients were excluded due to technical difficulties in achieving manipulation or measuring spinal reflex. These observations may lend physiological support for the clinical effects of manipulative therapy in patients with degenerative disc disease.
Chronic neck pain, standing balance, and suboccipital muscle atrophy--a pilot study, McPartland JM, Brodeur RR, Hallgren RC.	*J Manipulative Physiol Ther.* 1997 Jan;20(1):24-9. **OBJECTIVE:** To study the relationship between chronic neck pain, standing balance and suboccipital muscle atrophy. We hypothesize that patients with chronic neck pain have more somatic dysfunction in the cervical spine than control subjects without neck pain. We also hypothesize that patients with chronic neck pain and somatic dysfunction exhibit more atrophy of suboccipital muscles. Lastly, because suboccipital muscles have a high density of proprioceptors, we hypothesize that chronic pain patients exhibit a loss in standing balance. DESIGN: Randomized, controlled, partially blind study examining chronic neck pain patients and control subjects for differences in degree of upper cervical somatic dysfunction, standing balance and suboccipital muscle atrophy. **SETTING:** Subjects were recruited from a clinical practice at Michigan State University; controls were recruited from the faculty, staff and students. **PARTICIPANTS:** Seven chronic neck pain patients and seven asymptomatic control subjects. **MAIN OUTCOME MEASURES:** Palpation was used to diagnose somatic dysfunction in the upper cervical spine. Balance parameters were calculated using a force platform; muscle atrophy was judged with magnetic resonance images. **RESULTS:** Chronic neck pain patients had almost twice as many somatic dysfunctions as controls (p = .028). Force platform results showed a decrease in standing balance in patients compared with control subjects (p = .004). MRI showed that chronic neck pain subjects had marked atrophy of the rectus capitis posterior major and minor muscles, including fatty infiltration. **CONCLUSIONS:** This study suggests that there is a relationship between chronic pain, somatic dysfunction, muscle atrophy and standing balance. We hypothesize a cycle initiated by chronic somatic dysfunction, which may result in muscle atrophy, which can be further expected to reduce proprioceptive output from atrophied muscles. The lack of proprioceptive inhibition of nociceptors at the dorsal horn of the spinal cord would result in chronic pain and a loss of standing balance.
Upper trapezius muscle activity during the brachial plexus tension test in asymptomatic subjects, Balster SM, Jull GA.	*Man Ther.* 1997 Aug;2(3):144-149. **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.

Excitability changes in human sensory and motor axons during hyperventilation and ischaemia, Mogyoros I, Kiernan MC, Burke D, Bostock H.	*Brain.* 1997 Feb;120 (Pt 2):317-25. **Abstract:** This study was undertaken to compare the excitability changes of sensory and motor axons during hyperventilation and ischaemia, and to determine why ectopic impulse activity develops more readily during hyperventilation, and in sensory fibres. During hyperventilation for 20 min, all six subjects reported paraesthesiae in the hand and face, and four out of the six developed muscle twitching and cramps, associated with significant decreases of 20-30% in the threshold current required to produce sensory and motor potentials of constant size. During ischaemia four out of the six subjects reported paraesthesiae, but none reported muscle twitching. There were significant decreases of 15-20% in threshold for sensory and motor fibres. Ischaemia produced a marked decrease in supernormality, an increase in refractoriness and an increase in latency of the test compound sensory or motor potential, changes that were not seen with hyperventilation. The decrease in threshold during these manoeuvres was associated with a significant increase in strength--duration time constant (tau SD), indicating a relatively greater decrease in rheobase current. Using the technique of latent addition, we found that the changes in tau SD were consistent with a recently proposed model in which non-inactivating, voltage-dependent 'threshold channels' (presumably persistent Na+ channels) are active at resting potential. The failure of hyperventilation to alter conduction velocity, refractoriness or supernormality appreciably indicates that, unlike ischaemic depolarization, hyperventilation does not increase inactivation of conventional Na+ channels or activation of K+ channels, and this implies that the hyperventilation-induced increase in excitability is not the result of conventional depolarization, as seems to occur during ischaemia. These results suggest that hyperventilation has a rather selective action on the threshold channels, and they help to explain its greater effectiveness compared with ischaemia in provoking ectopic discharges. The greater expression of threshold channels in sensory than in motor fibres can explain why hyperventilation induces paraesthesiae before fasciculation and why only paraesthesiae occur during ischaemia.
A tension-based theory of morphogenesis and compact wiring in the central nervous system, Van Essen DC.	*Nature.* 1997 Jan 23;385(6614):313-8. **Abstract:** Many structural features of the mammalian central nervous system can be explained by a morphogenetic mechanism that involves mechanical tension along axons, dendrites and glial processes. In the cerebral cortex, for example, tension along axons in the white matter can explain how and why the cortex folds in a characteristic species-specific pattern. In the cerebellum, tension along parallel fibres can explain why the cortex is highly elongated but folded like an accordion. By keeping the aggregate length of axonal and dendritic wiring low, tension should contribute to the compactness of neural circuitry throughout the adult brain.
Chiropractic Treatment of the Musculoskeletal System During Pregnancy, Bilgrai-Cohen K.	*Journal Of The American Chiropractic Association* May 1997: 33-34, 90. **Abstract:** The childbearing year is a period of dynamic change and adaptation. Alterations occur in every system, including the musculoskeletal system. This article will discuss the major structural changes inherent in pregnancy, the goals of therapy and protocol for the major presenting complaints, including sacroiliac, lumbar and thoracic involvement Pregnancy is a time of profound change and adaptation. As early as 10-12 weeks after fertilization, increased estrogen and relaxin begin to affect the musculoskeletal system by causing the softening of ligaments and increased joint laxity. Compensation for the enlarging uterus, anteriorly, produces the need for the pregnant woman to lean back, thus increasing the lumbar lordosis shifting the center of gravity over the lower extremity. I point out the three joints in the ring (two SI joints and one pubic symphysis) and explain that hormonally, one or both of the SI joints has become softened and is less supportive than normal. The tender muscles and joint pain is the body's response to this instability in the joints. A portion of my treatment of sacroiliac dysfunction occurs with the patient in the prone position. I accomplish this by using SOT-type blocks and pillows. Sacroiliac Involvement In the non-gravid state, the sacroiliac (SI) joint is very stable relative to the lumbosacral joint. However, during pregnancy, the ligamentous support to the SI joint is significantly relaxed. This is the most common presenting musculoskeletal complaint

	comprising 75-85 percent of women seen during pregnancy. A portion of my treatment of sacroiliac dysfunction occurs with the patient in the prone position. I accomplish this by using SOT-type blocks and pillows. Lumbopelvic treatment considerations focus on the pelvic block placement with the patient in the prone position, sacral pumping into dural flexion on inhalation, adjust for bilateral AS ilium, and neurolymphatic drainage particularly over the sacrum. Thoracic techniques are also stressed in many ways during pregnancy due to enlargement and increased weight in the breasts, widening of the sub-costal angle and pressure on the lower four to five ribs, viscero-somatic reflex from stressed organs such as the stomach, liver and pancreas and response to increasing lordosis of the lumbar region.
Altered patterns of abdominal muscle activation in patients with chronic low back pain, O'Sullivan P, Twomey L, Allison G, Sinclair J, Miller K.	*Aust J Physiother.* 1997;43(2):91-98. **Abstract:** This study investigated patterns of abdominal muscle recruitment during the abdominal drawing in manoeuvre in subjects with chronic low back pain (CLBP) and radiological diagnosis of spondylolysis or spondylolisthesis. Data were collected using surface electromyography from 12 physically active subjects with CLBP and 10 controls. The control subjects displayed an ability to preferentially activate internal oblique with minimal activation of upper rectus abdominis during the action of drawing in the abdominal wall. The group with CLBP were unable to achieve this. This finding may reflect the presence of neuromuscular dysfunction in this group. Further study is required to investigate if these findings are linked to the ability of patients with CLBP to provide dynamic stability of their lumbar spine. **Comment:** In this compendium of evidence for the AK approach to health care there have been over 20 studies listed demonstrating that motor control does not function properly in patients with chronic LBP and neck pain. This type of muscular dysfunction, recognized as critical in patients with LBP and neck pain, involves the disruption of the what Dr. Panjabi terms the stability system of the spine, leading to the suggestion that improper stabilization responses may serve as a perpetuating factor in patients. It would therefore be beneficial for clinicians to have at their disposal simple, reliable, and accurate tests that are capable of detecting the disturbance of these motor control responses and of monitoring the effectiveness of treatment measures designed to correct this dysfunction. AK MMT provides this type of simple, reliable, repeatable physical test.
Posture effects on grip strength. Richards LG.	*Arch Phys Med Rehabil.* 1997 Oct;78(10):1154-6. **OBJECTIVE:** To examine whether grip strengths were different when measured in supine and sitting positions. **DESIGN:** Comparison, convenience sample. **SETTING:** Community. **PARTICIPANTS:** Seventy-four healthy adult participants with no history of psychiatric or neurological dysfunction, or upper extremity orthopedic dysfunction after the age of 18. **INTERVENTIONS:** Participants performed grips with each hand while sitting and standing. Shoulder was adducted and extended, with the elbow flexed, and wrist and forearm in neutral. **MAIN OUTCOME MEASURE:** The mean of the three trials with each hand in each posture. **RESULTS:** Men were stronger (49kg) than women (29kg; $p < .001$). Right hands were stronger (41kg) than left (39kg; $p < .001$). However, grip strengths while sitting were equivalent to those tested while supine ($p > .59$). **CONCLUSIONS:** Using identical upper extremity positions, grip strength is equivalent when tested in the supine and sitting positions. Thus, when determining grip strength, grips measured while the subject is supine can be compared with norms collected while the subject is sitting, provided the upper extremity position is invariant.
Interaction between the porcine lumbar intervertebral disc, zygapophysial joints, and paraspinal muscles, Indahl A, Kaigle AM, Reikeras O, Holm SH.	*Spine.* 1997 Dec 15;22(24):2834-40. **STUDY DESIGN:** A porcine model was used to study whether muscular activation in the paraspinal muscles caused by nerve stimulation in the anulus fibrosus of a lumbar intervertebral disc could be altered by saline injection into the zygapophysial (facet) joint. **OBJECTIVES:** To elucidate possible mechanisms regarding the nerve pathways and interactions between the intervertebral disc, zygapophysial joints, and the paraspinal musculature. **SUMMARY OF**

	BACKGROUND DATA: The physiologic basis for chronic low back pain, including muscular spasm, is uncertain. Although extensive research involving the lumbar motion segments and the surrounding tissues has been performed, the neuromuscular connection has not been sufficiently investigated. **MATERIALS AND METHODS:** Twenty-three adolescent pigs were used to measure the electromyographic response in the paraspinal musculature to electrical stimulation of the posterolateral L3-L4 anulus fibrosus, before and after introduction of physiologic saline into the zygapophysial joint. Motor unit action potentials were recorded using three sets of needle electrodes placed into the deepest fascicles of the multifidus, bilateral to the L4 and L5 spinous processes, and into the central longissimus musculature, bilateral to the L4 spinous process. **RESULTS:** Stimulation of the nerves within the posterolateral anulus of the disc elicited reactions in the paraspinal muscles, namely the lumbar multifidus and longissimus. Introduction of physiologic saline into the zygapophysial joint resulted in a reduction in the motor unit action potential amplitude. This reduction was manifested as an immediate and constant reduction, a graded reduction, or a delayed reaction, during which the reduction occurred an average of 5 minutes after the saline injection. **CONCLUSIONS:** Introduction of physiologic saline into the zygapophysial joint reduced the stimulation pathway from the intervertebral disc to the paraspinal musculature. The zygapophysial joints may therefore have a regulating function, controlling the intricate neuromuscular balance in the lumbar motion segment. **Comment:** This study shows that muscle strength changes specifically after stimulation or irritation of the facet joints of the spine.
Mechanisms of referred visceral pain: uterine inflammation in the adult virgin rat results in neurogenic plasma extravasation in the skin, Wesselmann U, Lai J.	*Pain.* 1997 Dec;73(3):309-17 **Abstract**: The purpose of this study was to investigate the mechanisms of referred pain observed in female patients with pain from the reproductive organs. We developed a model of inflammatory uterine pain in the rat. Inflammation of the uterus in rats pretreated with Evans Blue Dye resulted in dye extravasation in the skin over the abdomen, groin, lower back, thighs, perineal area and proximal tail, thus providing for the first time evidence for the trophic changes observed in the area of referred visceral pain in an animal model of uterine pain. The neuronal pathways mediating the observed dye extravasation in the skin after uterine inflammation may include dichotomizing afferent fibers, afferent-afferent interactions via a spinal cord pathway or a sympathetic reflex. This model will allow us to gain further insight into the mechanisms of referred pain and the trophic changes observed in the area of referred pain in visceral disease. **Comment:** A crucial development in AK occurred when Goodheart observed that if a patient touched an area of dysfunction, the results of MMT changed. Therapy localization has numerous applications in AK including TL to various reflexes, subluxations, meridian points, nerve receptors and other areas. This paper explains part of this fascinating development in the healing arts that has been proven helpful in the diagnosis of physical dysfunctions in patients.
Postural stability, neck proprioception and tension neck, Koskimies K, Sutinen P, Aalto H, Starck J, Toppila E, Hirvonen T, Kaksonen R, Ishizaki H, Alaranta H, Pyykko I.	*Acta Otolaryngol Suppl.* 1997;529:95-7. **Abstract:** We examined whether tension neck (TN) may due to inadequate proprioceptive and vestibular activation of the cervico-collic 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 erroneus facilitation of proprioception in TN subjects indicate that TN may be**

	raised by inadequate facilitation of CCR.
Theoretical basis for patterning EMG amplitudes to assess muscle dysfunction. Edgerton VR, Wolf SL, Levendowski DJ, Roy RR.	*Med Sci Sports Exerc.* 1996 Jun;28(6):744-51. **Abstract:** A theoretical basis for assessing muscle dysfunction due to sprain/strain injuries is presented. We propose that muscle tissue trauma results in an alteration in the patterns of neural recruitment, **a reduction in the force-generating capability of the injured muscle**, and/or pain sensations. Furthermore, **a lower than normal recruitment of motoneuron pools in the injured area can result in elevated recruitment levels from compensating motoneuron pools for a given motor task.** It is proposed that these changes in motoneuron recruitment can be readily apparent in the ratios of EMG amplitudes among multiple pairs of muscles associated kinesiologically with the affected muscle. Chronic compensating actions, such as those resulting from faulty neural feedback of the force-length-velocity relationships for a stretched tendon or muscle unit, could cause further injuries. It is proposed that consistent and valid measures of ratios of EMG amplitudes between many muscle pairs acquired for well-defined motor tasks can be used to facilitate diagnoses and direct treatment strategies for sprain/strain injuries and pain. **Comment:** Edgerton et al shows that underactivity of agonists and overactivity of synergists was able to discriminate chronic neck pain patients from those who had recovered with 88% accuracy. This paper describes for the neck what Lund et al have proposed globally for muscle imbalances, i.e. the pain adaptation theory. Lund hypothesizes that when pain is present, there is decreased activation of muscles during movements in which they act as agonists and increased activation during movements in which they are antagonists. This model is in stark contrast to the pain-spasm-pain model, which suggests that muscle tension is necessarily increased when painful stimuli are present. Rather it appears that muscle imbalance is the rule, with certain muscles tending toward inhibition and others toward hyperactivity. This agrees with a fundamental hypothesis of AK.
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.
The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia. Vicenzino B, Collins D, Wright A.	*Pain.* 1996 Nov;68(1):69-74. **Abstract:** Manipulative therapy is frequently used in the management of musculoskeletal pain. A frequently reported clinical feature of this treatment is the immediacy with which it appears to initiate improvement in pain and function. A randomised, double blind, placebo controlled, repeated measures design was employed to study the initial effects of a cervical spine treatment technique in a group of 15 patients with lateral epicondylalgia. Pressure pain threshold, **pain-free grip strength,** upper limb neurodynamics, pain and function were assessed prior to and following application of either a treatment, placebo or control condition. All subjects received all three conditions. Differences between the pre-post measures were used as indicators of change in subject's symptom profiles. **The treatment condition produced significant improvement in pressure pain threshold, pain-free grip strength, neurodynamics and pain scores relative to placebo and control conditions (P < 0.05).** In summary, this study demonstrates that manipulative therapy is capable of eliciting a rapid hypoalgesic effect. **Comment:** This study demonstrates the positive effects of SMT for cervical spine pressure pain, upper limb neurodynamic movement tests, pain, ROM, and an improvement in pain-free grip strength. This study demonstrates the immediate facilitation of muscle strength in the upper limb after SMT.
The manual muscle examination for rotator cuff strength. An electromyographic investigation, Kelly BT, Kadrmas WR, Speer KP.	*Am J Sports Med.* 1996 Sep-Oct;24(5):581-8. **Abstract:** The electromyographic activity of eight muscles of the rotator cuff and shoulder girdle (supraspinatus, infraspinatus, subscapularis, pectoralis, latissimus dorsi, and the anterior, middle, and posterior deltoid) was measured from the nondominant shoulders of 11 subjects during a series of 29 isometric contractions. The contractions simulated different positions used for strength testing of the rotator cuff and involved elevation, external rotation, and internal rotation at three degrees of initial humeral rotation (-45 degrees of internal rotation, 0 degree, +45 degrees of external rotation) and scapular elevation (0 degree, 45 degrees, 90 degrees). Isolation of the supraspinatus muscle was best achieved with the test position of elevation at 90 degrees of scapular elevation and +45 degrees (external rotation) of humeral rotation. Isolation of the infraspinatus muscle was best achieved with external rotation at 0 degree of scapular elevation and -45 degrees (internal rotation) of humeral rotation. Isolation of the subscapularis muscle was best achieved with the Gerber push-off test. This study used four criteria for identifying the optimal manual muscle test for each rotator cuff muscle: 1) maximal activation of the cuff muscle, 2) minimal contribution from involved shoulder synergists, 3) minimal provocation of pain, and 4) good test-retest reliability. Based on the results of this study and known painful arcs of motion, an objective identification of the optimal tests for the manual muscle testing of the cuff was elucidated.
Normative values for isometric muscle force measurements obtained with hand-held dynamometers, Andrews AW, Thomas MW, Bohannon RW. -- University of North	*Phys Ther.* 1996 Mar;76(3):248-59. **BACKGROUND AND PURPOSE:** The extent of a patient's impairment can be established by comparing measurements of that patient's performance with normative values obtained from apparently unimpaired individuals. Only a few studies have described normative values for muscle strength measured by hand-held dynamometry. The purpose of this study of older adults, therefore, was to obtain normative values of maximum voluntary isometric force using hand-held dynamometers. **SUBJECTS:** One hundred fifty-six asymptomatic adults (77 men, 70 women) participated in this study. The subjects' mean age was 64.4 years (SD=8.3, range=50-79). The

Carolina Hospitals, Chapel Hill, 27514, USA.	male subjects' mean age was 64.5 years (SD=8.4, range=50-79), and the female subjects' mean age was 64.3 years (SD=8.2, range=50-79). **METHODS:** Gender, age, dominant side, height, weight, and activity level were recorded. Eight upper-extremity movements (shoulder flexion, extension, abduction, and medial and lateral rotation; elbow flexion and extension; and wrist extension) and five lower-extremity movements (hip flexion and abduction, knee flexion and extension, and ankle dorsiflexion) were resisted by one of three experienced testers using a strain-gauge hand-held dynamometer. **RESULTS:** Gender, age, and weight were identified as independent predictors of force for all muscle actions on both the dominant and nondominant sides. These variables were used, therefore, to create regression equations and normative values for the force of each muscle action. **CONCLUSION AND DISCUSSION:** The reference values provided may allow clinicians who follow the described testing protocol to estimate the severity of force-generating impairments in patients aged 50 to 79 years.
Cervicogenic headache: the influence of mental load on pain level and EMG of shoulder-neck and facial muscles. Bansevicius D, Sjaastad O.	*Headache.* 1996 Jun;36(6):372-8. **Abstract:** The relationship between pain and EMG levels was studied in 17 cervicogenic 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.**
Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis, Hodges PW, Richardson CA.	*Spine*, 1996 Nov 15;21(22):2640-50. STUDY DESIGN: The contribution of transversus abdominis to spinal stabilization was evaluated indirectly in people with and without low back pain using an experimental model identifying the coordination of trunk muscles in response to a disturbances to the spine produced by arm movement. OBJECTIVES: To evaluate the temporal sequence of trunk muscle activity associated with arm movement, and to determine if dysfunction of this parameter was present in patients with low back pain. SUMMARY OF BACKGROUND DATA: Few studies have evaluated the motor control of trunk muscles or the potential for dysfunction of this system in patients with low back pain. Evaluation of the response of trunk muscles to limb movement provides a suitable model to evaluate this system. Recent evidence indicates that this evaluation should include transversus abdominis. METHODS: While standing, 15 patients with low back pain and 15 matched control subjects performed rapid shoulder flexion, abduction, and extension in response to a visual stimulus. Electromyographic activity of the abdominal muscles, lumbar multifidus, and the surface electrodes. RESULTS: Movement in each direction resulted in contraction of trunk muscles before or shortly after the deltoid in control subjects. The transversus abdominis was invariably the first muscle active and was not influenced by movement direction, supporting the hypothesized role of this muscle in spinal stiffness generation**. Contraction of transversus abdominis was significantly delayed in patients with low back pain with all movements.** Isolated differences were noted in the other muscles. CONCLUSIONS: **The delayed onset of contraction of transversus abdominis indicates a deficit of motor control and is hypothesized to result in inefficient muscular stabilization of**

