

## **Introduction**

Today with the specific techniques that a conservative care and manual therapy doctor use, the MUA procedure is gaining ground as one of the more effective procedures for both chronic and certain acute cases of pain from spinal dysfunction where manipulation/conservative care procedures are the treatment of choice but when the patient is minimally responsive to office treatment.

What makes MUA different is the use of Monitored Anesthesia Care (MAC). MAC places the patient in a position to be responsive but less apprehensive upon stretching and deep muscle massage designed to alter fibrotic adhesions. When the adhesions in and around the joints, discs and muscles are altered, a significant improvement in range of motion occurs with a reduction in pain.

MUA is not new or experimental and fits perfectly in today's multi-specialty approaches to care found within the rehabilitation community. MUA has been recorded as far back as 1938 and there is a significant amount of literature supporting MUA as a safe and effective procedure in the treatment of both acute and chronic spinal pain disorders in appropriately selected patients. In short, the patient is selected or qualified for the procedure using standards and protocols established by the American Association of Manipulation Under Anesthesia Providers (AAMUAP).

On the day of the procedure, the patient is given another history and physical by the medical clearance and the OR nursing staff and anesthesiologist. The anesthesia is given by a board certified anesthesiologist only when the patient and MUA certified doctor are ready to begin. The procedure is, in most instances completed in multiple days or what is called serial MUA with 2-3 procedures being the average. A little more movement, range of motion and stretching is accomplished each day to complete the desired effect. Once the procedures are completed, the patient is discharged to post MUA care designed to continue to redefine the mechanical alterations which have taken place and to rehabilitate the weakened areas which were altered by dis-use from injury.

## **The Scientific Basis for MUA**

From a manual therapy perspective, the vertebral motion unit is considered to be from the middle of one vertebrae to the middle of the next to include the vertebral bodies, the disc, facet joints, ligaments, nerve roots and vascular supply. Because of the complexities of the motion unit, many "discogenic" problems are in fact myofascial/facet syndromes (of note: this fact is often considered a major contributor to the 20-40% incidence of failed back surgeries). It is the medial branch of the dorsal primary ramus that is of paramount clinical relevance due to its distribution to the zygapophyseal joints. The medial branches of the dorsal rami supply the zygapophyseal joints above and below its course. Any structure that has a nerve supply is a potential source of pain. The structures in the lumbar spine that receive a nerve supply include the zygapophyseal joints, the ligaments of the posterior holding elements, the paravertebral muscles, the dura mater, the anterior and posterior longitudinal ligaments and the intervertebral discs are potential sources of pain.

It is well known from a biomechanical perspective that to achieve reduction in symptoms and decrease in pain, manipulation/adjustment can be used to recruit the neurological mechanism of collateral inhibition. Collateral inhibition is that part of the arthrokinetic reflex that inhibits the central

transmission of pain through mechanoreceptor collateral fibers, which inhibits the nociceptors in the posterior motor units of the spine and the zygapophyseal capsules. Spinal manipulation is designed to restore biomechanical integrity to areas of articular dyskinesia due to pathomechanical factors, including loss of joint mobility, fibroblastic proliferative changes of the supporting holding elements and soft tissue structures resulting in decreased or lost flexibility/viscoelasticity and the resulting neurological and/or vascular changes.

It has now been well documented by the use of MUA, that this complex mechanism of painful stimuli from mechanical dysfunction of the motion unit frequently mimics discogenic pain especially in failed back surgery where surgical intervention (usually minimally invasive) has left the patient with the same type of pain they had prior to the surgery. When the MUA is performed subsequently, the pain improves considerably.

## **The Inflammatory Cycle**

The facet joints are a primary site for adhesion accumulation. The core of the MUA program is altering fibrotic adhesions caused by inadequate remodeling at the end of the inflammatory cycle. The inflammatory cycle is composed of three phases:

- The initial hypoxia phase where fluids rush in bringing oxygen and swelling.
- The edema and hemorrhage phase when necrotic tissue is being flushed.
- The repair and remodeling phase.

Phase I (the acute inflammatory phase) lasts up to 72 hours and is characterized by a humeral response (coagulation, fibrinolysis, kinin, compliment, phagocytosis and chemotaxis), and cellular response (mast cell degranulation, and prostaglandin release).

Phase II (repair phase) lasts from 48 hours to six weeks and is characterized by synthesis and deposition of collagen. Collagen will contract between three weeks and fourteen weeks post injury but may take up to six months.

Phase III (remodeling phase) lasts from three weeks to twelve months or more. It is during this period in which collagen is remodeled to increase its functional capacity. Maximum strength of collagen is dependent upon forces exerted on it during this phase (stretching during the MUA procedure has a direct effect on collagen remodeling).

## **Role of Adhesions**

Adhesions form in the joints, joint capsules, muscle fibers and all areas of stress. These adhesions cause decreased movement from articular fixation and shortening of muscle fiber length from disuse. It is also important to note that it has been shown in the literature that intradural adhesions have been shown at the microscopic level to disrupt neurovascular bundles containing branches of the sinuvertebral nerve where they course between the adherent dura and the posterior longitudinal ligament. All of these are mechanisms and sources of “discogenic” type of pain and has been shown to reduce the patient’s pain when addressed. From an MUA perspective, it has been shown that the stretching that is accomplished

during the procedure has an altering effect on the adhesions in all of these structures and is the major reason why the patient has reduced pain post MUA.

One additional mechanism of pain and fibrotic adhesion formation that must be mentioned here is that caused from muscle splinting or protective rigidity. Usually after an injury, there is a protective muscular rigidity that occurs to prevent further damage and pain. This can usually be overcome with conservative care. This muscle contraction is defined as a shortening of the muscles or other tissues that cross a joint and restrict normal movement. When a muscle becomes chronically fatigued it will remain in a contracted state and develop adhesions within the tissue. It will be weak but appear strong. One type of contracture we deal with is myostatic where there is no specific pathology but is caused by disuse from lack of exercise or injury. Then there is scar tissue formation post surgery, from repetitive stress injuries and from repetitive overexertion injuries. These fibrotic adhesions dramatically reduce range of motion, cause fixation and reduce function by shortening the normal muscle fiber length.

## **Connective Tissue**

There are three types of connective tissue we concern ourselves with in MUA.

- Organized: Tendons, ligaments, etc.
- Dense: Fascial planes, capsules, adhesions
- Areolar: loose connective tissue between muscle fibers

If motion is maintained during the healing of trauma, connective tissue of the areolar type develops during remodeling. If the injured area is immobilized, dense contracted fibro-adhesions develop during remodeling. Immobilization of an injured area develops dense fibrous tissue 2 weeks after injury.

It is easier to prevent tightness and restriction