	the spine. **Comment:** This study elegantly demonstrates that sensory and motor function is integrated, and that improper sequencing of muscle groups results in disjointed movement and pain. AK has argued from its founding that postural control is dependent upon the ability of the individual to properly interpret sensory information and execute an appropriate motor response.
Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain, Hides JA, Richardson CA, Jull GA.	*Spine.* 1996 Dec 1;21(23):2763-9. **STUDY DESIGN:** A clinical study was conducted on 39 patients with acute, first-episode, unilateral low back pain and unilateral, segmental inhibition of the multifidus muscle. Patients were allocated randomly to a control or treatment group. **OBJECTIVES:** To document the natural course of lumber multifidus recovery and to evaluate the effectiveness of specific, localized, exercise therapy on muscle recovery. **SUMMARY OF BACKGROUND DATA:** Acute low back pain usually resolves spontaneously, but the recurrence rate is high. Inhibition of multifidus occurs with acute, first-episode, low back pain, and pathologic changes in this muscle have been linked with poor outcome and recurrence of symptoms. **METHODS:** Patients in group 1 received medical treatment only. Patients in group 2 received medical treatment and specific, localized, exercise therapy. Outcome measures for both groups included 4 weekly assessments of pain, disability, range of motion, and size of the multifidus cross-sectional area. Independent examiners were blinded to group allocation. Patients were reassessed at a 10-week follow-up examination. **RESULTS:** Multifidus muscle recovery was not spontaneous on remission of painful symptoms in patients in group 1. Muscle recovery was more rapid and more complete in patients in group 2 who received exercise therapy (P = 0.0001). Other outcome measurements were similar for the two groups at the 4-week examination. Although they resumed normal levels of activity, patients in group 1 still had decreased multifidus muscle size at the 10-week follow-up examination. **CONCLUSIONS:** Multifidus muscle recovery is not spontaneous on remission of painful symptoms. **Lack of localized, muscle support may be one reason for the high recurrence rate of low back pain following the initial episode.**
Excessive scapular motion in individuals recovering from painful and stiff shoulders: causes and treatment strategies. Babyar SR.	*Phys Ther.* 1996 Mar;76(3):226-38; discussion 239-47. **BACKGROUND AND PURPOSE:** Scapular excursion and the wrist speed were studied before and after instruction and practice designed to achieve symmetrical scapular movement. **SUBJECTS:** Subjects were 10 female and 6 male patients, aged 44 to 78 years (chi=60.3, SD=11.2), with diagnosed shoulder pathologies. **METHODS:** Subjects were videotaped performing a reaching task. Pain status was monitored. The subjects were instructed to make the scapular movement symmetrical. They then repeated the task, while being videotaped, to monitor the effect of instruction. **RESULTS: Individuals with asymmetric upper-extremity starting positions had excessive vertical motion of the involved scapula, which they controlled after instruction.** Peak wrist speed of the involved upper extremity was lower only after instruction. **CONCLUSION AND DISCUSSION: Even in the absence of biomechanical factors or pain, excessive scapular vertical motion appears to occur in the involved upper extremities of individuals recovering from unilateral shoulder problems.** Improved scapular control can follow simple verbal instruction and practice, with a slight decrement in wrist speed. **Comment:** This study demonstrated that poor motor control is correlated with shoulder pain.
Responses to mechanical stimulation of the upper limb in painful cervical radiculopathy, Hall T, Quintner J.	*Aust J Physiother.* 1996;42(4):277-285. **Abstract:** Clinical and electromyographic (EMG) responses to non-noxious mechanical stimuli were studied in four patients with painful cervical radiculopathy, and in two control subjects. In the symptomatic arm(s), palpation over one or more nerve trunks was painful and accompanied by EMG activity, whereas palpation of adjacent soft tissues was painless and unaccompanied by EMG activity. Electromyographic activity was widespread in three patients when myotatic reflexes were elicited in the symptomatic arm(s). In asymptomatic arms of patients and controls, EMG responses to the myotatic reflexes were more localised. Allodynic nerve trunks in cervical

	radiculopathy appear to be afferent correlates of central sensitization; **the accompanying EMG activity may represent a motor correlate of this same process.** **Comment:** Muscles throughout the area of the brachial plexus are commonly found inhibited or atrophying after cervical spine injury and inflammation. Patients who have experienced cervical trauma from whiplash and other dynamics often have perplexing symptoms. This leads some doctors who do not evaluate function to conclude that poor response to therapy is psychogenic and often related to the patient's conscious or subconscious effort to gain in the medicolegal process. 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. Hall and Quintner also showed in this paper that in chronic pain patients, light pressure elicits a widespread increase in EMG activity. This indicates that a procedure like therapy localization in AK, where the patient gently touches an area of suspected injury, produces a change in muscle function that can be helpful in diagnosis.
Suboccipital dermatomyotomic stimulation and digital blood flow, Purdy WR, Frank JJ, Oliver B.	*J Am Osteopath Assoc.* 1996 May;96(5):285-9. **Abstract:** The effect of gentle, soft tissue manipulation in the suboccipital region on digital blood flow, as a measure of sympathetic nervous system activity, was studied. Digital strain gauge plethysmography was used to measure the changes in pulse contour during (1) a normative test period with the subject in the supine position, (2) after a control interval (placebo) during which the investigator placed his hands under the suboccipital region, and (3) after an interval during which the investigator's fingers applied slow, steady, circular kneading in the suboccipital triangle region. Twenty-five studies were performed in a crossover design with the patient as his or her own control. Total pulse amplitude (Y) and the height from the dicrotic notch to the peak (X) were measured. Examination of the total data of all subjects revealed the occurrence of a significant change in X and Y with simply touching the suboccipital region with the hands. An even more favorable response ensued when suboccipital manipulation was applied. Those subjects reporting comfort or neutral responses had larger significant changes with manipulation when compared with the group reporting the experience as uncomfortable. The response within each group suggests that favorable autonomic changes (sympathetic dampening) occur with specific suboccipital manipulation as well as, indeed, the simple touching of the suboccipital triangle. **Comment:** The AK technique called jugular decompression works specifically with the tissues of the suboccipital triangle. Treatment to any of the 5-factors of the IVF that improves the tone of the muscles in this area may produce the positive effects noted in this study.
Postural stability following mild head or whiplash injuries, Rubin AM, Woolley SM, Dailey VM, Goebel JA.	*Am J Otol.* 1995 Mar;16(2):216-21. **Abstract:** Studies of the sequelae of head injury suggest that cochlear and vestibular dysfunctions, comprise some of the most frequently reported delayed complications following head trauma. **To date, little attention has been given to the relation between post-traumatic subjective symptoms of dizziness and the objective measures of postural stability or balance.** The purpose of this study was to quantify the balance deficits in individuals who had developed symptoms of dizziness following mild head and whiplash injuries. The balance abilities of 29 patients, who developed dizziness following some type of mild head or whiplash injury, were compared to those of 51 healthy symptom-free subjects. **Balance was assessed by examining the center-of-pressure movements, in the anterior-posterior and medial-lateral directions, and the total movement displacement.** The isolated contributions of visual and somatosensory inputs were estimated by comparing the magnitudes of the center-of-pressure movements for the various sensory conditions. Data were collected from three 30-second trials of each combination of three visual conditions (accurate, absent, and inaccurate) and two somatosensory conditions (accurate and inaccurate), with the patient standing on a fixed-force platform. Univariate analyses of variance indicated that the group with head injury, compared to the control group, exhibited significantly greater anterior-posterior movements in four of the six

	sensory conditions and greater total movement displacement during the inaccurate vision/inaccurate somatosensation condition. **These data suggest that patients who have sustained head or neck trauma exhibit increased reliance on accurate visual input and are unable to utilize vestibular orienting information to resolve conflicting information from the visual and somatosensory systems.** **Comment:** Goodheart introduced the Freeman-Wyke one-leg standing test into AK in 1989. The patient is asked to stand upon one foot in front of the doctor, to find their balance if they can, and then to close their eyes. If they lose their balance, the test is positive. Upon asking the patient to therapy localize to the cervical spine, they may immediately improve their balance. The Freeman Wyke one-leg standing test is a functional neurological evaluation that requires the integrated function of various proprioceptors all over the body. These complex types of challenges are an important part of the differential diagnostic information that a physician using AK methods can employ to determine dysfunction in the sensory-motor-postural-proprioceptive systems in patients with post-whiplash syndromes.
Muscle control-pain control. What exercises would you prescribe? Richardson CA, Jull GA.	*Man Ther.* 1995 Nov;1(1):2-10. **Abstract:** A very specific type of exercise has been devised which is proving to provide effective pain relief for chronic and recurrent back pain sufferers. The exercise approach focuses on retraining a precise co-contraction pattern of the deep trunk muscles, the transversus abdominis and lumbar multifidus. **The approach is based on the knowledge of how muscles provide stability for the spine in normal situations. It has been further developed according to research evidence which has demonstrated dysfunction in the deep trunk muscles in patients with back pain.** The mechanism for pain relief with this specific exercise approach is believed to be through enhanced stability of the lumbar spine segments. **Comment:** The stabilization exercise program developed here place a great emphasis on conscious control of posture during exercise so as to carefully isolate the inhibited muscles and thus avoid encouraging inappropriate muscle substitution and faulty movement patterns that result from these patterns of muscle weakness. The specific manipulative treatment to repair these dysfunctional muscles is not discussed.
Sacroiliac joint manipulation decreases the H-reflex, Murphy, B.A., Dawson, N.J., Slack, J.R.	*Electromyogr Clin Neurophysiol*, 1995;35:87-94. **Abstract:** Joint manipulation is widely utilized clinically to decrease pain and increase the range of motion of joints displaying limited mobility. Evidence of efficacy is based on subjective reports of symptom improvement as well as on the results of clinical trials. Experiments were designed to determine whether or not sacroiliac joint manipulation affects the amplitude of the Hoffman (H) reflex. Surface EMG recordings of the reflex response to electrical stimulation of the tibial nerve in the popliteal fossa were made from the soleus muscle. The averaged amplitudes of H-reflexes were compared on both legs before and after either sacroiliac joint manipulation or a sham procedure. H-reflex amplitude was significantly decreased (12.9%) in the ipsilateral leg ($p < 0.001$) following a sacroiliac joint manipulation while there was no significant alteration following the sham intervention. There was no significant alteration in reflex excitability in the contralateral leg to the sacroiliac joint manipulation. To further investigate the mechanism of these reflex alterations, the local anesthetic cream EMLA (Astra Pharmaceuticals) was applied to the skin overlying the sacroiliac joint and the experiments were repeated on a different group of subjects. This was intended to determine if excitation of cutaneous afferents was responsible for the reflex excitability changes. There was still a significant decrease in reflex excitability (10.6%) following sacroiliac joint manipulation ($p < 0.001$). These findings indicate that joint manipulation exerts physiological effects on the central nervous system, probably at the segmental level. The fact that the changes persisted in the presence of cutaneous anesthesia suggests that the reflex changes are likely to be mediated by joint and/or muscle afferents. **Comment:** This study offers further elucidation of the finding of the physiological response of muscles to sacroiliac manipulation. One basic physiologic response to spinal manipulative therapy is a transient decrease or increase in motoneuron activity as assessed by the Hoffmann

	reflex (H-reflex) technique, depending upon the patients neuromuscular status at the time of measurement. The H-reflex technique involves peripheral stimulation of the Ia-afferent feedback pathway to assess the excitability of the alpha motoneuron. The MMT in AK evaluates the same neurological mechanism. This study shows that the clinical efficacy of SMT may involve a change in motoneuron activity which, in turn, may lead to a reduction in hypertonic as well as an increase in hypotonic muscles. Thus, a basic neurophysiologic response to SMT is muscular response to treatment.
Static back endurance and the risk of low-back pain. Alaranta H, Luoto S, Heliövaara M, Hurri H.	*Clin Biomech* (Bristol, Avon). 1995 Sep;10(6):323-324. **Abstract:** Spinal physical capacity and in particular static back endurance were studied for their prediction of first-time experience of low-back pain. Of a total of 126 persons who were free from back complaints at entry, 33 developed low-back pain during a follow-up of 1 year. **The static back endurance test was found to be the only physical capacity measurement that indicated an increased risk of low-back pain.** Adjusted for age, sex, and occupation, the odds ratio of a new low-back pain in those with poor performance was 3.4 (95% confidence interval, 1.2-10.0) compared to those with medium or good performance. **RELEVANCE: The simple static back endurance test might have value in health examinations because of its strong predictive value of future low-back pain.** **Comment:** The static back extensor endurance test (i.e. Sorensen's test) has been found to be able to predict first time onset of LBP in healthy individuals and recurrence rates in those recovering from LBP.
Ankle inversion injury and hypermobility: effect on hip and ankle muscle electromyography onset latency. Beckman SM, Buchanan TS.	*Arch Phys Med Rehabil.* 1995 Dec;76(12):1138-43. **OBJECTIVE:** Changes in reflexes associated with chronically sprained ankles were examined by measuring the reflex response latency of hip and ankle muscles during instantaneous ankle/foot inversion. **DESIGN:** Randomized trials. **SETTING:** All studies were performed in the Research Department laboratories at a major rehabilitation center in a large metropolitan area. **PATIENTS AND OTHER PARTICIPANTS:** Twenty subjects were assigned to 2 groups (normal and hypermobile) based on goniometry testing. Subjects were recruited from hospital and University staff and had a mean age of 31 +/- 5 years. **OUTCOME MEASURES:** Subjects stood on a platform constructed such that either foot/ankle could be instantaneously inverted. Latency was measured by EMG surface electrodes placed over the right and left gluteus medius and peroneal muscles. Two-factor analysis of variance was calculated to determine significant muscle onset latency differences ($p < .01$) between groups. **RESULTS:** Significant EMG latency differences were found in comparing right gluteus medius of the hypermobile group (127.35 +/- 6.02msec) with the normal group (150.49 +/- 6.49msec) during right ankle perturbation, and the left gluteus medius of the hypermobile group (120.71 +/- 6.16msec) with the normal group (136.24 +/- 5.88msec) during left ankle perturbation. **CONCLUSIONS:** These data suggest that there is decreased latency of hip muscle activation after ankle inversion in the hypermobile population. In treating ankle instability, clinicians must decide to address the altered hip muscle recruitment pattern or accept this recruitment pattern as an injury-adaptive strategy and thus accept unknown long-term consequences of premature muscle activation (ie, possible articular predisposition to degenerative changes, altered joint reaction forces, and muscle imbalances). **Comment:** In AK it has been found that the presence of pain, muscular imbalance, trigger points, or joint dysfunction will alter the ability of the patient to perform stereotypic movement patterns. This paper demonstrates the common and strong correlation between muscle dysfunction and joint dysfunction, a primary thesis of the AK approach.
Manual muscle strength testing: intraobserver and interobserver reliabilities for the intrinsic muscles of the hand. Brandsma JW,	*J Hand Ther.* 1995 Jul-Sep;8(3):185-90. **Abstract:** The reliability of manual muscle strength testing of the intrinsic muscles of the hand is reported. The muscle strengths of 28 patients who had neuropathies of the ulnar nerve or the ulnar and median nerves were graded by two physiotherapists to determine intraobserver and

Schreuders TA, Birke JA, Piefer A, Oostendorp R.	interobserver reliabilities. Muscle strength was graded using the numeric scale developed by the Medical Research Council (grades 0 to 5). **Reliabilities were established for nine muscles or muscle groups. Intraobserver reliabilities ranged from 0.71 to 0.96 and interobserver reliabilities from 0.72 to 0.93. It is difficult to isolate, and hence grade, most of the intrinsic muscles of the hand. Therefore, it is suggested that specific movements be tested and graded when assessing and evaluating muscle or nerve function.** **Comment: In AK MMT procedures, the patients are commonly tested in positions that create pain. This method increases the irritation upon the nervous system and makes muscular inhibition more apparent. Using AK methods of TL and challenge, the treatment necessary to correct the muscular inhibitions found in these positions of pain are determined.**
Flexion-relaxation phenomenon in the back muscles. A comparative study between healthy subjects and patients with chronic low back pain, Shirado O, Ito T, Kaneda K, Strax TE.	*Am J Phys Med Rehabil.* 1995 Mar-Apr;74(2):139-44. **Abstract:** At a certain position of trunk flexion, there is a sudden onset of electrical silence in back muscles. This is called "flexion-relaxation (F-R) phenomenon." The goals of this study were (1) to evaluate the relationship between flexion angle and activity of back muscles during flexion movement and (2) to determine what the difference is between healthy subjects and patients with chronic low back pain (CLBP). Twenty-five healthy subjects (13 males and 12 females; average age, 28.3 yr) and 20 patients with CLBP (12 males and 8 females; average age, 34.1 yr) volunteered for this study. The subjects were asked to flex forward maximally from the erect position and to maintain full flexion, followed by returning to the initial upright position. Flexion angle of trunk and hip was measured during the examination. Electromyographic activity of erector spinae was also monitored simultaneously. F-R phenomenon was observed in all healthy subjects before reaching the maximum flexion. Electrical silence continued even after extending the trunk began. In contrast, no patients with CLBP demonstrated F-R phenomenon. A significant difference in muscular activities of erector spinae between the groups was obtained when returning to the erect position from the maximum flexion. Moreover, time lag between trunk and hip movement was much greater in patients than in healthy subjects. **This study demonstrated that neuromuscular coordination between trunk and hip could be abnormal in patients with CLBP.** **Comment:** The key technical factor in the examination of patients with CLBP would be the MMT that makes the detection of the muscular imbalances and aberrant muscular activation patterns cited in this paper identifiable.
Reflex responses associated with manipulative treatments on the thoracic spine: a pilot study, Herzog W, Conway PJ, Zhang YT, Gál J, Guimaraes AC.	*J Manipulative Physiol Ther.* 1995 May;18(4):233-6. **OBJECTIVE:** To test systematically if spinal manipulative treatments (SMT) and the audible release associated with SMT cause activation of spinal muscles. **DESIGN:** Experimental pilot study. **SETTING:** Human Performance Laboratory, The University of Calgary. PARTICIPANTS: One male and one female asymptomatic volunteer. **INTERVENTION:** Slow and fast SMTs to the left transverse process of thoracic vertebrae using a reinforced hypothenar contact. The treatment forces were directed in a posterior-to-anterior direction with the subjects in a prone position. **MAIN OUTCOME MEASURES:** Forces applied by the chiropractor during SMT. Measurements of the audible release using skin-mounted accelerometers. Electromyographical activity of selected spinal muscles. **RESULTS:** Electromyographical (EMG) activity was observed consistently 50-100 msec after the onset of each of the fast SMTs, whether the treatment resulted in an audible release or not; for slow SMTs, there was never any visible electromyographical activity of the target muscles, whether the treatment resulted in an audible release or not. **CONCLUSION: The results of this study suggest that fast treatment thrusts elicit muscle activation, whereas slow force application does not.** The timing of the onset of the EMG response suggests that activation may be produced by a reflex response originating in the muscle spindles. It also appears that the audible release does not (by itself) evoke muscle activation or a joint proprioceptive reflex response as has been speculated in the literature.

	Comment: There are numerous reports in this compendium showing the measurable and immediate physiological effects of spinal manipulative therapy on motor system function. This study shows an increase in muscle activation after SMT. 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.
Ankle inversion injury and hypermobility: effect on hip and ankle muscle electromyography onset latency. Beckman SM, Buchanan TS.	*Arch Phys Med Rehabil.* 1995 Dec;76(12):1138-43. **OBJECTIVE:** Changes in reflexes associated with chronically sprained ankles were examined by measuring the reflex response latency of hip and ankle muscles during instantaneous ankle/foot inversion. **DESIGN:** Randomized trials. **SETTING:** All studies were performed in the Research Department laboratories at a major rehabilitation center in a large metropolitan area. **PATIENTS AND OTHER PARTICIPANTS:** Twenty subjects were assigned to 2 groups (normal and hypermobile) based on goniometry testing. Subjects were recruited from hospital and University staff and had a mean age of 31 +/- 5 years. **OUTCOME MEASURES:** Subjects stood on a platform constructed such that either foot/ankle could be instantaneously inverted. Latency was measured by EMG surface electrodes placed over the right and left gluteus medius and peroneal muscles. Two-factor analysis of variance was calculated to determine significant muscle onset latency differences ($p < .01$) between groups. **RESULTS:** Significant EMG latency differences were found in comparing right gluteus medius of the hypermobile group (127.35 +/- 6.02msec) with the normal group (150.49 +/- 6.49msec) during right ankle perturbation, and the left gluteus medius of the hypermobile group (120.71 +/- 6.16msec) with the normal group (136.24 +/- 5.88msec) during left ankle perturbation. **CONCLUSIONS: These data suggest that there is decreased latency of hip muscle activation after ankle inversion in the hypermobile population. In treating ankle instability, clinicians must decide to address the altered hip muscle recruitment pattern or accept this recruitment pattern as an injury-adaptive strategy and thus accept unknown long-term consequences of premature muscle activation (ie, possible articular predisposition to degenerative changes, altered joint reaction forces, and muscle imbalances).** **Comment:** A growing number of studies have suggested that impairments in one joint can lead to changes in muscle activation in other joint complexes. These consistent results have proposed an implication of definite changes in the hip joint muscle activation response due to injuries elsewhere in the kinematic chain of the body. This finding is in agreement with the findings of AK physicians who detect these interactions with the MMT.
Changes in neck electromyography associated with meningeal noxious stimulation, Hu JW, Vernon H, Tatourian I.	*J Manipulative Physiol Ther.* 1995 Nov-Dec;18(9):577-81. **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 trapezium 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.
The influence of afferent inputs from skin and viscera	*Neurosci Res.* 1995 Sep;23(2):195-205

on the activity of the bladder and the skeletal muscle surrounding the urethra in the rat, Morrison JF, Sato A, Sato Y, Yamanishi T.	(1) Somato-visceral and viscero-visceral reflex interactions have been studied in the bladder branches of the pelvic nerve and in the electromyographic (EMG) activity of the periurethral skeletal muscles of the anesthetized rat, and by observations of changes in bladder motility. (2) Slow distensions of the bladder caused some elevation of intravesical pressure, and culminated in a micturition contraction. Periurethral EMG activity increased gradually during the bladder distension, and showed an oscillatory marked increase during the bladder contraction. There was a small increase in pelvic nerve efferent activity during slow distension, and there was a substantial increase before, or at the start, of a micturition contraction. (3) Oscillatory bursting activity occurred in recordings of the EMG activity from periurethral skeletal muscle during the rising phase of micturition contraction; this was particularly so during the most rapid rise in intravesical pressure, and periods of electrical silence lasting 80-270 ms alternated with bursts of activity in the periurethral EMG. (4) In the present experiments, the switching mechanism activated by pelvic afferent signals related to intravesical pressure reversed the behavior of a number of reflex pathways. **When the bladder pressure was low, nociceptive pinching of the perineal skin usually caused bladder contraction and a rise in pelvic nerve efferent activity and in periurethral EMG activity.** When the bladder was full, micturition contractions were present and reduced in size and frequency by pinching of the perineal skin. The pelvic nerve efferent activity was correspondingly reduced, while the EMG activity increased during and following the nociceptive stimulus. Cooling the scrotal skin with ice also decreased the frequency of bladder contractions. (5) When the bladder pressure was low, distension of the anus and colon increased periurethral EMG activity, but did not affect bladder tone. However, when the bladder was full, these stimuli reduced the size and frequency of bladder contractions, associated with a reduction in the pelvic nerve efferent activity. There was usually a simultaneous reduction in the EMG activity in periurethral muscles. Similar results were obtained during distension of the seminal vesicles or vagina, or following injection of 20-60 microliters of saline into the lumen of the vas deferens. Reversal of the responses at extremes of intravesical pressure was observed in every case. (6) Following spinal transection at the upper cervical or thoracic level, micturition contractions were absent at high bladder volumes. However the effects described when the neuraxis was intact and the bladder pressure was low were still observed. **Comment:** A crucial development in AK occurred when Goodheart observed that if a patient touched an area of dysfunction, the results of MMT changed. Therapy localization has numerous applications in AK including TL to various reflexes, subluxations, meridian points, nerve receptors and other areas. This paper explains part of this fascinating development in the healing arts that has been proven helpful in the diagnosis of physical dysfunctions in patients.
The role of the psoas and iliacus muscles for stability and movement of the lumbar spine, pelvis and hip, Andersson E, Oddsson L, Grundstrom H, Thorstensson A.	*Scand J Med Sci Sports*. 1995 Feb;5(1):10-6 **Abstract:** The activation patterns of the psoas and iliacus muscles were investigated in 7 healthy adult subjects (4 men and 3 women) during a variety of motor tasks in standing, sitting and lying. Myoelectric activity was recorded simultaneously from the 2 muscles using thin wire electrodes inserted under guidance of high-resolution ultrasound. In general, both muscles were coactivated, albeit to different relative levels, particularly when hip flexor torque was required. Selective activation of the iliacus could, however, be seen to stabilize the pelvis in contralateral hip extension during standing. Psoas was found to be selectively involved in sitting with a straight back and in contralateral loading situations requiring stabilization of the spine in the frontal plane. During training exercises from a supine position, such as sit-ups, the contribution of the psoas and iliacus muscles could be varied by changing the range of motion as well as the position and support for the legs. Thus, the 2 anatomically different muscles of the iliopsoas complex were shown to have individual and task-specific activation patterns depending on the particular demands for stability and movement at the lumbar spine, pelvis and hip.
Shoulder weakness in professional baseball pitchers,	*Med Sci Sports Exerc.* 1994 Jan;26(1):5-9. **Abstract:** The purposes of this study were to: 1) compare shoulder range of motion and strength

Magnusson SP, Gleim GW, Nicholas JA.	in professional baseball pitchers (N = 47) compared with age-matched controls (N = 16), and 2) examine the relationship of injury history to strength and range of motion. Based on injury history pitchers were categorized as: 1) none (N = 26), 2) injury requiring conservative intervention (N = 9), or 3) injury requiring surgical intervention (N = 12). Range of motion was measured for internal rotation (IROM) and external rotation (EROM). Eccentric strength was measured by hand-held dynamometer for internal rotation (IR), external rotation (ER), abduction (ABD), and supraspinatus muscle (SUP) strength. Injury history had no effect on strength and range of motion. Dominant EROM was greater in pitchers, $P < 0.0001$, and controls, $P < 0.05$, with pitchers having greater EROM motion bilaterally, $P < 0.0001$. **Pitchers were weaker in SUP on the dominant vs nondominant side, $P < 0.0001$, and on the dominant side for weight adjusted ER, ABD, $P < 0.01$, and SUP, $P < 0.0001$, compared with controls. In conclusion, dominance and pitching resulted in soft tissue adaptation. Pitchers displayed weakness in three of four tests by comparison with controls, suggesting that the demands of pitching are insufficient to produce eccentric strength gains and may in fact lead to weakness. Dominant-side SUP weakness in pitchers may reflect subclinical pathology or chronic fatigue.**
Thermal deficit in lumbar radiculopathy. Correlations with pain and neurologic signs and its value for assessing symptomatic severity, Takahashi Y, Takahashi K, Moriya H.	*Spine.* 1994 Nov 1;19(21):2443-9; discussion 2449-50. **STUDY DESIGN.** The relationship between areas of thermal deficit and areas exhibiting other symptoms and neurologic signs, and the significance of the magnitude of thermal deficit in lumbar radiculopathy were analyzed. **OBJECTIVES.** To determine the clinical significance and value of thermal deficit as a sign of lumbar radiculopathy. **SUMMARY OF BACKGROUND DATA. Thermal** deficit has been discussed as a factor in the diagnosis of involved nerve roots. However, it has not been previously correlated with any particular symptoms or signs. **METHODS.** Sixty-eight healthy subjects and one hundred nine patients with lumbar radiculopathy due to intervertebral disc herniation underwent thermography. Sensitivity, specificity, and the agreement rate of thermal deficit to symptoms and neurologic signs were calculated in ten body regions. Total temperature difference of the affected limb was compared with the Japanese Orthopaedic Association scoring system. **RESULTS.** The agreement rates of thermal deficit with pain, muscle tenderness, **motor weakness**, and sensory disturbance were 60.9, 69.3, **71.8**, and 71.8%, respectively. Sensitivity and specificity of thermal deficit to symptoms and signs were approximately 30% and 80%, respectively. The correlation coefficient of temperature decrease of the affected limb and the Japanese Orthopaedic Association score was 0.57, indicating a moderate correlation. **CONCLUSIONS.** Thermal deficit should be considered an independent sign of lumbar radiculopathy. The relatively high specificity suggests that a normal temperature may indicate an asymptomatic region. Symptomatic severity of lumbar radiculopathy may be assessed by measuring the magnitude of thermal deficit in the affected limb. **Comment:** The correspondence between thermal deficit and motor weakness was the highest correlation cited in this study, indicating that measuring motor weakness in the affected limb may also assess the severity of lumbar radiculopathy. This study showed that disturbances of muscle function change skin temperature readings also.
The role of sensory information in the guidance of voluntary movement, McCloskey, D.I., Prochazka, A.	*Somatosensory and Motor Research,* 1994;11:69-76 **Abstract:** For voluntary movements to be well timed and accurate, they require coordinated tactile, visual and proprioceptive information about the movement in progress. Locomotion should be a stable cycle generated by the sensory links between the musculoskeletal system, the neural system and the environment.
Cervical musculoskeletal dysfunction in post-concussional headache, Treleaven J, Jull G, Atkinson	Cephalalgia, 1994 Aug;14(4):273-9; discussion 257. **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

L.	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. **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.
Isokinetic Muscle Testing: Is It Clinically Useful?, Almekinders LC, Oman J.	*J Am Acad Orthop Surg*, 1994 Jul;2(4):221-225. **Abstract**: The use of computer-driven muscle-testing devices has become increasingly popular during the past two decades. This expensive equipment allows evaluation of muscles and muscle groups in an isokinetic manner. Isokinetic muscle testing is performed with a constant speed of angular motion but variable resistance. Isokinetic dynamometers have been shown to produce relatively reliable data when testing simple, uniaxial joints, such as the knee, as well as when testing the spine in flexion and extension. Isokinetic strength data are generally not helpful in the diagnosis of orthopedic abnormalities. Isokinetic testing can be helpful during the rehabilitation of orthopedic patients, since it allows easy monitoring of progress. It also enables the patient to work on muscle rehabilitation in a controlled manner at higher speeds than are possible with more conventional exercise equipment. An isokinetic rehabilitation program can be easily tailored with concentric and eccentric components that closely resemble muscle actions during occupational and sports activities.
Arthrogenic quadriceps inhibition and rehabilitation of patients with extensive traumatic knee injuries, Hurley M, Jones D, Newham D	*Clin Sci (Lond).*1994 Mar;86(3):305-10. **Abstract:** 1. The relationship between joint damage, quadriceps weakness and arthrogenic muscle inhibition was investigated in eight patients who had sustained extensive traumatic knee injury. Isometric and isokinetic quadriceps and hamstring voluntary strength, and quadriceps arthrogenic muscle inhibition during isometric contractions, were measured before and after 4 weeks (approximately 100 h) of intensive rehabilitation. 2. Compared with the uninjured leg, before rehabilitation the injured leg had larger amounts of quadriceps arthrogenic muscle inhibition ($P < 0.025$), quadriceps ($P < 0.0001$) and hamstring ($P < 0.0001$) weakness and severe functional joint instability. There was a negative correlation between the amount of arthrogenic muscle inhibition and quadriceps voluntary contraction force ($P < 0.025$). 3. After rehabilitation in the injured leg there were small hamstring strength increases ($P < 0.05$-0.025), but no overall significant quadriceps strength increase. Arthrogenic muscle inhibition was statistically unchanged. Severe functional joint instability was still reported by all patients. 4. Previous studies have shown that minimal joint damage evokes relatively less arthrogenic muscle inhibition that does not impede rehabilitation. These data indicate that greater joint damage is associated with greater arthrogenic muscle inhibition, quadriceps weakness and joint instability. Furthermore, intensive rehabilitation had little affect on either quadriceps arthrogenic muscle inhibition or atrophy. **Comment:** This study indicates that specific injuries to the knee joint produce measurable inhibitions of quadriceps and hamstring muscles. This is a central tenet of AK, i.e. that joint injuries will produce muscle weakness that can be specifically diagnosed and treated. On a clinical basis, AK physicians find this consistently when testing patients with knee injuries. The fact that rehabilitation did not improve the arthrogenic inhibition found in these patients may indicate that the totality of their joint and muscle problems in the knee was not adequately

	treated.
Atrophy of suboccipital muscles in patients with chronic pain: a pilot study, Hallgren RC, Greenman PE. Rechtien JJ.	*J Am Osteopath Assoc.* 1994 Dec;94(12):1032-8. **Abstract:** Magnetic resonance imaging studies were performed in six patients with chronic head and neck pain and in five control subjects to determine whether irreversible atrophic changes resulting in destruction of muscle fibers have a role in patients with chronic pain specific to the cervical spine. Both groups of subjects had medical history obtained and underwent physical examination and proton density-weighted (PD-weighted) magnetic resonance imaging. Subjects with chronic pain had substantial restriction of motion. Axial proton density-weighted images of the rectus capitis major and minor muscles were examined. In the subjects with chronic pain, the muscles had high signal intensity, indicating replacement of dead suboccipital skeletal muscle with fatty tissue. This infiltration was not observed in the control subjects who were free of significant motion restrictions and had no history of recurring neck and head pain. Analysis of pixel intensity values confirmed this finding. The reduction in proprioceptive afferent activity in affected muscles may cause increased facilitation of neural activity that is perceived as pain. At least mean squares algorithm was used to define a linear estimating equation for each subject. Linear regression analysis, using an alpha level < .005, was used to determine how well each subject's data fit the estimating equation. This preliminary work indicates substantial infiltration of fatty tissue into suboccipital muscles of some subjects being treated for chronic head and neck pain.
Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain, Hides JA, Stokes MJ, Saide M, Jull GA, Cooper DH.	*Spine.* 1994 Jan 15;19(2):165-72. **Abstract:** The effect of low back pain on the size of the lumbar multifidus muscle was examined using real-time ultrasound imaging. Bilateral scans were performed in 26 patients with acute unilateral low back pain (LBP) symptoms (aged 17-46 years) and 51 normal subjects (aged 19-32 years). In all patients, multifidus cross-sectional area (CSA) was measured from the 2nd to the 5th lumbar vertebrae (L2-5) and in six patients, that of S1 was also measured. In all normal subjects, CSA was measured at L4 and in 10 subjects measurements were made from L2-5. Marked asymmetry of multifidus CSA was seen in patients with the smaller muscle being on the side ipsilateral to symptoms (between-side difference 31 +/- 8%), but this was confined to one vertebral level. Above and below this level of wasting, mean CSA differences were < 6%. In normal subjects, the mean differences were < 5% at all vertebral levels. The site of wasting in patients corresponded to the clinically determined level of symptoms in 24 of the 26 patients, but there was no correlation between the degree of asymmetry and severity of symptoms. Patients had rounder muscles than normal subjects (measured by a shape ratio index), perhaps indicating muscle spasm. Linear measurements of multifidus cross-section were highly correlated with CSA in normal muscles but less so in wasted muscles, so CSA measurements are more accurate than linear dimensions. The fact that reduced CSA, i.e., wasting, was unilateral and isolated to one level suggests that the mechanism of wasting was not generalized disuse atrophy or spinal reflex inhibition. **Comment:** The researchers in this paper have found lumbar multifidus muscle atrophy occurs in patients with low back pain. In this study, no therapy for this finding was offered, and the functional state of these muscles was not evaluated. Were the muscles neurologically inhibited or facilitated; were they capable to functioning better? AK has presented the new principle that the scientific literature had not previously dealt with; the correct form of manual treatment can instantly improve muscle function.
Electromyographic analysis of neck muscle fatigue in patients with osteoarthritis of the cervical spine. Gogia PP, Sabbahi MA.	*Spine.* 1994 Mar 1;19(5):502-6. **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.
The influence of ankle sprain injury on muscle activation during hip extension, Bullock-Saxton JE, Janda V, Bullock MI.	*Int J Sports Med.* 1994 Aug;15(6):330-4. **Abstract: The likely influence of a localized injury in a distal joint on the function of proximal muscles is an important consideration in assessment and treatment of musculoskeletal injuries.** However, little experimental evidence in humans exists in this area. Accordingly, a controlled study was carried out, in which the function of muscles at the hip was compared between subjects who had suffered previous severe unilateral ankle sprain and matched control subjects. The pattern of activation of the gluteus maximus, the hamstring muscles and the ipsilateral and contralateral erector spinae muscles was monitored through the use of surface electromyography during hip extension from prone lying. **Analyses revealed that the pattern of muscle activation in subjects with previous injury differed markedly from normal control subjects**, and that changes appeared to occur on both the uninjured and the injured sides of the body. A significant difference between the two groups was the delay in onset of activation of the gluteus maximus in previously injured subjects. **The existence of remote changes in muscle function following injury found in this study emphasise the importance of extending assessment beyond the side and site of injury.**
Muscle strength in relation to muscle length, pain and muscle imbalance, Janda V. In: *Muscle Strength*, Harms-Ringdahl K (ed.)	Churchill Livingstone, New York, 1993. **Abstract:** According to Janda, the most typical types of functional muscle weakness are as follows. *Tightness weakness* develops when a muscle is chronically shortened and eventually loses strength (i.e., the psoas). *Stretch weakness* occurs if a muscle is perpetually placed in a lengthened position so that the muscle spindles become desensitized to stretch (i.e. gluteus maximus). *Arthrogenic weakness* occurs when nociceptive afferent barrage from a joint or ligament causes reflex inhibition. Examples given are the vastus medialis after injury of the anterior cruciate ligament or meniscus or gluteus maximus weakness when a sacroiliac dysfunction is present. Finally, *trigger point weakness* occurs when a muscle cannot fully activate all its contractile fibers because of the presence of a trigger point. **Comment:** According to Janda, certain muscles tend to become inhibited whereas other muscles tend to become overactive. Postural or antigravity muscles are those that tend to become overactive or shortened. Phasic muscles have a predisposition to becoming inhibited or weak. This muscle imbalance seems to be reinforced by reciprocal inhibition of antagonists muscles. This is called “Sherrington’s Law of Reciprocal Inhibition” and explains why in the presence of a hypertonic muscle, there will usually be a hypotonic or inhibited muscle. Janda has described one of the most clinically relevant patterns of muscle dysfunction and called it the “lower crossed syndrome”, and the “upper crossed syndrome” which are typified by the following pairs of tight and weak muscles. **Lower Crossed Syndrome:** Weak gluteus maximus and short hip flexors Weak abdominals and short lumbar erector spinae

	Weak gluteus medius and short tensor fascia lata and quadratus lumborum **Upper Crossed Syndrome:** Weak lower and middle trapezius and short upper trapezius and levator scapulae Weak deep neck flexors and short suboccipitals and sternocleidomastoid Weak serratus anterior and short pectoralis major It is important to point out that shortness/tightness of a postural muscle ***does not imply strength***. Such muscles will often test as weak.
Trunk strength and lumbar paraspinal muscle activity during isometric exercise in chronic low-back pain patients and controls. Cassisi JE, Robinson ME, O'Conner P, MacMillan M.	*Spine.* 1993 Feb;18(2):245-51. **Abstract:** The purpose of this study was to describe trunk strength and lumbar paraspinal muscle activity across five angles of flexion during isometric exercise and rest in chronic low-back pain patients and control subjects. High muscle tension as measured by surface integrated electromyography is predicted by a muscle spasm model, and low muscle tension is predicted by a muscle deficiency model. Prior lumbar surgery had no affect on peak torque or maximum surface integrated electromyography data. Both groups produced greater torque and less surface integrated electromyography in more flexed positions. Chronic low-back pain patients exhibited lower peak torque and lower maximum surface integrated electromyography bilaterally during isometric extension effort across all angles. **A muscle deficiency model of chronic low back pain was supported by these data and a muscle spasm model was not supported.** Discriminant analyses indicated that monitoring maximum surface integrated electromyography of lumbar muscles during isometric effort facilitates classification of chronic low-back pain patients. Future directions are discussed in terms of applying psychophysiologic methods to pain rehabilitation. **Comment:** After 50 years, the research evidence is suggesting the demise of the hyperactivity-causality model for musculoskeletal pain. The lack of convincing evidence to support the belief in hyperactivity as an etiological factor in musculoskeletal conditions has been pointed out in many of the research reviews contained in this compendium. These data indicate that the body's reaction to injury and pain is not primarily increased muscular tension and stiffness; **rather *muscle inhibition is often more significant.*** The later works of Panjabi, Janda, Lewit, Jull, Sahrmann, Bergmark, Hammer and Liebenson have confirmed the findings of Goodheart , the ICAK, and Kendall, showing that muscles predictably respond to pain, inflammation, and/or injury with *weakness*.
Various Forms of Chiropractic Technique, Bergmann, T.	*Chiropractic Technique,* May 1993; 5(2):53-5. Doctors who noticed a regularity in their results and began to ask why those results occurred started the majority of chiropractic technique systems. The apparent fallacy to many of these system approaches is that the evaluative procedure linked to the manipulative procedure is often singular and very simplistic. The human body; however, is a very complex and integrative organism, and to rely on a single evaluative tool for the sole application of a therapeutic intervention should not be considered sound clinical practice. It has not been established that any adjective or evaluative procedure is more or less effective than any other for any condition. Studies comparing the effectiveness and efficiency of technique systems are long over due.
Neuromuscular effects of temporomandibular joint dysfunction, Esposito, V., Leisman G, Frankenthal Y.	*Intern J Neuroscience,* 1993;68 **Abstract:** Neurologically intact male and female TMJ dysfunction patients with or without cervical spine involvement were examined using standard clinical neurologic testing for balance and coordination. Seventy percent of the TMJ patients without cervical involvement exhibited positive signs for balance, coordination, and/or ataxia found in response to having the patient's mandible stressed by extending it a far as possible laterally, and also opened (as wide as possible) or closed (biting down). The performance of patients with cervical involvement was not significantly different than those without cervical involvement. Further examination of the relation between the TMJ and auditory, visual, cerebellar, and coordination mechanisms is

	therefore indicated.
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) ($t = -5.98$, $p < 0.00005$), 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.
The influence of arthrogenous muscle inhibition on quadriceps rehabilitation of patients with early, unilateral osteoarthritic knees, Hurley MV, Newham DJ.	*Br J Rheumatol*, 1993 Feb;32(2):127-31. **Abstract:** Reflex arthrogenous muscle inhibition (AMI) may cause muscle atrophy or impede effective rehabilitation of affected muscle groups. To investigate this, bilateral quadriceps AMI, isometric and isokinetic muscle strength were measured in 10 patients with unilateral osteoarthritic knees, before and after a course of routine physiotherapy. Before rehabilitation, quadriceps of all the diseased legs were inhibited ($P < 0.05$) and 40% weaker ($P < 0.02$) than the non-diseased legs. Following rehabilitation, AMI decreased ($P < 0.01$) in the diseased leg and strength increased at all test velocities ($P < 0.05$-0.005); however, strength deficits compared with the non-diseased leg remained. Subjective improvements in functional ability and confidence in the diseased leg were reported. Though AMI may be partially responsible for unilateral muscle weakness, it does not preclude strength gain in affected muscles. Possible physiological mechanisms which evoke AMI may also adversely affect muscle proprioception, implicating AMI as a possible cause of initiation or progression of degenerative joint disease. **Comment:** This study demonstrates that being able to reduce arthrogenous muscle inhibition in patients recovering from joint injuries is important to the rehabilitation process. It also shows that a measurable change in muscle strength, from inhibition to strength, occurs after manipulative therapy. AMI is the inability of a muscle to recruit all motor units of a muscle group during a maximal effort voluntary muscle contraction and it is a natural response designed to protect joints from further damage. The AMI phenomenon is frequently found during AK evaluations when there is muscle weakness around joints that have been injured. Mechanoreceptor activity plays a primary role in AMI. Manipulation of a joint has been shown to activate mechanoreceptors from structures in and around the manipulated joint. The altered afferent input arising from the stimulation of these receptors is thought to cause changes in motor neuron excitability, **with a subsequent decrease in AMI.** This is assumed to influence motor neuron pool recruitment during voluntary muscle contraction.
Reflex activation of gluteal muscles in walking. An approach to restoration of muscle function for patients with low-back pain, Bullock-Saxton JE, Janda V, Bullock	*Spine*, 1993 May;18(6):704-8. **Abstract:** Gluteal activation and pelvic stability often are decreased in chronic low-back pain sufferers, but the importance of motor control and programming in treatment has not been fully evaluated. This study investigated whether gluteal muscles could be activated more effectively by stimulating the proprioceptive mechanism during walking. Labile support, through wearing "balance shoes," offered facilitation of cerebellovestibular circuits. Electromyographic recordings

MI.	of gluteus maximus and medius in 15 healthy subjects were made during barefoot and balance shoes walking before and after 1 week of facilitation. Significant increases ($P < 0.0002$) in gluteal activity and significant decreases ($P < 0.01$) in time to 75% maximum contraction, demonstrated the value of sensorimotor elicitation of subconscious and automatic responses in muscles often weakened in back pain sufferers. **Comment:** AK adds a dynamic aspect to orthopedic examination as it relates to the extremities. Knowledge of predictable muscle function resulting from stimulating the foot proprioceptors (the object of this study) helps understand how subluxations and muscle dysfunction of the feet affect remote areas of the body.
Childhood psychological trauma and chronic refractory low-back pain, Schofferman J, Anderson D, Hines R, Smith G, Keane G.	*Clin J Pain.* 1993 Dec;9(4):260-5. **OBJECTIVE:** To examine the correlation between childhood psychological trauma(s) and refractory back pain in patients with and patients without prior spine surgery. **DESIGN:** Retrospective chart review survey of 101 consecutive patients who had undergone multidisciplinary evaluation for refractory back pain. **SETTING:** Private practice, tertiary care spine center. **MAIN OUTCOME MEASURES:** Each psychological risk factor (physical abuse, sexual abuse, emotional neglect or abuse, abandonment, and chemically dependent caregiver) was rated as present or absent. Spinal pathology was graded as significant or not significant. **RESULTS:** There were 56 patients with failed back surgery syndrome, 28 men and 28 women, with a mean age of 43 and mean pain duration of 45 months. There were 45 patients with no prior surgery, 26 men and 19 women, with a mean age of 43 and mean pain duration of 33 months. In the failed back surgery syndrome group, 27 (48%) had three or more risks and 39 (70%) had two or more. When the 12 patients with significant pathology are not considered, 24 of the remaining 44 (55%) patients had three or more risks. In the group with no prior surgery, 26 (58%) had three or more risks and 38 (84%) had two or more. When the five patients with significant pathology are not considered, 24 (60%) had three or more risks. **CONCLUSIONS:** Multiple childhood psychological traumas may predispose a person to chronic low back pain. In patients in this setting with refractory low back pain with or without prior lumbar spine surgery, three or more childhood psychological risk factors are prevalent, especially in patients with minimal structural pathology.
Chronic musculoskeletal pain and depressive symptoms in the National Health and Nutrition Examination. I. Epidemiologic follow-up study, Magni G, Marchetti M, Moreschi C, Merskey H, Luchini SR.	*Pain.* 1993 May;53(2):163-8. **Abstract:** We report here follow-up data on subjects who were examined in two surveys conducted by the United States Center for Health Statistics at an interval of 8 years. The first survey was the 1st National Health and Nutrition Examination Survey (NHANES-1), and the second conducted 8 years later was the National Health and Nutrition Epidemiologic Follow-up Study (NHEFS). From an original sample of 3023 subjects, 153 were known to be deceased, leaving a potential sample of 2870 cases, of whom 2341 were ultimately examined in the NHEFS. The definition of pain used in the NHANES-1 survey identified 15% of the subjects as suffering from persistent pain. Using a different pain definition, in the NHEFS, the frequency of subjects with chronic pain was 32.8%. Applying this second definition, the percentage of subjects with chronic pain in the NHANES-1 had risen from 15 to 20.2. Some subjects (32.5%) who originally had chronic pain were free from pain at the time of follow-up; 59% of the subjects with chronic pain on follow-up did not have it initially. As found originally in the NHANES-1, the group with chronic pain at the NHEFS comprised significantly more females, older people, and people with lower income. **On logistic regression analysis the strongest relationship found at the NHEFS between the variables examined was between chronic pain and depression.** **Comment:** In AK examination it is frequently found that many mental and emotional problems are due to physiological dysfunction. This paper highlights the fact that depression and other psychological concomitants to spinal pain may be resolved with successful chiropractic treatment to the patient's pain syndromes.
Cervical spine subluxation	*Plast Reconstr Surg.* 1993 Jun;91(7):1187-95; discussion 1196-7.

associated with congenital muscular torticollis and craniofacial asymmetry, Slate RK, Posnick JC, Armstrong DC, Buncic JR.	**Abstract:** The relationship between craniofacial asymmetry, congenital muscular torticollis, and cervical spine subluxation was examined in a study of 30 children who presented to our Craniofacial Program from 1987 through 1990. Twenty-six of the 30 patients had craniofacial asymmetry and muscular torticollis without true suture synostosis documented by head and neck CT scans. These 26 patients had positional skull molding with consistent flattening of the contralateral occipitoparietal region and the ipsilateral fronto-orbital region relative to the side of the torticollis. Thirteen of the 26 patients also were found to have a C1-C2 subluxation. C1 was rotated forward of C2 on the side contralateral to the muscular torticollis in 12 of 13 patients. None of the patients with subluxation had neurologic deficits or required spinal stabilization. Ophthalmologic evaluations demonstrated amblyopia (4 patients) and horizontal strabismus (1 patient), both thought to be coincidental, with no evidence of nystagmus in any case. Seven of the 26 patients required surgical therapy for their neck muscle tightness, while the remainder responded to physiotherapy. Only 2 of the 26 patients underwent cranio-orbital reshaping for correction of their upper face asymmetry. Recognition of cervical subluxation in patients with congenital muscular torticollis may help to explain residual head-neck posturing problems even after successful neck muscle therapy.
The lumbar multifidus muscle five years after surgery for a lumbar intervertebral disc herniation, Rantanen J, Hurme M, Falck B, Alaranta H, Nykvist F, Lehto M, Einola S, Kalimo H.	*Spine.* 1993 Apr;18(5):568-74. **Abstract:** Biopsy specimens of the lumbar multifidus were obtained from 18 patients with lumbar disc herniation at operation and after a postoperative follow-up period of 5 years. The structure and morphometry of the muscle fibers were analyzed and these data were compared with intraoperative biopsy results and the clinical outcome of the operation. The main findings were: 1) on the basis of occupational handicap score 10 patients belonged in the "positive" and 8 in the "negative" outcome group; 2) the intraoperatively recorded selective type 2 muscle fiber atrophy and the extent of pathologic inner structure changes both decreased in the "positive" outcome group, whereas they persisted in the "negative" group; 3) grouping as a definite sign of reinnervation was seen in only two versus four patients of the "positive" versus "negative" outcome group; 4) the relative amount of adipose tissue within the muscle decreased more markedly in the "positive" outcome group. The authors propose that both inactivity and axonal injury (mainly of neurapraxia type) contribute to the selective type 2 atrophy and inner structure changes in disc patients' multifidus muscle. **These pathologic structural changes correlated well with the clinical outcome, and most importantly they are reversible and can be diminished by adequate therapy.**
The effects of neutral posture deviations on perceived joint discomfort ratings in sitting and standing postures, Genaidy AM, Karwowski W.	*Ergonomics.* 1993 Jul;36(7):785-92. **Abstract:** There is a pressing need to rank body deviations from neutral postures which occur due to variety of body movements around different joints. Such knowledge is needed to better understand potentially adverse effects of poor working postures on the industrial population. The main objective of this study was to examine the effects of postural deviations on perceived joint discomfort ratings assessed under similar working conditions. Twelve males and seven females participated in the laboratory study. The results revealed several distinct classes of joint deviations from neutral postures, which need to be assigned different weights of postural stress. A preliminary ranking system for assessment of stressfulness of human body deviations about different joints was proposed. **Comment:** Postural analysis is a major source of information in AK. It is one of several methods for locating probable muscle dysfunction. As one becomes more familiar with AK, nearly all postural imbalances can be readily understood as a result of aberrant muscle function in nearly all cases.
The reflex effects of spinal somatic nerve stimulation on viscera function, Sato, A.	*J Manipulative Physiol Ther,* 1992;15(1):57-61 **Abstract:** This paper studies somatovisceral reflex responses in the cardiovascular organ,

	gastrointestinal tract, urinary bladder and adrenal medulla in anesthetized animals after eliminating emotional factors following somatic sensory stimulations. Various somatic sensory stimulations, including cutaneous, muscle and articular sensory stimulations, can produce differing autonomic reflex responses, depending on which visceral organs and somatic afferents are stimulated. Some responses have dominant sympathetic efferent involvement, whereas others have dominant parasympathetic efferent involvement. Some responses have propriospinal and segmental characteristics, while others have supraspinal and generalized characteristics in their reflex nature. These somatovisceral reflex responses may be functioning during spinal manipulative therapy in conscious humans.
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. -- Canadian Memorial Chiropractic College, Toronto, Ontario.	*J Manipulative Physiol Ther.* 1992 Jul-Aug;15(6):343-9. **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.
Effect of osteopathic medical management on neurologic development in children, Frymann VM, Carney RE, Springall P.	*J Am Osteopath Assoc.* 1992 Jun;92(6):729-44. **Abstract:** For 3 years, children between 18 months and 12 years of age with and without recognized neurologic deficits were studied at the Osteopathic Center for Children. Their response to 6 to 12 osteopathic manipulative treatments directed to all areas of impaired inherent physiologic motion was estimated from changes in three sensory and three motor areas of performance. Houle's Profile of Development was used to compare neurologic with chronologic age and rate of development, and scores were age-adjusted. Results in children after treatment were compared with those following a waiting period without treatment. Neurologic performance significantly improved after treatment in children with diagnosed neurologic problems and to a lesser degree in children with medical or structural diagnoses. The advances in neurologic

	development continued over a several months' interval. The results support the use of osteopathic manipulative treatment as part of pediatric healthcare based on osteopathic medical philosophy and principles.
Postural control in young and elderly adults when stance is perturbed: kinematics, Alexander, N. B, Shepard, N, Gu, MJ, Schultz, A.	*Journal of Gerontology*, 1992; 47:M79-M87. **Abstract:** Increased postural sway and falling are associated with aging and are likely related to problems with postural control in the elderly. We investigated the motions of individual body segments in 24 healthy young adults and 15 healthy elderly adults (mean ages 26 and 72) in response to four tasks: (a) standing with feet flat on an anteriorly accelerating platform (Flat Translation); standing on a narrow beam support that was (b) stationary (Beam Standing) and (c) accelerating anteriorly (Beam Translation); and (d) standing on a rotatable but otherwise stationary springboard (Springboard Standing). An optoelectronic camera system was used to measure rotations of body segments, particularly regarding their maximum excursions, time to first rotation response, direction of initial rotation, and time to first rotation reversal. In general, larger rotation excursions were noted in the elderly compared to the young group, particularly in the Beam Standing and Beam Translation tasks, but the magnitude of rotation difference was small. All rotation magnitudes were well within the available ranges of motion of the body joints. In both excursion magnitudes and directions of initial rotation, the elderly showed greater variability than the young. In the Beam Translation task, the elderly group, compared to the young, tended to rotate their upper body segments more than in the Flat Translation task. These data suggest that healthy elderly adults with no apparent musculoskeletal or neurological impairments have small but consistent differences in postural control kinematics, particularly when more challenging conditions are presented. Moreover, these data provide the basis for biomechanical analyses of joint torques and other dynamic requirements of these responses. **Comment:** Manual muscle testing is the method of testing functional neurology and postural mechanisms in applied kinesiology. Normally there is predictable facilitation and inhibition of muscle function. When there is not, applied kinesiology testing methods are employed to discover and correct the factors responsible for the disturbance in predictable muscle function. The importance of restoring normal function in elderly patients is demonstrated by the postural kinematic disturbances of the patients in this study.
The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement, Panjabi MM.	*J Spinal Disord*, 1992 Dec;5(4):383-9; discussion 397. **Abstract:** Presented here is the conceptual basis for the assertion that the spinal stabilizing system consists of three subsystems. The vertebrae, discs, and ligaments constitute the passive subsystem. **All muscles and tendons surrounding the spinal column that can apply forces to the spinal column constitute the active subsystem**. The nerves and central nervous system comprise the neural subsystem, which determines the requirements for spinal stability by monitoring the various transducer signals, and directs the active subsystem to provide the needed stability. A dysfunction of a component of any one of the subsystems may lead to one or more of the following three possibilities: (a**) an immediate response from other subsystems to successfully compensate**, (b) a long-term adaptation response of one or more subsystems, and (c) an injury to one or more components of any subsystem. It is conceptualized that the first response results in normal function, the second results in normal function but with an altered spinal stabilizing system, and the third leads to overall system dysfunction, producing, for example, low back pain. In situations where additional loads or complex postures are anticipated, **the neural control unit may alter the muscle recruitment strategy**, with the temporary goal of enhancing the spine stability beyond the normal requirements. **Comment:** This paper elegantly describes a number of the fundamental tenets of AK. Under normal conditions, structural balance is maintained by the muscles of the body (“the active subsystem”), that is controlled by the nervous system. With MMT, when a muscle tests as inhibited, treatment to the portion of the nervous system causing the inhibition restores the muscle to normal facilitation. Importantly, Dr. Panjabi suggests that changes in neural function produces immediate changes in muscle function. This correlation is at the center of the successes

	achieved using AK therapeutics.
The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis, Panjabi MM	*J Spinal Disord,* 1992 Dec;5(4):390-6; discussion 397. **Abstract:** The neutral zone is a region of intervertebral motion around the neutral posture where little resistance is offered by the passive spinal column. Several studies--in vitro cadaveric, in vivo animal, and mathematical simulations--have shown that the neutral zone is a parameter that correlates well with other parameters indicative of instability of the spinal system. It has been found to increase with injury, and possibly with degeneration, **to decrease with muscle force increase across the spanned level**, and also to decrease with instrumented spinal fixation. In most of these studies, the change in the neutral zone was found to be more sensitive than the change in the corresponding range of motion. The neutral zone appears to be a clinically important measure of spinal stability function. It may increase with injury to the spinal column **or with weakness of the muscles, which in turn may result in spinal instability or a low-back problem**. It may decrease, and may be brought within the physiological limits, by osteophyte formation, surgical fixation/fusion, **and muscle strengthening.** The spinal stabilizing system adjusts so that the neutral zone remains within certain physiological thresholds to avoid clinical instability. **Comment:** Unless there is a bony deformity, muscle imbalance is basic to structural distortion and changes in the motion and positioning of the spinal joints. For distortions in the kinematics of the neutral zone or for spinal subluxations to be maintained, muscle imbalance must be present. Dr. Panjabi's paper once again elucidates several fundamental tenets of AK.
Intrarater reliability of manual muscle test (Medical Research Council scale) grades in Duchenne's muscular dystrophy, Florence JM, Pandya S, King WM, Robison JD, Baty J, Miller JP, Schierbecker J, Signore LC.	*Phys Ther.* 1992 Feb;72(2):115-22; discussion 122-6 **Abstract: The purpose of this study was to document the intrarater reliability of manual muscle test (MMT) grades in assessing muscle strength in patients with Duchenne's muscular dystrophy (DMD).** Subjects were 102 boys, aged 5 to 15 years, who were participating in a double-blind, multicenter trial to document the effects of prednisone on muscle strength in patients with DMD. Four physical therapists participated in the study. Two identical (duplicate) evaluations were performed within 5 days of each other by the same examiner initially and after 6 and 12 months of treatment. A total of 18 muscle groups were tested on each patient, 16 of them bilaterally, using a modification of the Medical Research Council scale. Reliability of muscle strength grades obtained for individual muscle groups and of individual muscle strength grades was analyzed using Cohen's weighted Kappa. **The reliability of grades for individual muscle groups ranged from .65 to .93, with the proximal muscles having the higher reliability values. The reliability of individual muscle strength grades ranged from .80 to .99, with those in the gravity-eliminated range scoring the highest. We conclude the MMT grades are reliable for assessing muscle strength in boys with DMD when consecutive evaluations are performed by the same physical therapist.**
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 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.
Quantitative cervical flexor strength in healthy subjects and in subjects with mechanical neck pain, Silverman JL, Rodriquez AA, Agre JC.	*Arch Phys Med Rehabil.* 1991 Aug;72(9):679-81. **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 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.
Reliability of testing measures in Duchenne or Becker muscular dystrophy, Barr AE, Diamond BE, Wade CK, Harashima T, Pecorella WA, Potts CC, Rosenthal H, Fleiss JL, McMahon DJ.	*Arch Phys Med Rehabil.* 1991 Apr;72(5):315-9. **Abstract:** In a multiinstitutional collaborative study, we ascertained the interevaluator and intraevaluator reliability of six physical therapists who performed assessment measures on 36 boys (11.7 +/- 3.9 years) with Duchenne or Becker muscular dystrophy. Upper and lower extremities were evaluated by manual muscle testing for function, range of motion, and strength. The data were analyzed using intraclass correlation coefficients (ICCs). For the interevaluator phase, ICCs were as follows: **average muscle strength, .90; range of motion, .76; and upper extremity functional performance, .58. For the intraevaluator phase, corresponding ICCs were .80 to .96; .33 to .97; .34 to 1.00. Our results confirm and extend observations by others that these assessment measures are sufficiently reliable for use in a multiinstitutional collaborative effort. Such results can be used to design clinical trials that have sufficient statistical power to detect changes in the rate of disease progression.** Investigators planning clinical trials in a multiinstitutional collaborative setting should first standardize the assessment methods, provide evaluator training, and document reliability.
Effects of restrained cervical mobility on voluntary eye	*Acta Otolaryngol,* 1991;111(4):664-70.

movements and postural control, Karlberg M, Magnusson M, Johansson R.	**Abstract:** The effects of restrained cervical mobility on pursuit eye movements (PEMS), voluntary saccades and postural control, as measured by posturography, were studied in 11 healthy subjects whose cervical spine movement had been restrained for 5 days by means of a rigid neck-collar. At day 5 mean peak velocity of voluntary saccades at amplitudes of 40 degrees and 60 degrees was significantly reduced, as was mean peak gain of PEMs at a stimulus velocity of 50 degrees/s; the variance of body position in vibration-induced body sway was significantly increased, but there was no difference in variance of galvanically-induced body sway or in velocity of vibration-induced body sway. The results suggest that restriction of cervical movements per se affects voluntary eye movements, a conclusion also consistent with findings in patients with tension headache. Restriction of cervical movement only marginally affects postural control. **Comment:** In applied kinesiology chiropractic methodology, a means for testing the integration of the muscles in the body with the visual reflexes has been termed *ocular lock*. It demonstrates the failure of the eyes to work together on a binocular basis through the cardinal fields of gaze. When the eyes are turned in a specific direction, a previously strong indicator muscle will weaken when the ocular lock test is positive, and there is probably disturbance in the visual righting, vestibulo-ocular, or opto-kinetic reflexes. The eyes must work together as a team so that each eye is directed to the same fixation point on a page, somewhat like two spotlights highlighting a dancer at the center of the stage. This is called convergence. The focus of the eyes must also be quickly adjusted from one distance or angle to another, called accommodation. The eyes must be able to track or scan along the horizon or a line of print smoothly and evenly so that the brain can receive a flow of sequentially correct visual information. This is called tracking. Eye motion and position are integrated with proprioceptors throughout the body, as well as those of the vestibular apparatus and head-on-neck reflexes. This is usually not gross pathology of cranial nerves III, IV, and VI; rather it is poor functional organization. Mechanical irritation of cranial nerves III, IV, or VI (usually VI) may be responsible for disturbed binocular function leading to discordant sensory inputs from the visual righting reflex. This paper shows that erroneous cervical spine sensory information converges in the central nervous system with the visual system, and this could affect the perception of body orientation and lead to a misinterpretation of relation to the surrounding.
Forefoot pain associated with muscle strain in the lower extremity, Hsieh CY.	*J Manipulative Physiol Ther.* 1991 Nov-Dec;14(9):527-9. **Abstract:** A case of forefoot pain at the first metatarsophalangeal joint is discussed. **Local treatment with ultrasound failed to bring significant relief. However, dramatic and lasting relief occurred when treatment was applied to the muscle belly of the extensor hallucis longus. The patient also suffered from hallux valgus with mild foot pronation.** Two years after therapy, the patient stated she had not experienced any foot pain since the last treatment, and she continued to wear the prescribed flexible foot orthotics on a daily basis.
The pain-adaptation model: a discussion of the relationship between chronic musculoskeletal pain and motor activity, Lund JP, et al.	*Canadian Journal of Physiology and Pharmacology,* 1991;69:683-694. **Abstract:** Articles describing motor function in five chronic musculoskeletal pain conditions (temporomandibular disorders, muscle tension headache, fibromyalgia, chronic lower back pain, and postexercise muscle soreness) were reviewed. It was concluded that the data do not support the commonly held view that the pain of these conditions is maintained by some form of **tonic muscular hyperactivity**. **Instead**, it seems clear that in these conditions the activity of agonist muscles is often **reduced** by pain, even when this does not arise from the muscle itself. On the other hand, pain causes small increases in the level of activity of the antagonist. As a consequence of these changes, force production and the range and velocity of movement of the affected body part are often reduced. To explain how such changes in the behavior come about, we propose a neurophysiological model based on the phasic modulation of excitatory and inhibitory interneurons supplied by high-threshold sensory afferents. We suggest that the "dysfunction" that is characteristic of several types of chronic musculoskeletal pain is a normal protective adaptation and is not a cause of pain.

	Comment: This paper articulates with fascinating similarity one of the major hypotheses in AK, namely that physical, chemical, or emotional imbalances produce secondary muscle dysfunction, specifically a muscle inhibition (usually followed by overfacilitation of an opposing muscle). Muscles lose function and become inhibited because of structural problems like trauma or chemical imbalance due to a hormonal influence or mental/emotional stress.
Interobserver agreement in the assessment of muscle strength and functional abilities in Guillain-Barré syndrome. Kleyweg RP, van der Meché FG, Schmitz PI.	*Muscle Nerve.* 1991 Nov;14(11):1103-9. **Abstract:** In studies of Guillain-Barré syndrome, functional deficit is usually assessed according to a functional scale consisting of several categories. The level of interobserver agreement in this scoring method is not known; furthermore, this method seems to be insensitive when applied to bedridden and artificially ventilated patients. We have developed an additional score (MRC-sumscore), reflecting muscle strength in general. Both scoring methods, tested in Guillain-Barré patients, have an almost perfect interobserver agreement. For the functional score kappa = 0.85, and for the MRC-sumscore r2 = 0.96. The MRC-sumscore is easily assessed and more sensitive than the functional score when patients are bedridden or artificially ventilated.
Musculoskeletal ontogeny, phylogeny, and functional adaptation, Carter DR, Wong M, Orr TE.	*J Biomech.* 1991;24 Suppl 1:3-16. **Abstract:** Physical forces applied to connective tissues may cause significant changes in cell metabolism and gene expression. Theoretical investigations indicate that mechanical loading histories beginning very early in skeletal development may guide endochondral ossification patterns and the initial architectural construction of bones. Developmental patterns and structures of bones can be emulated using mathematical algorithms or "rules of construction" which relate developmental processes to tissue stress (or strain) histories. Skeletal forms and tissues are well-designed for their mechanical function primarily because their histomorphological construction has been guided by mechanical loading during growth and development. Construction rules of developmental mechanics can also be used to describe many of the histological and morphological adaptations of mature skeletal tissues to changes in customary physical activity. Over many generations, changes in the heritable genetic information occurs by mutation and genetic variability. The range of skeletal forms that are possible in evolution due to such variations, however, is constrained by the developmental rules of construction that reflect biophysical processes associated with the tissue mechanical loading. **Comment:** This study shows how the intraosseous distortions of skeletal bones occur. These are found in AK to affect the spine, the cranium, and the extremities. Specific means of testing for abnormal intraosseous distortions have been developed in AK for treatment.
Effects of Soft Tissue Technique and Chapman's Neurolymphatic Reflex Stimulation on Respiratory Function, Lines, D., McMillan, A., Spehr, G.	*J Aust Chiro* Assoc 1990 Mar;20(1):17-22. Thirty asymptomatic subjects were treated on four separate occasions using soft tissue technique and Chapman's neurolymphatic reflex stimulation for the diaphragm. Spirometric assessment of respiratory function before and after each treatment was performed. Measurements of forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and FEV1/FVC% over the whole sample showed no significant improvement following the treatment regime. Eight of the thirty subjects had lower than predicted initial FVC and FEV1 values. Five of these subjects reported a past history of asthma or bronchitis. When the results for this group of eight subjects were analyzed separately, it was found that a significant improvement was attained from the first pre-treatment FVC to the last post-treatment FVC (paired t-test significant at alpha = 0.02). These results suggest that traditional chiropractic soft tissue and reflex techniques may have therapeutic value in the treatment of patients who exhibit below average respiratory function.
Limb Segment Information Transmission Capacity Infers Integrity of Spinothalamic Tracts and Cortical Visual-	*International Journal of Neuroscience*. 1990; 50:175-183. **Abstract:** Limb segment movement times have been investigated previously in relation to Fitts' Index of Difficulty (ID = $\log_2 2A/W$) over various movement distances. Results supported Fitts' theory that different limb segments show different maximum information processing rates. The

Motor Control, Leisman, G., Vitori, R.	results indicated that visually-mediated discrete correction control processes are used. In the presently reported experiments, normal human subjects performed movements with left or right arms. Visual-motor control was inter- or intrahemispheric. Direction of movement was adductive or abductive. It was hypothesized that abductive movements are controlled by the contralateral hemisphere while adductive movements are controlled by either hemisphere. It was also hypothesized that abductive movements are related to the lateral system which projects to the contralateral side of the spinal cord. The control of adductive movements is related to the medial system which projects bilaterally to the spinal cord.
Spinal learning: central modulation of pain processing and long-term alteration of interneuronal excitability as a result of nociceptive peripheral input, Slosberg M.	*J Manipulative Physiol Ther.* 1990 Jul-Aug;13(6):326-36 **Abstract:** The influence of nociceptive peripheral input on the response characteristics of spinal interneurons may result in long-term alterations of interneuronal excitability and modify their responses to subsequent stimuli. Such neuromodulation has been found to result in physiological changes including hyperalgesia, lowering of pain thresholds, expansion of receptive fields and **changes in response behaviors of muscles**. These types of alterations may contribute to clinically significant findings including muscle spasm, hypomobility, edema, chronic pain, recurrences in areas of previous injury and resistance to treatment. This article reviews studies concerning plasticity of response behaviors of interneurons including habituation, spinal learning, spinal fixation, neuromodulation and the effects of substance P. Potential clinical and chiropractic application are discussed and a brief review of clinically relevant studies of chiropractic adjustments are cited. **Comment:** This paper provides biological plausibility to the hypothesis of the AK "challenge method." Challenge tests are maneuvers performed by the examiner for stimulating subtle muscular changes in the body via mechanoreceptors in muscles, meninges, diarthrodial joints, ligaments or tendons, associated with the spine, cranial sacral mechanism, or extraspinal articulations.
Interactions between non-symmetric mechanical vector forces in the body and the autonomic nervous system: basic requirements for any mechanical technique to engender long-term improvements in autonomic function as well as in the functional efficiency of the respiratory, cardiovascular, and brain systems, Kullok S, Mayer C, Backon J, Kullok J.	*Med Hypotheses.* 1990 Jul;32(3):173-80. **Abstract:** There are known anatomical asymmetries in the respiratory, cardiovascular, and nervous system. The coupling mechanisms between each of these systems--lungs-heart, heart-brain, and lungs-brain--are also asymmetrical. There is a growing body of literature indicating that mechanical pressure asymmetrically applied to certain areas of the human body produces changes in the balance of autonomic parameters. These findings implicitly indicate that not only magnitude but also the direction and point of application of the force play a role in its influence upon the autonomic nervous system. Therefore, we suggest that asymmetrical vector forces resulting from the mechanical activity of the lungs, heart and blood moving throughout the circulatory system, will also produce a lateralization effect in autonomic balance. We postulate the existence of negative feedback loops between brain autonomic control and mechanical functions in the body as a fundamental part of the body's homeostatic mechanisms. **It follows that any mechanical assist to the respiratory or cardiovascular system will be significantly reduced or even eliminated if these homeostatic mechanisms are not taken into account. Our hypothesis predicts that a long-term improvement in autonomic balance as well as in respiratory, cardiovascular, and brain function can be achieved if mechanical forces are applied to the body with the aim of reducing existing imbalances of mechanical force vectors.** This technique implies continually controlling for precise timings resulting from physiological periodical forces as well as factors derived from anatomical and coupling asymmetries in the respiratory, cardiovascular, and nervous systems.
Testing of isokinetic muscle strength in the ankle, Oberg B, Bergmann T, Tropp H.	*Med Sci Sports Exerc.* 1989;19:318-322. **Comment:** This important study used a Cybex isokinetic dynamometer to measure strength at the ankle during plantar flexion and dorsiflexion. The investigators found that they could not evaluate individual muscles but could develop standardization in the testing of muscle groups as

	functional units. They concluded that this type of evaluation could be helpful in athletic training. It has been pointed out by many researchers with expertise in the MMT that if the limb is positioned properly and the pressure applied in the correct direction, any muscle or group of muscles may be evaluated, even by a small examiner. By isolating the primary muscle, the skilled examiner will observe during the MMT the patient's effort and his or her body's effort at "recruitment" or "synergistic muscle" activity, showing that the prime mover is inhibited.
Shoulder pain and repetition strain injury to the supraspinatus muscle: etiology and manipulative treatment, Jacobson EC, Lockwood MD, Hoefner VC Jr, Dickey JL, Kuchera WL.	*J Am Osteopath Assoc.* 1989 Aug;89(8):1037-40, 1043-5. **Abstract:** Chronic inflammation and degenerative tendonitis of the supraspinatus muscle is an important cause of intrinsic shoulder pain. Injury to this muscle is usually caused, not by a single event, but by slight to moderate trauma repeatedly to the same anatomic area. The term repetition strain injury is used to describe this form of microtrauma. Repetition strain injury of the supraspinatus muscle is not an isolated event, but rather a form of microtrauma that affects the entire shoulder girdle. This functional unit must be evaluated and considered in the treatment plan. The authors discuss the diagnosis of this pain syndrome, which is based on the patient's work history, motion and strength testing, and palpation for trigger points. They also provide instruction in treatment involving manipulation with functional and counterstrain techniques combined with home exercise and modification of work posture.
Chronic cervical dysfunction: correlation of myoelectric findings with clinical progress. Beal MC, Vorro J, Johnston WL.	*J Am Osteopath Assoc.* 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.
Stability of the lumbar spine. A study in mechanical engineering, Bergmark A.	*Acta Orthop Scand Suppl.* 1989;230:1-54. **Abstract:** From the mechanical point of view the spinal system is highly complex, containing a multitude of components, passive and active. In fact, even if the active components (the muscles) were exchanged by passive springs, the total number of elements considerably exceeds the minimum needed to maintain static equilibrium. In other words, the system is statically highly indeterminate. The particular role of the active components at static equilibrium is to enable a virtually arbitrary choice of posture, independent of the distribution and magnitude of the outer load albeit within physiological limits. Simultaneously this implies that ordinary procedures known from the analysis of mechanical systems with passive components cannot be applied. Hence the distribution of the forces over the different elements is not uniquely determined. Consequently nervous control of the force distribution over the muscles is needed, but little is known about how this achieved. This lack of knowledge implies great difficulties at numerical simulation of equilibrium states of the spinal system. These difficulties remain even if considerable reductions are made, such as the assumption that the thoracic cage behaves like a rigid body. **A particularly useful point of view about the main principles of the force distributions appears to be the distinction between a local and a global system of muscles engaged in the equilibrium of the lumbar spine. The local system** consists of muscles with insertion or origin (or both) at lumbar vertebrae, whereas **the global system** consists of muscles with origin on the pelvis and insertions on the thoracic cage. Given the posture of the lumbar spine, the force distribution over the local system appears to be essentially independent of the outer load of the body (though the force magnitudes are, of course, dependent on the magnitude

	of this load). Instead different distributions of the outer load on the body are met by different distributions of the forces in the global system. Thus, roughly speaking, the global system appears to take care of different distributions of outer forces on the body, whereas the local system performs an action, which is essentially locally determined (i.e. by the posture of the lumbar spine). The present work focuses on the upright standing posture with different degree of lumbar lordosis. The outer load is assumed to consist of weights carried on the shoulders. By reduction of the number of unknown forces, which is done by using a few different principles, a unique determination of the total force distributions at static equilibrium is obtained. **Comment:** **Muscle System Classifications (after Bergmark)** ***Local—Deep Muscles:*** ***Typically become inhibited or lengthened*** Quadratus plantae Peronei Vastus medialis Gluteals Transverse abdominus Internal oblique Multifidus Quadratus lumborum (medial) Medial & lower erector spinae Lower & middle trapezius Serratus anterior Deep neck flexors Digastricus ***Global—Superficial Muscles:*** ***Typically become overactive or shortened*** Gastro-soleus Adductors Hamstrings Tensor fascia lata Hip flexors Piriformis Quadratus lumborum (lateral) Rectus abdominus External obliques Lateral & thoraco-lumbar erector spinae Upper trapezius Levator scapulae Pectorals Subscapularis Suboccipitals SCM Laternal pterygoids Masseter It is important to point out that shortness/tightness of a postural muscle ***does not imply strength***. Such muscles will often test as weak.
Disorders of the iliopsoas muscle and its role in gynecological diseases, Dobrik I.	*J Manual Medicine* 1989;4:130-133. **Abstract:** The topographic and anatomic connections among the iliopsoas muscle, the internal genitalia, other internal organs, and the osteotendomyogenic structures as well as their common vascular and nervous supply provides implication for their mutal reflex influence. This gives a possibility of the reflex influence of the iliopsoas muscle to the internal genitalia. Clinically one can observe cases in which functional disorder of the iliopsoas muscle is accompanied by a

	dysfunction of internal genitalia or gynecological disease. The resulting functional state of the iliopsoas muscle will be reflexed by the interaction of not only the lower extremities, pelvis and spine, but by a reflex signalization from the internal organs. **Comment:** This paper suggests that the muscle-organ-gland relationship that has been observed clinically in AK for 40 years has neurophysiologic rationale. In this paper possibilities are provided for the following reflex relationships to occur: viscero-muscular somatic, viscera-spino-muscular, viscera-musculo-visceral relationships, and viscera-spino-visceral relationships. Similarly, the reverse interaction may occur: musculo-arthro-spino-visceral and musculo-somato-spino-visceral relationships, etc.
Reliability of quantitative muscle testing in healthy children and in children with Duchenne muscular dystrophy using a hand-held dynamometer, Stuberg WA, Metcalf WK.	*Phys Ther.* 1988 Jun;68(6):977-82. **Abstract:** The purpose of this study was to examine intratester and test-retest reliability using a hand-held dynamometer for the measurement of isometric muscle strength in 28 healthy children and children with Duchenne muscular dystrophy. The Dystrophic Group consisted of 14 children diagnosed with Duchenne muscular dystrophy, and the Healthy Group consisted of 14 age-matched children with no history of orthopedic or neuromuscular disorders. One physical therapist tested hip and knee extension, elbow flexion, and shoulder abduction in each child bilaterally. A two-way analysis of variance for repeated measures was used to analyze differences between measurements taken within and across the testing sessions. Pearson product-moment correlation coefficients were determined on mean values across the testing sessions for each variable. No significant differences (p greater than .05) between measurements taken within or across testing sessions were found in either the Dystrophic Group or the Healthy Group. Correlation coefficients for the Dystrophic Group ranged from .83 to .99 for the variables tested. Correlation coefficients for the Healthy Group ranged from .74 to .99. The results suggest that the hand-held dynamometer can be used as a reliable instrument in measuring the isometric strength of selected muscles in children.
Influence of different static head-body positions on spinal lumbar interneurons in man: the role of the vestibular system, Rossi A, Mazzocchio R.	*ORL J Otorhinolaryngol Relat Spec,* 1988;50(2):119-26. **Abstract:** The present experiments were made in man with the aim of studying the possible influences of different head-body tilts on the activity of the interneurons Ia, Ib and the Renshaw cells functionally coupled to the soleus alpha-motoneurons. Subjects were seated on a chair, rotable with respect to the vertical axis, and were studied at 80 degrees and 40 degrees to the horizontal. The excitability of the soleus alpha-motoneurons slightly decreased when the body was placed at 40 degrees of backward inclination whereas the Renshaw cell activity showed a reinforcement of inhibition on the same motoneurons. The reciprocal inhibition from the anterior tibial to the soleus muscle increased at 40 degrees of backward inclination with respect to the control values at 80 degrees. Finally, short-latency homonymous facilitation and inhibition showed no significant change in relation to body position. The results indicate that different head-body positions are able to modify the bias of spinal interneurons in man. We discuss the hypothetical role of the vestibular system in producing the effects seen. **Comment:** The labyrinthine and visual righting reflexes may be disturbed by joint or muscle problems in the neck, as well as by cranial faults that may result from either whiplash dynamics or a blow to the head during an automobile accident or other head and neck trauma. It is hypothesized in AK that temporal bone cranial faults can result in imbalance in one or both sternocleidomastoid and upper trapezius muscles due to mechanical irritation of cranial nerve XI as it exits the skull through the jugular foramina, and could thereby disturb the biomechanics of the joints in the neck. This phenomenon is found on a daily basis in the clinical setting, and muscles anywhere in the body may be facilitated by proper cranial therapy. Anatomical distortions of the geometry of the vestibular mechanism within the temporal bones (producing a tilt in the angular geometry of the semicircular canals) may create discordant sensory input into the CNS compared to that coming into it from the spinal joints and muscles, thereby producing poor stability and deficient motor activity.
Effects of altered afferent	*J Manipulative Physiol Ther.* 1988 Oct;11(5):400-8.

articular input on sensation, proprioception, muscle tone and sympathetic reflex responses, Slosberg M.	**Abstract: The influence of afferent articular and periarticular input on muscle tone, joint mobility, proprioception and pain is of considerable interest to practitioners using manipulation.** It has long been hypothesized that dysfunctional articulations may generate altered patterns of afferent input. This article reviews the relevant studies that have investigated the impact of articular input on efferent activity under normal conditions and under conditions of altered joint function. **The findings suggest that sensory input does have a substantial effect on efferent function and sensation**. Furthermore, the studies indicate that the pattern of articular input may be significantly modified by joint inflammation, trauma and effusion and result in changes of muscle tone, joint mobility, proprioception and pain. **Comment:** This paper provides biological plausibility to the hypothesis of the AK "challenge method." Challenge tests are maneuvers performed by the examiner for stimulating subtle muscular changes in the body via mechanoreceptors in muscles, meninges, diarthrodial joints, ligaments or tendons, associated with the spine, cranial sacral mechanism, or extraspinal articulations.
Comparison of lumbar paravertebral EMG patterns in chronic low back pain patients and non-patient controls, Ahern DK, Follick MJ, Council JR, Laser-Wolston N, Litchman H.	*Pain.* 1988 Aug;34(2):153-60. **Abstract:** According to myogenic models that relate abnormal EMG patterns to the experience of pain, lumbar paravertebral muscle activity has been considered to play an important role in chronic low back pain. In the present study, 40 chronic low back pain patients and 40 matched non-patient controls were compared on lumbar paravertebral EMG during mechanically stabilized static and dynamic postures. Differences between groups in lumbar curvature and spinal range of motion were determined using a dual goniometer technique. Although the two groups did not differ on absolute levels of EMG during quiet standing, **significant differences were found for EMG patterns during dynamic postures.** In addition, most patients did not show the flexion-relaxation response or the expected pattern of EMG responses during trunk rotation, most likely because of restricted range of motion and/or compensatory posturing. These findings provide support for the biomechanical model of chronic pain and indicate the need for further research pertaining to pain behavior and movement-related lumbar muscle activity. **Comment:** In this study, chronic low back pain patients were limited in flexion and rotation ROM, which were in turn associated with lower absolute EMG levels. This is consistent with other findings described in this compendium showing lower muscle activities were observed in the chronic low back pain group. A brief survey of the recent scientific literature shows that several dozen investigators were unable to identify reliably increased myoelectric behaviors that correlated to the diagnosis or severity of LBP. From the evidence now available, the hyperactivity-causality model for musculoskeletal pain should be abandoned. It appears to the contrary that muscle weakness or inhibition is the most consistent finding in patients with LBP.
Intrarater reliability of manual muscle testing and hand-held dynametric muscle testing, Wadsworth CT, Krishnan R, Sear M, Harrold J, Nielsen DH.	*Phys Ther.* 1987 Sep;67(9):1342-7. **Abstract:** Physical therapists require an accurate, reliable method for measuring muscle strength. They often use manual muscle testing or hand-held dynametric muscle testing (DMT), but few studies document the reliability of MMT or compare the reliability of the two types of testing. We designed this study to determine the intrarater reliability of MMT and DMT. A physical therapist performed manual and dynametric strength tests of the same five muscle groups on 11 patients and then repeated the tests two days later. The correlation coefficients were high and significantly different from zero for four muscle groups tested dynametrically and for two muscle groups tested manually. The test-retest reliability coefficients for two muscle groups tested manually could not be calculated because the values between subjects were identical. We concluded that both MMT and DMT are reliable testing methods, given the conditions described in this study. Both testing methods have specific applications and limitations, which we discuss.
Changes in Electrical Activity in Muscles Resulting	*J Manipulative Physiol Ther* 1987;10(6):300-304.

from Chiropractic Adjustment: A Pilot Study, Shambaugh P.	**Abstract:** This study examines the effects of chiropractic adjustment on the muscles of the back. Vertebrae that are hypomobile may be held in that state by the erector spinae muscle group; adjusting such vertebrae should result in less muscle tension. By measuring the change in electrical activity, such relaxation can be observed. Hypomobile vertebrae were found by motion palpation. The patient was then placed prone and surface electrodes were placed over the upper trapezius, upper erector spinae (T3-T5), and lumbar erector spinae (L1-L3) muscle groups on both sides of the body. The patient was adjusted using full spine toggle recoil thrusts, and postadjustment readings were taken. Results from this study show that significant changes in muscle electrical activity occur as a consequence of adjusting. On average, a 25% reduction in muscle activity was observed across the 20 subjects tested, while no significant reductions were observed with the control group of 14 subjects. Significant reductions in side-to-side imbalances were also observed.
Effects of joint pathology on muscle, Young A, Stokes M, Iles JF.	*Clin Orthop Relat Res,* 1987 Jun;(219):21-7. **Abstract:** The muscle wasting associated with joint damage may be highly selective; knee disorders produce quadriceps wasting but little change in the size of the hamstrings. This causes isolated quadriceps weakness, so predisposing to a position of knee flexion. Nociceptors and other receptors in and around the joint can have flexor excitatory and extensor inhibitory actions. At the knee, these receptors are likely to excite hamstrings and inhibit quadriceps. Although other actions could occur, quadriceps inhibition may be favored by a position of knee extension. Quadriceps inhibition will weaken voluntary contraction, reduce tone, and contribute to wasting of the muscle, further predisposing to a position of knee flexion. The potency of quadriceps inhibition may be considerable, even in the absence of perceived pain. A small, apparently trivial effusion (or even a clinically undetectable effusion) may cause important inhibition. In order to improve the orthopedist's ability to prevent flexion contracture of the injured or operated joint, he must look not only for ways of reducing joint pain, but also for ways of preventing activity in other joint afferents. For example, he must consider the possible effects of joint position, intraarticular pressure, suture-line tension, and afferent blockade. **Comment:** This study demonstrates that structural alterations in the knee joints produce immediate and measurable weaknesses in the muscles that support and stabilize the knee. If the muscles at the front of the knee (quadriceps) are weak, this may produce joint instability and perpetuate the knee joint dysfunction until corrected.
Quantifying the Effects of Spinal Manipulations on Gait, Using Patients with Low Back Pain: A Pilot Study, Herzog W, Nigg B, Robinson R, Read L.	*J Manipulative Physiol Ther* 1987;10(6):295-299 A pilot study was performed to investigate the effects of chiropractic treatment on the gait of one patient with a chronic sacroiliac joint syndrome. Qualitative and quantitative measures were used to describe pain, sacroiliac joint mobility, functional ability and gait patterns of this patient before and after receiving chiropractic treatment, and throughout the rehabilitation period. For this patient, chiropractic treatment reduced the low back pain and was associated with significant changes in selected gait parameters. A study involving 10-20 subjects is under way to possibly generalize the findings of this investigation.
Finger flexion function in rheumatoid arthritis: the reliability of eight simple tests, Armstrong R, Horrocks A, Rickman S, Heinrich I, Kay A, Gibson T.	*Br J Rheumatol* 1987;26:118-122. The inter- and intra-observer errors of eight tests of finger flexion function were estimated from the results obtained by three observers assessing 10 patients with rheumatoid hand involvement. Measurements of finger flexion and muscle power involved both conventional and novel techniques using simple and easily constructed apparatus. For each test, measurements were in agreement between observers and were reproducible on three occasions. These tests may now be used with confidence by other investigators.
Functional assessment of the hand: reproducibility,	*Ann Rheum Dis* 1987;46:203-208 A new system for measuring strength of the hand using a torsion dynamometer linked to a

acceptability, and utility of a new system for measuring strength, Helliwell P, Howe A, Wright V.	microprocessor is described. The system permits analysis of timed squeezes of both grip and pinch and is adjustable to all sizes of hand and degrees of hand deformity. Results obtained with the system were found to be reproducible, and the rigid device was acceptable to a group of patients with arthritic hands. In rheumatoid arthritis, there is a marked reduction in maximum grip and pinch strength, together with a prolongation of the time taken to reach this maximum, and increased fatigue. The limitations of grip strength as a measure of function of the hand are discussed.
Clinical and electromyographical course of sciatica: prognostic study of 41 cases, Negrin P, Fardin P.	*Electromyogr Clin Neurophysiol* 1987;27:125-127 **Abstract:** The study of the clinical and EMGraphical course of patients with sciatica may help us to decide between a simple symptomatic treatment and an admission to hospital for neuroradiological tests and possible surgery. 41 patients with acute lumbosciatalgia and EMGraphically proven monoradicular denervation were studied: the root affected was L5 in 39 cases (78%), L4 in 7 cases and S1 in 2 cases. 19 of these cases were then submitted to surgical treatment of disc protrusion removal, the other 22 were treated medically. 3 to 8 years later, the following parameters were tested: pain, motor impairment, EMG denervation and degree of patient's subjective judgment. We concluded that urgent hospital admission is indicated only in the case of severe and/or recent (within 1 month) paralysis or in the case of intolerable painful symptomatology. The diagnostic and prognostic role of EMG is hence confirmed: this examination yields information on the identity of the root involved, the severity of the denervation, its course and the degree of final improvement expected.
The use of major and minor therapy forms in Australian chiropractic practice, Leboeuf, C, Patrick, K.	*Journal of the Australian Chiropractic Association*, 1987;17:109-11. A survey of Australian chiropractors showed that most use five major chiropractic techniques (Diversified, Sacro-Occipital technique, Gonstead, Nimmo and **Applied Kinesiology**). High velocity adjustive techniques (Diversified and Gonstead) were the most commonly reported major core techniques. Predominantly low velocity manual techniques such as Applied Kinesiology, Sacro-Occipital technique and Nimmo were most commonly reported as minor core techniques. Most employ adjunctive therapies, mainly nutrition, extremity techniques and exercise.
The relationship of knee and ankle weakness to falls in nursing home residents, Whipple, R, Wolfson, L, Amerman, P.	*J Am Geriatr Soc,* 1987;35:329-32 A study of nursing home residents with a history of falling found that muscle force and isokinetic power were significantly decreased in knee flexors (quadriceps) and extensors (hamstrings), and ankle dorsiflexors (tibialis anterior) and plantar flexors (gastrocnemius and soleus). Dorsiflexors were particularly weak in fallers, suggesting that they are an important factor contributing to balance. Of particular interest was ankle flexor and extensor strength because these muscles are linked to balance impairment in older adults with a history of falling. Strength training and other treatments that may improve muscle function in these areas may enhance balance in balance-impaired older adults.
Piriformis syndrome: pathogenesis, diagnosis, and treatment, Steiner C, Staubs C, Ganon M, Buhlinger C.	*J Am Osteopath Assoc* 1987;87:318-323 The failure of conservative treatment for lumbosacral disk disorders often leads to surgery. If the pain is produced by sciatic neuritis rather than sciatic radiculitis, operative treatment may be unavailing. This paper describes the mechanism by which piriformis syndrome causes sciatic neuritis and differentiates neuritis from radiculitis, the treatment of which often results in the "failed disk syndrome." Sciatic neuritis is now believed to result from irritation of the sciatic nerve sheath, which is caused by biochemical agents released from an inflamed piriformis muscle where the two structures meet at the greater sciatic foramen. The symptoms of piriformis syndrome present almost identically to lumbar disk syndrome, except for the consistent absence of true neurologic findings. Diagnosis is accomplished by palpation of myofascial trigger points

	within the piriformis muscle. Computed tomography, myelography, roentgenography, and electromyography are of limited diagnostic value. Treatment, which consists of a conservative approach employing local anesthetics and osteopathic manipulation, is without significant risk. Reducing muscle spasm, restoring joint motion, and keeping the patient ambulatory and in motion are keys to successful treatment.
Correlation of objective measure of trunk motion and muscle function with low-back disability ratings, Triano, J, Schultz, A	*Spine,* 1987;12:561-5. **Abstract:** A study was undertaken to examine relations among some objective and subjective measures of low-back-related disability in a group of 41 low-back pain patients and in seven pain-free control subjects. Subjective measures of disability were obtained by Oswestry patient questionnaires. Oswestry disability score related significantly (P less than 0.001) to presence or absence of relaxation in back muscles during flexion. Mean trunk strength ratios were inversely related to disability score (P less than .05), and trunk mobility was meaningfully reduced (P less than .01). Despite loss of motion, a large enough excursion was observed to predict presence of back muscle relaxation. These findings imply that myoelectric signal levels, trunk strength ratios, and ranges of trunk motion may be used as objective indicators of low-back pain disability. **Comment:** The findings in this study imply that muscle function, as measured by EMG, MMT, and ranges of trunk motion may be used as objective indicators of low-back pain disability.
Clinical biomechanical correlates for cervical function: Part II. A myoelectric study, Vorro J, Johnston W.	*J Am Osteopath Assoc* 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.**
The relationship of injuries of the leg, foot, and ankle to proximal thigh strength in athletes, Nicholas JA, Marino M.	*Foot Ankle.* 1987 Feb;7(4):218-28 **Abstract:** Rehabilitation programs designed to restore leg, ankle, and foot function following injury frequently ignore the proximal muscles. During athletics, these knee, hip, and trunk muscles derive much of their functional power from the foot and ankle. They also serve to integrate distal segment motions into a total movement pattern such as jumping, running, or kicking. The linkage system, which is a theoretical concept, describes the normal biomechanical and physiological interactions between proximal and distal musculoskeletal structures. Immobilization or injury of distal segments interrupts the normal generation, summation, and transmission of muscular forces across joints. Adequate measures must be taken to properly assess proximal structures for weakness and tightness and to prescribe specific exercises to prevent the migration of the effects of injury away from the involved segment. **Comment:** In AK examination and treatment, the "linkage system" is appreciated. The leg, foot, and ankle are part of a complex system that links the foot and leg and their related muscle attachments and other soft tissues, and neurologic and vascular components, to the rest of the neuromusculoskeletal system The use of AK methods, especially challenge and therapy localization, greatly assists the practitioner in finding concealed or hidden linkages between problems in the foot and leg and other muscular problems throughout the body.
The craniocervical junction and disturbance of equilibrium, Lewit K.	*Manuelle Medizine.* 1986;24:26-9 **Abstract:** A random group of 106 patients affected by pain due to functional disturbances in the spinal column with no symptoms of vertigo were examined using the two-scales test and

	Hautant's test in various head and neck positions. The sample was divided into two groups: one had a difference of more than 4 kg on both scales, and one a difference of up to 4 kg. It was shown that: (1) all patients with a difference of more than 4 kg showed a cervical pattern when examined by the (modified) Hautant's test and in patients with a difference below 4 kg this was found in only 5 cases; (2) a cervical pattern therefore existed in 55 (52%) of a random group with vertebrogenic disturbances; (3) the greatest difference in both groups was in the incidence of movement restriction in the craniocervical junction. This was absent in the first group in only 5 patients, and in 35 in the second. The cervical pattern was closely correlated with nystagmus in the extreme position when examined using Frenzel's spectacles. Immediately after treatment, the cervical pattern (Hautant's test) was usually normalized; frequently (in about half the cases) we obtained normal results on both scales; nystagmus in the extreme position examined with Frenzel's spectacles usually remained positive. The dominating influence of the craniocervical junction for human equilibrium is stressed; disturbance of the equilibrium is much more frequent without vertigo (dizziness) than with. **The term "latent vertigo" is suggested for the former. In this disturbance the motor system plays a decisive role. Equilibrium can therefore be defined as a function of the motor system subserving posture in the field of gravity.**
Contractile changes in opposing muscles of the human ankle join with aging, Vandervoort, A, McComas, A.	*J Appl Physiol,* 1986;61:361-7 This article demonstrates that strength declines approximately 15% per decade between the ages of 50 and 70 years, and approximately 1.5% per year after the age of 70 years, and decreases in strength are associated with falling in elderly people.
Manual muscle test scores and dynamometer test scores of knee extension strength, Bohannon RW.	*Arch Phys Med Rehabil.* 1986 Jun;67(6):390-2. The knee extension force of 50 patients was investigated using traditional manual muscle testing and hand-held dynamometry. The relationship between manual muscle test word scores and dynamometer force scores was determined using Kendall tau, as was the relationship between manual muscle test percentage scores and dynamometer scores expressed as a percentage of "normal." Percentage scores were also compared to determine if a significant difference existed. Manual muscle test scores and dynamometer test scores were significantly correlated (p less than .001). Percentage manual muscle test and dynamometer test scores were significantly different (p less than .001). These results suggest that the two procedures measure the same variable-strength. Manual muscle test percentage scores of knee extension may, however, overestimate the extent to which a patient is "normal."
Predictive value of manual muscle testing and gait analysis in normal ankles by dynamic electromyography, Perry, J.P. et al	*Foot Ankle.* 1986 Apr;6(5):254-9. Eight muscles about the ankle of seven normal subjects were assessed by electromyography (EMG) during manual muscle testing (MMT) and walking. Three strength levels (normal, fair, trace) and three gait velocities (free, fast, slow) were tested. The muscles studied included the gastrocnemius, soleus, posterior tibialis, flexor digitorum longus, flexor hallucis longus, anterior tibialis, extensor digitorum longus, and extensor hallucis longus. Relative intensity of muscle action was quantitated visually (using an eight-point scale based on amplitude and density of the signal). The data showed that EMG activity increased directly as more muscle force was required during the different manual muscle test levels and increased walking speeds. No MMT isolated activity to the specific muscle though being tested. Instead, there always was a synergistic response. Both the gastrocnemius and soleus contributed significantly to plantarflexion regardless of knee position. The intensity of muscle action during walking related to the manual muscle test grades. Walking at the normal free velocity (meters/min) required fair (grade 3) muscle action. During slow gait the muscle functioned at a poor (grade 2) level. Fast walking necessitated muscle action midway between fair and normal, which was interpreted as good (grade 4).
Reliability of lumbar	*Arch Phys Med Rehabil.* 1986 Oct;67(10):762-5.

paravertebral EMG assessment in chronic low back pain, Ahern DK, Follick MJ, Council JR, Laser-Wolston N.	**Abstract:** The reliability of lumbar paravertebral EMG assessment was investigated in a sample of 70 patients with chronic low back pain, (CLBP). Dual-site EMG monitoring was employed during both static postures and movements. Flexion and rotation indices were divided to assess the reliability of patterning of paravertebral EMG during movement. Within-session reliabilities computed for the full sample ranged from 0.66 to 0.97, and between-session reliabilities, computed on a subset of 29 patients retested after varying intervals, ranged from 0.26 to 0.92. Average EMG levels, flexion, and rotation indices showed no statistically significant differences between surgical (n = 40) and nonsurgical patients (n = 30), although EMG variability was consistently greater for surgical patients across the postures and movements. **These results indicate that lumbar paravertebral EMG can be reliably measured and therefore has potential utility as an assessment and treatment variable in CLBP.**
Muscle dysfunction in male hypogonadism, Chauhan AK, Katiyar BC, Misra S, Thacker AK, Singh NK.	*Acta Neurol Scand.* 1986 May;73(5):466-71. **Abstract:** Twenty-eight consecutive male patients with primary and secondary hypogonadism (14 each) were evaluated clinically and electrophysiologically for muscle dysfunction. Although generalised muscle weakness was initially reported by only 9 patients, on direct questioning, it was recorded in 19. Objective weakness was found in 13 patients and it involved both the proximal and distal limb muscles. Quantitative electromyography showed evidence of myopathy in the proximal muscle in 25 patients, i.e., reduced MUP duration and amplitude with increased polyphasia in the deltoid and the gluteus maximus. There were no denervation potentials. None of the patients showed clinical neuropathy or NCV abnormalities. **Thus, the profile of muscle involvement in hypogonadism closely simulates limb-girdle muscular dystrophy and other endocrine myopathies. The incidence of muscle involvement was higher in secondary hypogonadism. Diminished androgens in primary hypogonadism and diminished growth hormone in the secondary hypogonadism are probably responsible for the myopathy. Comment:** This paper demonstrates what has been demonstrated clinically in AK for many years, namely that endocrine disturbances may often be reflected in muscle dysfunction.
Reflex inhibition of the quadriceps after meniscectomy: lack of association with pain, Shakespeare DT, Stokes M, Sherman KP, Young A.	*Clin Physiol.* 1985 Apr;5(2):137-44. **Abstract:** We have examined the severity and duration of reflex inhibition of quadriceps activation after arthrotomy and meniscectomy, its relationship with pain, and the effect of local anesthesia on this relationship. Fourteen men, on completion of medial meniscectomy by arthrotomy, received either 10 ml (B10 group) or 15 ml (B15 group) of 0.5% bupivacaine hydrochloride ('Marcaine Plain') into the knee, or no injection (control group). Reflex inhibition of quadriceps was measured as the percentage reduction, from the ipsilateral preoperative value, in the integrated surface electromyogram recorded during maximal voluntary isometric contractions with the knee in extension. Pain during each contraction was recorded on a linear analogue scale. Unoperated limbs showed no evidence of quadriceps inhibition. In the operated limbs, at 1-2 h post-operatively, controls had both severe inhibition (median = 62%) and severe pain on attempting a maximal quadriceps contraction. The B10 group had similar inhibition but less pain (P less than or equal to 0.005, Wilcoxon 2-sample, 1-tailed test). In the B15 group both inhibition (P less than or equal to 0.05) and pain (P less than or equal to 0.01) were less than in the controls. These effects of bupivacaine had been lost by 4-5 h post-operatively. At 3-4 days, inhibition was still severe (median = 75%) in all three groups of patients but pain was only mild or absent. At 10-15 days, median inhibition was still 35%, but there was little or no pain. We conclude that postmeniscectomy inhibition is not simply due to perceived pain but is due, at least in part, to stimuli from the knee.
Quantification of lumbar function. Part 2: Sagittal plane trunk strength in chronic low-back pain	*Spine.* 1985 Oct;10(8):765-72. **Abstract:** A prototype sagittal plane trunk strength tester was used to measure trunk strength in 286 chronic low-back pain patients. Initial data for this patient group are compared with data

patients, Mayer TG, Smith SS, Keeley J, Mooney V.	acquired previously from a group of controls, adjusted for age, sex, and body weight. **Distinct patterns characterize the patient sample as opposed to the controls: Patient values for both flexors and extensors were markedly decreased, with greater variability; Extensor strength was affected more significantly than flexor strength; Discrepancies between patients and controls were greater for females than for males;** High-speed dropoff ratios were much lower for patients, both in flexion and extension. **These results demonstrate that strength deficits are a major factor in the deconditioning syndrome associated with chronic low-back pain.** **Comment:** This test protocol, applied to a symptomatic population, reveals significant global weakness in low back pain sufferers. 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 low back pain. This paper very elegantly demonstrates one of the prime contentions of AK.
Hand grip strength--a simple prognostic indicator in surgical patients. Hunt DR, Rowlands BJ, Johnston D.	*JPEN J Parenter Enteral Nutr.* 1985 Nov-Dec;9(6):701-4. **Abstract:** This study evaluates hand grip strength as an indicator of nutritional status and a predictor of postoperative complications. Hand grip strength and other parameters of nutritional status, namely, midarm muscle circumference, forearm muscle circumference, triceps skinfold, percentage ideal body weight, serum albumin, and percent usual weight were determined preoperatively in 205 patients. Complications occurred in 28 patients (14%). Patients with at least one abnormal nutritional parameter had a higher incidence of postoperative complications. Their length of total and postoperative hospitalization was greater by 6.2 and 4.6 days, respectively (p less than 0.01). **Grip strength was the most sensitive single parameter**, but forearm muscle circumference and percentage ideal body weight were the most specific indices. **Hand grip strength is a simple measure of nutritional status and an accurate prognostic indicator that requires further clinical evaluation.** **Comment:** This study shows that testing the muscles of the hand for weakness specifically correlates with patients with post-surgical complications. In AK, the relationship between muscle function and general neurological function has been hypothesized. Studies like these show that there is continuity between muscle strength and general biological function. A number of research papers are now in the literature showing the relationship between handgrip strength and many other neuro-metabolic conditions and syndromes.
The relationship between paraspinal EMG and chronic low back pain. Nouwen A, Bush C.	*Pain.* 1984 Oct;20(2):109-23. **Abstract:** Two models of the relationship between paraspinal EMG and low back pain have been proposed. Specific predictions arising from these are listed and the literature relating to them reviewed. Recent research on patterns of EMG rather than absolute levels is also discussed. **It is concluded that there is no consistent evidence that low back pain patients have elevated paraspinal EMG**, or that its reduction is likely to be an active ingredient in biofeedback therapy. Research on paraspinal EMG patterns is still preliminary, and therefore treatment based on their modification is experimental. **Comment:** After 50 years, the research evidence is suggesting the demise of the hyperactivity-causality model for musculoskeletal pain. The lack of convincing evidence to support the belief in hyperactivity as an etiological factor in musculoskeletal conditions has been pointed out in recent reviews of several chronic musculoskeletal disorders. The research data presented here suggest that the body's reaction to injury and pain is not primarily increased muscular tension and stiffness; **rather *muscle inhibition is often more significant.***
Clinical trials in Duchenne dystrophy. Standardization and reliability of evaluation procedures, Florence JM, Pandya S, King WM,	*Phys Ther.* 1984 Jan;64(1):41-5. **Abstract:** A multiclinic, collaborative study has been designed to assess the natural progression and efficacy of treatment of Duchenne muscular dystrophy. This article describes the protocol for the evaluation technique and the method used to establish within (intraobserver) and between

Robison JD, Signore LC, Wentzell M, Province MA.	(interobserver) reliability of the protocol evaluation procedures. Standardized patient evaluations were used, and consistency of evaluation was monitored by a computer. The reliability of the measures was analyzed 1) within observers by comparing the results of each of the first three tests done by each evaluator for all patients and 2) between observers by comparing, at multicenter group meetings, the results of each of the four evaluators' tests of the same patient. We have demonstrated reliability for an evaluation method that will provide an objective foundation on which to claim a drug or therapeutic procedure does or does not have an effect in treating Duchenne muscular dystrophy. **Comment:** This paper showed that there was significant improvement in the degree of consistency of a given examiner's MMT scores when the examiner had more clinical experience and training in MMT. Many other researchers of MMT have discussed the importance of considering the examiner's training upon the outcomes of studies that assess strength via MMT.
Physical measurements as risk indicators for low back trouble over a one year period, Biering-Sorensen, F.	*Spine,* 1984;9:106-19 **Abstract:** Of all 30-, 40-, 50-, and 60-year-old inhabitants of Glostrup, a suburb of Copenhagen, 82% (449 men and 479 women) participated in a general health survey, which included a thorough physical examination relating to the lower back. The examination was constituted of anthropometric measurements, flexibility/elasticity measurements of the back and hamstrings, as well as tests for trunk muscle strength and endurance. The reproducibility of the tests was found to be satisfactory. Twelve months after the physical examination 99% of the participants completed a questionnaire sent by mail concerning low back trouble (LBT) in the intervening period. The prognostic value of the physical measurements was evaluated for first-time experience and for recurrence or persistence of LBT by analyses of the separate measurements and discriminant analyses. The main findings were that good isometric endurance of the back muscles may prevent first-time occurrence of LBT in men and that men with hypermobile backs are more liable to contract LBT. Recurrence or persistence of LBT was correlated primarily to the interval since last LBT-episode: the more LBT, the shorter the intervals had been. Weak trunk muscles and reduced flexibility/elasticity of the back and hamstrings were found as residual signs, in particular, among those with recurrence or persistence of LBT in the follow-up year.
Knee joint effusion and quadriceps reflex inhibition in man, Spencer JD, Hayes KC, Alexander IJ.	*Arch Phys Med Rehabil.* 1984 Apr;65(4):171-7. **Abstract:** This study was designed to elucidate the role of effusion in producing the reflex inhibition, and subsequent atrophy, of quadriceps musculature following knee trauma. In particular, consideration was given to determining the extent, threshold and linearity of inhibition of the motoneuron pool induced by experimental introduction of small increments of 0.9% physiological saline (up to 60ml) into the joint space of the knee in ten healthy subjects. Inhibition of the quadriceps muscle motoneuron pool was indirectly assessed through recording Hoffmann (H) reflexes evoked from vastus medialis, lateralis and rectus femoris. All ten subjects showed a significant (p less than 0.05) reduction in H-reflex amplitude following the introduction of saline: vastus medialis reduced to 55.7 +/- 4.3% of its control 0ml value, rectus femoris to 69.1 +/- 6.1% and vastus lateralis to 65.3 +/- 4.0%. Post hoc analyses of the H-reflex amplitudes at each increment of simulated effusion revealed the threshold for reflex inhibition of the vastus medialis to be between 20 and 30ml of saline and for rectus femoris and vastus lateralis to be between 50 and 60ml. These procedures were repeated on eight subjects following an injection of the anesthetic lidocaine (1%) to the intra-articular space of their knee joints but there was no significant reduction in H-reflex amplitude. Linear relationships were found to adequately describe the relationships between the volume of effusion and intra-articular pressure; and volume of effusion and reduction in H-reflex amplitude. **Comment:** This paper shows that experimentally induced noninflammatory effusions in the knees of 10 human subjects produced a significant reflexly induced inhibition of the alpha-motoneuron pool of the quadriceps muscles in the absence of pain, joint damage, trauma or movement. Furthermore, they state that the reflex inhibition is blocked by intra-articular anesthesia. They conclude that the inhibition is neurologically mediated in response to changes in

	articular mechanoreceptive input. Altered muscle tone and mobility are consistently found in AK examination in response to changes of articular or periarticular afferent input.
Musculoskeletal performance testing and profiling of elite competitive fencers, Sapega AA, Minkoff J, Valsamis M, Nicholas JA.	*Clin Sports Med.* 1984 Jan;3(1):231-44. **Abstract:** Twenty-four male members of the 1976 United States Olympic Fencing Squad were profiled. **Data were collected on anthropometry; flexibility; and muscular strength, endurance, and power. Five of the physical variables measured in the laboratory were shown to have a significant relationship to competitive success.**
Muscular endurance and electromyographic fatigue in myofascial shoulder pain. Hagberg M, Kvarnström S.	*Arch Phys Med Rehabil.* 1984 Sep;65(9):522-5. **Abstract:** An endurance test in shoulder flexion was made in 10 patients (median age 30 yr) with a history of shoulder-neck pain of at least one year's duration. No signs of inflammatory, rheumatic, or neuromuscular diseases were present among the patients but there was localized muscular pain and tenderness in the shoulder-neck region. In a sitting position the patients performed an endurance test of a 30 degree isometric shoulder flexion on both the left and right sides. EMG was recorded from the descending part of the trapezius muscle by surface electrodes and from the supraspinatus muscle by intramuscular wire electrodes. Myoelectric amplitude increase and mean power frequency (MPF) decrease with time during the endurance test were used as measures of fatigue development. **All patients had a shorter duration of endurance on the more painful side. The endurance time was short in relation to the load.** The regression between endurance time and MPF decrease was similar to that for healthy subjects. **The short endurance time for the patients appears to be an effect of increased physiologic fatigability of the muscle which may be due to a change in its work capacity.**
Electromyographic activity of anterior temporal area pain patients and non-pain subjects. Majewski RF, Gale EN.	*J Dent Res.* 1984 Oct;63(10):1228-31. **Abstract:** Anterior temporal area and non-specific facial muscle activity were recorded from 11 patients with unilateral anterior temporal area muscle pain and from 11 matched asymptomatic individuals at various mandibular openings. No significant differences were observed (1) in temporal area EMG activity between pain and non-pain sides and (2) between temporal area and non-specific facial muscle EMG activity between patient and non-patient groups. In relation to increased vertical mandibular opening from centric occlusion: (a) anterior temporal area EMG activity decreased to a minimum level (with further opening, anterior temporal area EMG did not significantly change); and (b) non-specific facial muscle EMG activity decreased to a minimum level (with further opening, non-specific facial muscle EMG increased). **Comment:** In the hyperactivity-causality model of musculoskeletal and TMD pain, if "muscle tension" or "muscle hyperactivity" are pathognomic of these conditions, then EMG levels ***should be higher*** in this patient population compared to other similarly matched groups. The evidence in this study demonstrates that pain does not cause muscles to become tonically hyperactive.
Effect of cranial laser acupuncture on muscle strength in healthy individuals, Sopler D.	*Am J Acupunct.* 1984;12(2):117-124. **Abstract:** Cranial acupuncture zones for the lower extremities, trunk area and upper extremities were stimulated with a helium-neon laser on a group of bodybuilders. The purpose of this study was to test the hypothesis that stimulation of these zones could increase muscle strength. The twelve subjectds were randomly divided into treatment and control groups. Four treatments were given, with subjects in both groups reporting any increases in their ability to lift weights after each treatment. Results of the study showed that the treatment group increased 12.77 percent more in muscle strength over the control group.
Myofascial origins of low back pain. 1. Principles of diagnosis and treatment,	*Postgrad Med.* 1983 Feb;73(2):66, 68-70, 73 passim. **Abstract:** Myofascial trigger points (TPs) are frequently overlooked sources of acute and chronic low back pain. An active myofascial TP is suspected by its focal tenderness to palpation

Simons DG, Travell JG.	and by restricted stretch range of motion. The restricted lengthening of the muscle is due to the tense band of muscle fibers in which the TP is located. The presence of a TP is confirmed by a local twitch response and by reproduction of its known pattern of referred pain, which matches the distribution of the patient's pain. Only an active TP causes a clinical pain complaint; a latent TP does not. The pain can be relieved by the stretch-and-spray procedure, ischemic compression, or precise injection of the TP with procaine solution. Relief is usually long lasting only if mechanical and systemic perpetuating factors are corrected. **Comment:** The work of Dr. Janet Travell has influenced allopathic and complimentary and alternative medicine and is one of the foundations of AK.
Myofascial origins of low back pain. 2. Torso muscles, Simons DG, Travell JG.	*Postgrad Med.* 1983 Feb;73(2):81-92. **Abstract:** Trigger points (TPs) in muscles of the lower torso associated with the spine are an important cause of low back pain. The quadratus lumborum is the muscle most commonly involved, but TPs located there are often overlooked because of inadequate physical examination techniques. TPs in the lower rectus abdominis refer pain horizontally across the low back, and those in the iliopsoas refer pain in a vertical pattern, parallel to the lumbosacral spine. The pain pattern of TPs in the serratus posterior inferior is noted in the region of the muscle itself.
Myofascial origins of low back pain. 3. Pelvic and lower extremity muscles, Simons DG, Travell JG.	*Postgrad Med.* 1983 Feb;73(2):99-105, 108. **Abstract:** Gluteal, pelvic, and lower extremity muscles are common sites of origin of myofascial low back pain. Trigger points (TPs) in the gluteus maximus and medius muscles refer pain locally to the gluteal and sacral regions, while those in the gluteus minimus are likely to refer pain down the lower extremity as far as the ankle on the same side. TPs in intrapelvic muscles refer pain chiefly to the pelvic region. Besides producing referred myofascial pain, TPs in the piriformis muscle can cause symptoms of entrapment of the peroneal portion or all of the sciatic nerve. TPs in the soleus muscle may refer pain to the sacroiliac joint.
A quantitative study of trunk muscle strength and fatigability in the low-back-pain syndrome. Suzuki N, Endo S.	*Spine.* 1983 Jan-Feb;8(1):69-74. **Abstract:** A quantitative study of the trunk muscle strength and fatigability was performed using an isokinetic dynamometer to determine the role of trunk muscles in the low-back-pain syndrome and in particular to investigate the correlation of trunk muscle strength and lumbar lordosis. **Most patients demonstrated a generalized weakness of the trunk muscles. The trunk muscle strength of patients suffering from backache for less than one month was significantly lower than that of the controls. The strength of the trunk muscles was not influenced by the duration of symptoms.** There was no imbalance between the trunk flexors and extensors. **The patients with back pain had a greater fatigability of the trunk flexors than the controls.** There was negative correlation between the trunk muscle strength or fatigue and lumbar lordosis.
The efficacy of manual assessment of muscle strength using a new device, Marino M, Nicholas JA, Gleim GW, Rosenthal P, Nicholas SJ.	*Am J Sports Med.* 1982 Nov-Dec;10(6):360-4 **Abstract:** The purpose of this study was to compare the manual assessment of muscle strength with a small, handheld (by the examiner) force-measuring device developed by the Institute of Sports Medicine and Athletic Trauma (ISMAT). One hundred twenty-eight patients presented with a known lower extremity orthopaedic pathology. All patients were clinically evaluated for hip abductor and hip flexor weakness in standard positions using the "break test" technique. All 128 patients were then evaluated with the ISMAT Manual Muscle Tester, a small, hand-held device which recorded the peak force (kg) required to break a muscle contraction. Three bilateral measures of hip abduction and hip flexion were recorded, averaged, and compared to the subjective clinical evaluation using a chisquare analysis. **Bilateral values which were within 5% of each other were not considered significant and therefore not included in the calculations. The average hip abduction and hip flexion scores measured by the ISMAT tester were consistent with the examiner's perception of muscle weakness (P less than 0.001). The results demonstrate consistent detection of muscle weakness by the ISMAT**

	Manual Muscle tester over a broad range of testing conditions. **Comment:** The MMTs employed in this study used the standard positions delineated by Kendall and Kendall and the ones used in AK, specifically for the rectus femoris and gluteus medius muscles.
Comparative analysis of paraspinal and frontalis EMG, heart rate and skin conductance in chronic low back pain patients and normals to various postures and stress. Collins GA, Cohen MJ, Naliboff BD, Schandler SL.	*Scand J Rehabil Med.* 1982;14(1):39-46. **Abstract:** Eleven chronic low back pain (CLBP) patients were compared with eleven age-matched controls to different postures and stress while measuring paraspinal and frontalis EMG activity, heart rate and galvanic skin response. **Contrary to current theory, results indicate that the CLBP group exhibited similar or significantly less paraspinal muscle activity than the control group.** Frontalis EMG and skin conductance were significantly higher in the CLBP group. It was concluded that the theories are not supported. An alternative explanation of an increased arousal response and altered ability to respond to demanding tasks leading to pain and eventually to decreased paraspinal muscle activity is suggested. **Comment:** After 50 years, the research evidence is suggesting the demise of the hyperactivity-causality model for musculoskeletal pain. The lack of convincing evidence to support the belief in hyperactivity as an etiological factor in musculoskeletal conditions is clearly pointed out in this study. These data indicate that the body's reaction to injury and pain is not primarily increased muscular tension and stiffness; rather *muscle inhibition is often more significant.*
Trunk muscle strength and low back pain, Thorstensson A, Arvidson A.	*Scand J Rehabil Med.* 1982;14(2):69-75. **Abstract:** The strength of the trunk muscles was measured in a group of young males with low back insufficiency (n=7) and in an age matched (19-21 yrs) healthy control group (n=8). A recently designed new application of the isokinetic technique was used to record maximal torque produced by the trunk muscles during flexion, extension and lateral flexion. Trunk muscle strength was measured during isometric contractions in different trunk positions and during slow isokinetic contractions in the whole range of motion. No significant differences between the groups were observed for trunk extension, lateral flexion or flexion with the centre of rotation at L2-L3 level. However, in the initial part of isokinetic trunk flexion with the pivot point at the hip joint the strength values for the back patients were significantly lower than for the controls. **The present results demonstrate the importance of a comprehensive approach to the assessment of trunk muscle strength, including different movement velocities, body positions and pivot points. Further studies are needed to evaluate the significance of the specific weakness observed in dynamic trunk flexion strength in the back patients.**
Detection of dangerous malnutrition. Klidjian AM, Archer TJ, Foster KJ, Karran SJ.	*JPEN J Parenter Enteral Nutr.* 1982 Mar-Apr;6(2):119-21. **Abstract:** The assessment of malnutrition by simple methods was studied in 120 patients undergoing elective major abdominal surgery to determine which index was of the most value in predicting postoperative complications. Weight for height and weight loss were of little significant value; serum albumin less than 35 g/l was more significant (p less than 0.05) but predicted only a quarter of those patients who developed serious complications. Measurements of muscle stores by anthropometry (arm and forearm muscle circumference) predicted nearly half the patients (p less than 0.01). **By far the most useful index was hand-grip dynamometry, which predicted 90% of those who developed complications (p less than 0.001). The incidence of serious complications was 6 times greater in those patients with a low grip strength. Hand-grip dynamometry appears to be a useful screening test of patients at risk, and a valuable additional test for nutritional assessment.** **Comment:** This study shows that testing the muscles of the hand for weakness specifically correlates with patients with post-abdominal surgery complications. In AK, the relationship between muscle function and general neurological function has been hypothesized. Studies like these show that there is continuity between muscle strength and general biological function. A number of research papers are now in the literature showing the relationship between handgrip

	strength and many other neuro-metabolic conditions and syndromes.
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.	*J Manipulative Physiol Ther* 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.
Investigation of over-the-skin electrical stimulation parameters for different normal muscles and subjects, Moreno-Aranda J, Seireg A.	*J Biomech.* 1981;14(9):587-93 This study demonstrates a small part of the potentiality of the AK technique called Therapy Localization or TL.
Usefulness of electrophysiological studies in the diagnosis of lumbosacral root disease, Tonzola R, Ackil A, Shahani B, Young R.	*Ann Neurol* 1981;9:305-308 **Abstract:** Clinical, electrophysiological, and myelographic findings were correlated in 57 patients with the clinical diagnosis of lumbosacral root disease. Conventional motor and sensory (including sural nerve) conduction studies were normal in all patients. Electromyography, late response studies in different muscles of the lower extremity, the myelogram, or combinations of these tests were abnormal in 44 patients (77%). Of 36 patients (63%) with abnormal myelograms, 14 had normal electrophysiological studies. Twenty-nine (51%) had an abnormal electrophysiological or myelographic finding; although 8 patients in this group had a normal myelogram, 2 had an abnormal discogram and 1 an abnormal epidurogram. Electrophysiological or myelographic findings, in some cases both, correlated well with clinical signs and symptoms in 41 patients (72%). H-reflex and F response studies, when abnormal, helped in localizing a lesion in the appropriate root distribution. **Comment:** This study demonstrates that EMG shows better correlation with neurological examinations than CT scans or myelograms for nerve root disturbances in the lumbosacral spine. In other words, muscle dysfunction correlates better with lumbosacral nerve root injuries than CT scans or myelograms.
Trunk strengths in attempted flexion, extension, and lateral bending in healthy subjects and patients with low-back disorders, McNeill T, Warwick D, Andersson G, Schultz A.	*Spine.* 1980 Nov-Dec;5(6):529-38. **Abstract:** Trunk strengths were measured in 27 health males and 30 health females, and in 25 male and 15 female patients with low-back pain and/or sciatica. Maximum voluntary isometric strengths were measured during attempted flexion, extension, and lateral bending from an upright standing position. Both male and female patients had approximately 60% of the absolute trunk strengths of the corresponding healthy subjects. Intra-individual trunk strength ratios were used to interpret the results. Use of these ratios tends to avoid interpretational problems created by the general weakness of the patients and any lack of motivation of either patients or healthy subjects. The ratios showed that the patients had attempted extension strengths that were significantly less than their strengths in the other types of movements tested. The strength ratios for attempted extension were particularly low for patients with sciatica.
Trunk strengths in patients	*Spine.* 1980 Nov-Dec;5(6):539-44.

seeking hospitalization for chronic low-back disorders, Addison R, Schultz A.	**Abstract:** Trunk strengths of 16 male and 17 female patients with chronic low-back disorders were measured. The patients sought hospitalization for four weeks in a pain clinic. Maximum voluntary trunk strengths in the standing position were measured during attempted flexion, extension, and lateral bending. The trunk strengths of these patients were then compared with those of health subjects and with those of patients with low-back disorders who sought treatment as outpatients of a general orthopaedic office practice. In making the comparisons, intra-individual trunk-strength ratios were used to overcome problems due to the effects of patients' general weakness and any psychologic factors. **When compared with healthy subjects, the patients seeking hospitalization had significantly smaller strengths during attempted extension relative to their strengths during attempted flexion or lateral bending.** Their trunk-strength ratios did not differ significantly from those of the outpatient group.
Back and leg complaints in relation to muscle strength in young men, Karvonen MJ, Viitasalo JT, Komi PV, Nummi J, Jarvinen T.	*Scand J Rehabil Med.* 1980;12(2):53-9. **Abstract:** Back and leg complaints were studied by using a questionnaire and medical examination in 183 male conscripts and relating the results to background variables, anthropometry, the isometric strength of large muscle groups, and endurance running. A history of sciatica was reported by 8%, lumbago by 13%, back injury by 13% and low back insufficiency by 63%. Weak trunk extensors were associated with a history of sciatica, weak trunk flexors with back injuries and with current backache at work/exercise. Weak leg extensors showed associations with a history of low back insufficiency and of sick leave due to the back and with current hip pain. Men with a history of lumbago and of hip and knee complaints performed poorly during 12 min of running. Back and leg complaints were more frequent in men with high socio-economic status, who engaged in little physical activity, or who were obese. The questionnaire and strength measurements proved suitable for studying low back syndrome in its early stages.
The Application of Neurological Reflexes to the Treatment of Hypertension, Mannino, R.	*Journal of the American Osteopathic Association*, Dec 1979:225-230
Factors influencing manual muscle tests in physical therapy, Nicholas JA, Sapega A, Kraus H, Webb JN.	*J Bone Joint Surg Am.* 1978 Mar;60(2):186-90 **Abstract:** To determine whether it is the amount or the duration of the force applied manually by the tester, or both, that determines the tester's perception of the strength of the hip flexor or abductor muscles, an electromechanical device was designed which was placed between the tester's hand and the subject's limb. With the device we measured the force applied to the limb, the time interval during which it was applied, and the angular position of the limb during the entire test. In 240 such tests, the testers' ratings of the differences in strength between the right and left sides were correlated with seven variables involving force and time. It was found statistically that the impluse--that is, the duration of the tester's effort multiplied by the average applied force during each test--was the factor that most influenced the tester in the ratings. **Comment:** The skills of the examiner related to conducting tests and interpreting the derived information will affect the usefulness of muscle performance data. The examiner is obliged to follow a standardized protocol that specifies patient position, verbal instructions or demonstration to the patient, alignment of the muscle and direction of examiner resistance to insure precise, repeatable, and reliable MMT results. When a muscle is tested in voluntary isometric contraction, EMG testing reveals that additional muscle fibers contract at low forces; when the force increases, the rate of firing becomes the predominant mechanism to increase strength. Tension, velocity, and electrical activity are interdependent and indicate the importance of proper neurologic control for the muscle to meet the changing pressure demands of the MMT. This requires effective function of the gamma system adjusting the neuromuscular spindle cell, and proper interpretation of its afferent supply by the central nervous system. Thus it is patient or

	more precisely the patient's neuromuscular adaptive capacity that is being examined during a proper MMT.
Muscular Strength Correlated to Jaw Posture and the Temporomandibular Joint – Examination of a Professional Football Population, Smith SD.	*New York State Dental Journal*, 44(7);Aug/Sept 1978. **Comment:** This study utilizes manual muscle testing and Cybex dynamometer testing. The study evaluates Diamond's 4-phase breathing cycle and repositioning the mandible constructed by the lower jaw brought from physiologic rest position toward the closest speaking space (at the first bicuspids), with the midlines evenly aligned. The mandibular wax position was compared to the teeth together position. According to Smith, there was approximately a 90% correlation between the manual muscle test and the Cybex II dynamometer.
The use of skin stimulation to produce reversal of motor unit recruitment order during voluntary muscle contraction in man [proceedings], Buller NP, Garnett R, Stephens JA.	*J Physiol.* 1978 Apr;277:1P-2P. This paper demonstrates the specific effect of skin stimulation upon muscle function, and shows the neurological relationships that may be occurring during the therapy localization procedure in AK diagnosis and treatment.
Reversal of recruitment order of single motor units produced by cutaneous stimulation during voluntary muscle contraction in man, Stephens JA, Garnett R, Buller NP.	*Nature.* 1978 Mar 23;272(5651):362-4. This paper demonstrates the specific effect of skin stimulation upon muscle function, and shows the neurological relationships that may be occurring during the therapy localization procedure in AK diagnosis and treatment.
Discogenic radiculopathy: use of electromyography in multidisciplinary management, Lane M, Tamhankar M, Demopoulos J.	*NY State J Med* 1978;78:32-36 This study demonstrated an 85% agreement between EMG evaluation and neurological work-up, evidencing nerve root compromise. There is evidence offered that EMG readings may be equivalent to subluxation determination. This study shows that changes in muscle electrical activity measured in distinct myotomes revealed nerve root disturbance. The study concludes that a positive EMG finding, indicating the presence of a lesion at the level of the root or proximal in the spinal cord, should alert the clinician.
Reflex changes in heart rate after mechanical and thermal stimulation of the skin at various segmental levels in cats. Kaufman A, Sato A, Sato Y, Sugimoto H.	*Neuroscience.* 1977;2(1):103-9. Kaufman et al have demonstrated that cutaneosympathetic reflexes can be elicited throughout the body. This paper describes some of the neurology involved in the AK testing method called Therapy Localization. In AK, TL is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system. A number of papers in this Compendium have presented the neuro-physiological basis for this finding. The cutaneomuscular reflexes have been extensively investigated in the scientific literature, and they are part of the mechanism for what is found clinically with TL testing. In AK, positive TL always calls for further investigation to the area concerned.
A study of thigh muscle weakness in different pathological states of the lower extremity, Nicholas JA, Strizak AM, Veras G.	*Am J Sports Med.* 1976 Nov-Dec;4(6):241-8. **Comment:** General manual muscle testing procedures are described. The author states that he has been using these tests for 15 years and finds them to be very revealing regarding the susceptibility to injury and offers a quick, effective testing procedure. "All medical personnel concerned with injuries to the lower extremities must realize that the strength of the lower body

	is an integrated unit which can be affected in many different areas, some quite remote from the site of pathology by a single pathological disorder. What is measured manuall cannot be measured by the Cybex dynamometer alone."
Grip strength and chiropractic adjustment, Howitt Wilson MB.	*Anglo-European College of Chiropractic,* 1975. **Abstract:** Six student controls and 50 patients had their grip strength measured with a sphygmomanometer after CMT to the T1 vertebra. 21 patients had significant contralateral grip strength increases.
Towards standardization of muscle strength testing, Kroemer KH, Howard JM.	*Med Sci Sports.* 1970 Winter;2(4):224-30 **Abstract:** Male subjects (N=24) exerted maximal horizontal forces either trying to maintain a constant level over 5 seconds, or increasing steadily to the subjective maximum, or in vigorous jerks of the body. Statistical analysis ($p<0.01$) indicated that these different techniques of force generation can result in different peak impulses. For the force maintained over 5 seconds, different scores (peak, and 12 averages during the exertion period) were extracted from the recorded force curves. Many of the resulting scores were significantly different from the others. Thus, a number of distinctly different "strength" scores resulted either from techniques of force generation used by the subjects, or from different statistical treatments of the same raw data by the experimenter. To standardize measures of "strength," a definition of strength, a checklist to control experimental techniques, and a regimen to calculate the strength index are proposed.
Further standardization of manual muscle test for clinical study: applied in chronic renal disease. Silver M, McElroy A, Morrow L, Heafner BK.	*Phys Ther.* 1970 Oct;50(10):1456-66.
Dysponesis: a neurophysiologic factor in functional disorders, Whatmore GB, Kohi DR.	*Behav Sci.* 1968 Mar;13(2):102-24. **Abstract:** Dysponesis is described as a reversible patho-physiologic state consisting of unnoticed, misdirected neurophysiologic reactions to various agents (environmental agents, body sensations, emotions and thoughts) and the repercussions of these reactions throughout the organism. **Comment:** In AK it is proposed that these errors in energy expenditure, potentially capable of producing functional disorders, consist mainly of covert errors in action potential output from the motor and premotor areas of the cerebral cortex and include the consequences of that output. These neurophysiologic events result in aberrant muscle activity that may be evaluated through manual muscle testing technique.
Cord cells responding to fine myelinated afferents from viscera, muscle and skin, Pomeranz B, Wall PD, Weber WV.	*J Physiol.* 1968 December; 199(3): 511–532. **Abstract:** 1. Micro-electrode recordings were made in the thoracic cord of acute spinal cats. **Cells, which were located in the histologically defined lamina 5, responded both to the fine myelinated afferents from the splanchnic nerve and to afferents from the skin**. Splanchnic afferents inhibit the effect of converging cutaneous inputs for periods up to 150 msec. Skin stimuli may also inhibit the effect of afferent nerve impulses from viscera. Some cells respond monosynaptically to the splanchnic afferents, others indirectly. 2. Fine myelinated afferents from gastrocnemius (group 3) stimulate lamina 5 cells which also have cutaneous receptive fields. Cutaneous and group 3 muscle afferents interact by mutual inhibition in their effect on the cells. 3. Fine myelinated afferents from skin excite lamina 5 cells. The cutaneous responses of lamina 5 cells contrast with those of lamina 4 cells in the following respects: (*a*) the receptive fields are

	larger, (*b*) they respond with an increased latency to Aβ afferents, (*c*) there is a low pressure threshold at the edge, (*d*) **they respond to a wide range of pressure stimuli from light brush to heavy pinch applied to the centre of the receptive fields** and (*e*) they respond to AΔ afferents. 4. **Lamina 5 cells receive fine myelinated afferents either from viscera or from muscle or from skin.** Lamina 4 receives large myelinated afferents from skin and lamina 6 receives large myelinated afferents from muscle. **The results suggest the hypothesis that some fine myelinated afferents form a class of afferents which signal the state of tissue, and end on lamina 5 cells.** **Comment:** This early paper describes the neurology involved in the AK testing method called Therapy Localization. In AK, TL is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system.
Joint distension and reflex muscle inhibition in the knee, DeAndrade JR, Grant C, Dixon ASJ.	*J Bone Joint Surg* 1965;47:313. This paper shows that joint inflammation in the knee can lead to reflex muscle inhibition.
An Introduction to Chapman's Reflexes, Chaitow, L.	*British Naturopathic Journal*, Spring 1965
Muscle testing. Part 2: Reliability in clinical use, Iddings DM, Smith LK, Spencer WA.	*Phys Ther Rev* 1961;41:249-256.
Quantitative muscle testing: Principles and applications to research and clinical services, Beasley W	*Arch Phys Med Rehabil* 1961;42:398-425
Study of the reproducibility of muscle testing and certain other aspects of muscle scoring, Lilienfeld AM, Jacobs M, Willis M.	*Phys Ther Rev* 1954;41:249-256. **Comment:** In a study comparing the results of manual muscle testing among five examiners, there was a 9.1% average difference. The examiners consisted of two physical therapists who were instructors in manual muscle testing, two physicians and one nurse who were essentially unfamiliar with muscle testing prior to the orientation session. The elimination of the nurse from the comparison yielded a 5.3% difference in MMT outcomes between the testers. The difference between the instructors was 3.0%. Although this study shows a high level of consistency in MMT examination, even among people with little training as compared with those highly trained, it does show a need for expertise in manual muscle testing to obtain consistency of results.
Excitatory and inhibitory skin areas for flexor and extensor motoneurons, Hagbarth KE.	*Acta Physiol Scand Suppl.* 1952;26(94):1-58. **Comment:** This early paper describes some of the neurology involved in the AK testing method called Therapy Localization. In AK, TL is a simple, non-invasive technique to find out where a problem in the body exists. TL doesn't show the physician what the problem is but shows that something under the hand that is contacting the patient's body is disturbing the nervous system.
Electromyographic studies of structural abnormalities. 1941. Denslow JS, Clough	*J Am Osteopath Assoc.* 2001 Feb;101(2):101-5. **Abstract:** Denslow and colleagues made early observations that spinal lesions were associated

GH.	with long-lasting alterations in EMG, muscle tissue texture, and electrodermal activity.
Some interesting observations about the after care of infantile paralysis patients, Kendall HO	*J Excep Child* 1936;3:107.
A method of recording muscle tests, Lowman CL.	*Am J Surg* 1927;3:586-591. **Abstract:** It has been quite generally accepted that muscle reeducation, as applied particularly to paralysis causes, is of very decided value in treatment. A grading system for muscle measurement is delineated, ranging from 0 (no appreciable motion) to 9 (normal muscle strength and motion). Allowance must be made for the personal equation which usually accounts for at least a variance of one degree between examiners. Preferably the same persons should make all the tests, and the longer they do this the more reliable they become.
On Weakness of the Posterior Cervical Muscles as a cause of Headache, Cyriax E.	*Medical Press and Circular* 1920, N.S. cviv:461-463. **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.
Certain aspects of infantile paralysis with a description of a method of muscle testing, Lovett RW, Martin EG.	*JAMA.*1916 Mar 4; LXVI(10):729-33.
A method of testing muscular strength in infantile Paralysis, Martin EG, Lovett RW.	*JAMA.* 1915 Oct 30; LXV(18):1512-3.
Treatment of infantile paralysis, Lovett RW.	*JAMA* 1915;64:2118
Muscle training in the treatment of infantile paralysis, Wright WG.	Boston Med Surg J 1912;167:567-574.

	PUBLISHED ARTICLES ABOUT APPLIED KINESIOLOGY IN "NON-PEER REVIEWED" JOURNALS
Collected Papers of the International College of Applied Kinesiology	International College of Applied Kinesiology, Shawnee Mission, KS, 1976-2006 (**www.ICAKUSA.com**) Over 2,000 papers published by and for members of the organization.
Is it Possible to Eliminate Pain Instantaneously by Applying Neurophysiological Reflexes? Kaufman S.	*Dynamic Chiropractic*, January 15, 2008;26: 02. The treatment of trigger and tender points in muscles by the use of reflexes described in AK (neurophysiological reflexes, neurolymphatic, neurovascular), as well as golgi tendon organ and muscle spindle cells, is hypothesized in this paper to dramatically reduce the pain produced from these reflexes in symptomatic patients.
A Test to Define Supraspinatus Strength, Hammer W.	*Dynamic Chiropractic*, Sept 14 2006;24(19):30.
The Neurodevelopmental Basis for Spine Stability, Liebenson C.	*Dynamic Chiropractic*, February 13, 2006;24:04. **Abstract:** The search for patterns of how individual muscles react to injury or inflammation has continued for many decades. **It has been demonstrated that certain muscles have a predictable tendency to become inhibited**, whereas others become tense. **Muscles in the knee (vastus medialis oblique), lumbar spine (multifidus), or cervical spine (deep neck flexors, suboccipitals), respond to inflammation or injury by becoming inhibited and atrophying.** Other muscles such as the upper trapezius, sternocleidomastoid (SCM), or lumbar erector spinae (loss of flexion-relaxation phenomena) respond to injury or overload by tensing or becoming overactive. **Comment:** Goodheart, Janda and Lewit have shown that frequently even the muscles that become "tense" or "short" after injury will test weak on MMT.
Essential Evaluation Tools For The Kinesiology Practitioner, Corwin M.	*Energy Kinesiology Association of the US*, June 2005 (Salt Lake City)
Muscle Testing & Manipulation – A Talk with the Pioneer of Applied Kinesiology, George Goodheart, D.C.	*Am Chiro*, Sept 2005:44-45 (www.theamericanchiropractor.com)
The Importance of Proprioceptive Testing To Chiropractic, Cuthbert, S.	*Dynamic Chiropractic*, Sept 13 2004;22(19) (http://www.chiroweb.com/archives/22/19/09.html) For about 76 million Americans, proprioceptive disorders cause more than a passing problem.

	More than 5 million of them visit their doctors each year because occasional or chronic feelings of wooziness, spinning, lack of balance, and fainting are seriously interfering with their ability to work or to enjoy their leisure. In fact, dizziness and other equilibrium disorders are among the most common symptoms reported to physicians. Body posture and balance can be adversely influenced by dysfunctions affecting the central nervous system, the peripheral nervous system, the eyes, the ears, and the musculoskeletal system, where proprioceptor and mechanoreceptor sensory organs lie. Defects in any of these tissues can lead to diminished postural function and increased instability, and eventually to trauma from falling. There is evidence that multiple factors can adversely affect the postural mechanism and that these factors are cumulative. One of the causes of the chiropractic subluxation may be found in faulty proprioceptive mechanisms in our patients. Proprioception, equilibrium and balance are at the core of human functioning.
Applied Kinesiology and the Motor Neuron, Belli, R.	*Dynamic Chiropractic*, April 2003, 21(9). (http://www.chiroweb.com/archives/21/09/04.html) Hardly a single human function takes place without muscular involvement. Consequently, proficiency in analyzing muscles via AK MMT, coupled with a thorough understanding of the central nervous system, provides clinicians with an almost limitless method of evaluating functional conditions and all their nuances.
Applied Kinesiology: How To Add Cranial Therapy To Your Daily Practice, Cuthbert, S.	*Dynamic Chiropractic*, May 2003;21(11). (http://www.chiroweb.com/archives/21/11/10.html) Many chiropractic physicians feel intimidated by the concept of cranial evaluation and treatment. If they were more sensitive to cranial-system dysfunction, they might be better able to help their difficult patients overcome many problems related to cranial dysfunction and lead happier, more successful lives. Not only chiropractors, but also osteopaths; holistic dentists; some medical doctors (especially in Europe); physical therapists; and massage therapists actively pursue cranial manipulative procedures. With our many gifts in functional neurological assessment, more chiropractors should possess the greatest gifts in cranial evaluation and treatment. DeJarnette and Goodheart introduced into our profession diagnostic methods for the evaluation and treatment of cranial dysfunctions. The key technical factor that has advanced cranial diagnosis and treatment, and brought the entire field of cranial therapy into accessible, reproducible, practice and scientific form, was provided by Goodheart's discovery that the musculoskeletal system and manual muscle testing (MMT) reflects what is going on within the cranial mechanism.
AK Manual Muscle Testing: As Reliable As The Deep Tendon Reflex?, Caso, M.	*Dynamic Chiropractic*, June 2003;21(13). (http://www.chiroweb.com/archives/21/13/04.html) Just as a DTR represents a "snapshot" of a spinal cord reflex loop, a manual muscle test is also a "snapshot." It is a clinical window of the central nervous system which, due to its plasticity, is constantly in flux. The only difference is that the manual muscle test is exceedingly more complex, not only in terms of its mechanism, but also in how well a doctor can be trained to perform it. That is where the science and the art must blend. The experienced neurologist will likely be more successful at eliciting an accurate DTR, and appropriately interpreting it in the context of an exam, than the family practice physician. By the same token, expert applied kinesiologists are better equipped with the psychomotor skills necessary to perform accurate

	MMT.[7] In light of this, it is my opinion that the use of AK MMT, when understood as part of a greater clinical picture, can become standard procedure, as have DTRs.
Applied Kinesiology and Sports, Heidrich JM.	*Today's Chiropractic,* March-April 2003. An old saying is that knowledge is useless until applied. In developing applied kinesiology (AK), Dr. George Goodheart's genius has been a unique ability to "re-search" basic academic knowledge and convert seemingly unrelated tidbits of information into workable clinical technique. Goodheart became the first chiropractor appointed to the U.S. Olympic medical staff at the Lake Placid Winter games. This appointment was undoubtedly enhanced by his successful recovery of then Olympic medical director, Irving Dardik, MD, who was suffering a persistent leg symptom while running. Subsequently, while working with the downhill skiers at Lake Placid, Goodheart observed a specific muscle failure pattern that developed during a competitor's tuck position, resulting in an obvious performance slump for the athlete. As an avid and accomplished skier himself, Goodheart's familiarity with the sport allowed him to ferret out the problem. The concept of aerobic muscle weakness, a decrease in muscle endurance with repetitive contraction, was then discovered and researched. The positive chiropractic exposure during these games helped pave the way for chiropractic inclusion at future Olympics. In addition to numerous Olympic athletes, applied kinesiology doctors have participated in a host of professional sports programs, including major league baseball, the NBA, the NFL and world cup soccer. Dozens serve at the collegiate and scholastic levels, as well as tending to the "weekend warriors" seen in everyday practice.
A new breed of healers	*Time*, April 16, 2001:62 This was a feature article about the founder of AK, Dr. George Goodheart.
Manual Muscle Testing and Postural Imbalance, Christensen, K.	*Dynamic Chiropractic*, November 2000;18(24). (http://www.chiroweb.com/archives/18/24/02.html) **Abstract:** The best posture is one in which the body segments are balanced in the position of optimal alignment and maximum support, with full mobility available. Optimal posture allows for pain-free movement with a minimum of energy expenditure, and is a sign of vigor and harmonious control of the body.[1] One of the most useful diagnostic procedures in chiropractic practice is the manual testing of the muscles responsible for maintaining postural alignment. This part of an examination provides valuable clinical information, which can be correlated with a patient's history and reported symptoms.
Achilles Tendon Strain, Muzinski SE.	*Metrosports Mag* Feb 1999
That Annoying Knee Pain, Muzinski SE.	*Metrosports Mag* Sept 1998:45
Muscle Tears in the Calf, Muzinski SE.	*Metrosports Mag* Jul 1998:15
Spinal Instability and Pain: Is There a Connection?, Liebenson C.	*Dynamic Chiropractic* December 15, 1997;15(26). **Abstract:** Research studies demonstrating the connection between muscle dysfunction (including muscle weakness) and spinal pain are reviewed.
Conservative Treatment of Shoulder Injuries, Muzinski SE.	*Maryland Sports, Health and Fitness Mag* Nov-Dec 1997:8

Skiing and Muscle Balance, Muzinski SE.	*Metrosports Mag* Nov 1997:52
Common Shoulder Pain: Shoulder Impingement Syndrome, Muzinski SE.	*Metrosports Mag* Oct 1997:50
Low Back Pain and Cycling, Muzinski SE.	*Metrosports Mag* May 1996:24
A Lesser Known Cause of Hiking Injuries, Muzinski SE.	*Metrosports Mag* Jul-Aug 1995:23
Applied Kinesiology facilitates a truly holistic approach, Butler B.	*Positive Health Mag* Oct-Nov 1996:45-48.
The Research Status of applied kinesiology, Part I, Rosen, M.S.	*AK Review*, 1(1);Fall 1990:42, and Chiro Econ, 37(2);Sept-Oct 1994:17
The Research Status of applied kinesiology, Part II, Rosen, M.S.	*AK Review*, 1(2);Spring 1991:34 and Chiro Econ, 37(6);May-June 1995):40
The applied kinesiology technique, Goodheart, G.	*Today's Chiro*, 22(4);Jul/Aug 1993:56-58.
Applied Kinesiology: An Historical Overview, McCord K.M.	*Dig Chiro Econ* Sep/Oct 1991;34(1):20-27.
Infantile Colic – Does Every Baby Have It?, Arcadi, V.C.	*Dynamic Chiropractic*, February 1991;9(3). (http://www.chiroweb.com/archives/09/03/35.html) The treatment, which is 90 percent effective in treating newborns and infants right from the moment they are born, is full spine chiropractic adjustments, especially in the occiput/C1 area and thoracics from T8 superior to T1. A newborn with cephalgia and cranial molding requires a cranial adjustment utilizing such gentle techniques as Upledger, Sacro-occipital Technique (SOT), or Applied Kinesiology. A cranial adjustment in my experience can be the most important adjustment that can be made to a newborn or infant. Reversing the damage done from the birth can be of optimal benefit to the baby as an infant, and throughout the child's life. Temporomandibular joint dysfunction early on can lead to breast feeding difficulties, headache, and improper feeding which in turn can lead to colic and digestive problems.
Thoughts About Muscle Testing, Hammer W.	*Dynamic Chiropractic*, May 1991;9(11). http://www.chiroweb.com/archives/09/11/31.html
Suprascapular Nerve Entrapment, Hammer W.	*Dynamic Chiropractic*, September 1990;8(19). http://www.chiroweb.com/archives/08/19/34.html
Applied kinesiology – what	*J Am Dietetic Assoc*, 89(4);Apr 1989:476.

does the term mean? (Letter to the Editor), Goodheart, G.	
Combating a vitamin B deficiency, Goodheart, G.	*Today's Chiro,* 17(2);Mar/Apr 1988: 19-22.
Structural imbalance and nutritional absorption, Goodheart, G.	*Today's Chiro,* 16(1);Mar/Apr 1987:19-24.
Managing lactic acid excess, Goodheart, G.	*Am Chiro,* Sep 1989: 48-52.
Structural imbalance and nutritional absorption, Goodheart, G.	*Am Chiro,* Oct 1989:40-44.
Celebrating Applied Kinesiology's gold and silver, Maffetone P, Durlacher J.	*Dig Chiro Econ,* 1989;31(6):14-5.
The Clorox Test: A Screening Test for Free Radical Pathology, Part I. Schmitt, WH.	*Dig Chiro Econ,* 1987 Sept/Oct: 57. **Abstract:** The use of sniffing the household bleach, Clorox, is discussed as a screening test for free radical problems initiated by the inability of the body to neutralize the free radical OCl- (Hypochlorite). Generalized muscle weakness induced by sniffing Clorox may be neutralized by one or more of the following: 1) taurine, 2) niacin or niacinamide, 3) selenium, 4) vitamin E, 5) certain essential fatty acids, and/or 6) vitamin C. The biochemical mechanisms behind the neutralization of the Clorox sniff test are discussed for each of the six substances listed, including the use of aspirin as a screening test for the need for essential fatty acid supplementation. The concept of free radical pathology in the etiology and perpetuation of a number of symptoms is covered, including pain and inflammatory conditions, autoimmune processes and Candida albicans syndrome. In addition, the concept of pseudoinfection syndrome is introduced in relation to free radical pathology at the local tissue level and in relation to the Clorox sniff test as a screening tool to be used in apparent infectious processes, especially those of the recurring type.
Further Explanation of Surrogate Testing and Therapy Localization, Sprieser P.	*Dig Chiro Econ,* Jan/Feb 1987:131-135.
On the balancing of candida albicans and progenitor cryptocides: a triumph of the science of applied kinesiology, Rochlitz, S.	*Townsend Letter for Doctors,* May 1986;37:113-152. (http://www.tldp.com)
Fundamentals of Essential Fatty Acid Metabolism, Parts I and II, Schmitt WH.	*Dig Chiro Econ,* 1985 Jul-Aug:38, and Sept/Oct:48. **Abstract:** The biochemical importance of EFA's to human health are reviewed, as well as the AK methods of diagnosing the need for EFA's are presented.

Kinesiology Korner: 21st Century Chiropractic, Mladenoff, E.	*Am Chiro,* Dec 1985:55. The cranium is a living structure, which has motion occurring in all sutures, if the cranium is functioning properly. It is believed that if the cranium is not functioning properly then cranial malfunction might cause health problems. It is noted that cranial malfunction can also produce local pain in the sutures, disturbances in the endocrine system, and inhibit cerebrospinal fluid motion and production. Cranial bone dysfunction can affect conditions such as hypertension, brain vascularity, visual difficulties, learning disabilities and temporomandibular joint imbalance.
Applied Kinesiology celebrates 20th anniversary, Thie J, Durlacher J.	*Dig Chiro Econ,* 1984;26(4):14-5.
A study of the results of Applied Kinesiology in a group of 123 Patients, McDowall, D.	*Journal Of The Australian Chiropractic Association,* 1983;13(2):26-7
Applied kinesiology: the advanced approach to athletic health care, B.M. Chambul, T.G. Chambul	*Canadian Runner,* May 1983:18-19.
Dyslexia and learning disabilities cured, Ferrari C.	*Dig Chiro Econ,* 1983;25(6):74.
Applied kinesiology – the tangible measure of health imbalance and correction, Dalrymple H.	*Nature & Health,* Winter 1982:79-81.
Iron, Vitamin B-12, and Folic Acid: A Correlation of Laboratory Findings (Complete Blood Count with Differential) and AK Findings, Schmitt WH.	*Dig Chiro Econ,* 1982;Mar-Apr:40. **Abstract:** The AK testing methods for iron, vitamin B-12, and folic acid are reviewed. The usefulness of the CBC with differential in aiding in the detection of deficiencies of these three nutrients is discussed, particularly the relationship of B-12 and/or folic acid deficiency to leucopenia associated with neutropenia and relative lymphocytosis. A series of 15 patients, each of whom showed AK testing for one or more of these substances, is reviewed in light of CBC's with differentials performed after the AK diagnosis was made.
German electro-acupuncture, Applied Kinesiology and gastric digestion, Hanicke B.	*Dig Chiro Econ,* 1982;24(5):10-12.
The education dimensions of Applied Kinesiology, Tyler RH.	*Dig Chiro Econ,* 1981;23(4): 34.
A multi-disciplinary view of Herpes Simplex II, Goodheart, G.	*The Journal of Energy Medicine,* 1980, 1:12.
Applied kinesiology diagnosis and treatment of	*The Journal of Energy Medicine,* 1980, 1:40-45.

emotional stress overload, Goodheart, G, Schmitt, W.	
The good hands man	*Sports Illustrated*, 51(3);July 16 1979:34 This was a feature article about the founder of AK, Dr. George Goodheart.
Applied Kinesiology, related organs, meridians and ear-ricular therapy, Wing TW.	*Dig Chiro Econ*, 1979;21(4):51-3.
Vertebral fixations which mask other faults, Schmitt W.	*Dig Chiro Econ*, 1978;21(1):62-65.
The role of the adductor muscle group in persistent posterior shoulder girdle pain, Odden CC.	*Dig Chiro Econ*, 1978;20(6):14-6.
Applied Kinesiology used in detecting potentially harmful ingredients in nutritional supplements, White NN.	*Dig Chiro Econ*, 1978;20(4):14-15.
Kinesiological differentiation of low back syndrome including the pseudo disc and true disc and the ramrod spine, Duffy DH.	*Dig Chiro Econ*, 1978;20(4):60-65.
Cranial Technique: A Clarification of Certain Principles, Goodheart, G, Schmitt W.	*Dig Chiro Econ*, Nov/Dec 1977;20(3):26-29,74. Normal cranial bone movement with respiration is reviewed. The frontal bone's two halves rotate internally at the metopic suture on inspiration and externally on expiration. The temporal bone and innominate bones have similar but not identical respiratory movements. The mastoid process moves posteriorly and medially on inspiration, the opposite on expiration. Correction of "inspiration – and expiration – assist" cranial faults is therefore based on exaggeration of the fault and the "rebound" response of the dura mater.
Correlative orthopedic kinesiology, Feder K.	*Dig Chiro Econ,*1977;20(1):32-4.
One common cause of foot subluxations, Schmitt W.	*Dig Chiro Econ*, 1977;19(6):28.
Experimental Characterization of The Reactive Muscle Phenomenon, Triano J, Davis B.	*Dig Chiro Econ*, Sept/Oct 1976:44-50. **Abstract:** As the authors recognize, much discussion and doubt has been cast towards the clinical impressions and teachings of applied kinesiology since its original inception. Though today more and more practitioners are utilizing these techniques, there has of yet been no clear definition of these techniques, as well as other chiropractic techniques, by scientific investigation. Muscle testing provides an excellent approach to verification of physiologic effects of chiropractic techniques through the widely accepted media of electromyography.

	A group of 40 subjects were analyzed and found to include 10 individuals susceptible to the reactive muscle phenomenon of Goodheart. These subjects were then studied in order to characterize the reactive phenomenon. This study demonstrated that the reactive muscle phenomenon is, in fact, a physiologic imbalance of muscle and that it is not simply a psychologic suggestion or an overpowering of the tested arm by brute force. These data have provided the first quantitative evidence, to our knowledge, that in the case of the deltoid-rhomboid interactions the clinically observed "reactive muscle" represents a real physiological phenomenon. Further studies to detect its mechanism and clarify its treatment are under way.
Biofeedback and kinesiology, Eversaul, G.	*Journal of the American Society of Psychosomatic Disease*. 1976; 6: 19-23
The vertebral challenge, Schmitt WH.	*Dig Chiro Econ*, 1976;18(6):24-28.
Applied Kinesiology and athletics, Perry LR.	*Dig Chiro Econ*, 1976;19(2):30-32.
Glaucoma and the kinesiological approach, Duffy DH.	*Dig Chiro Econ*, 1976;19(3):48-9. **Abstract:** The case history and AK cranial therapeutic techniques are presented regarding the treatment of a 32 year old female who had been legally blind for 24 years (able to discern only between light and absence of light) who was capable of reading with 20-70 vision immediately following AK cranial treatment.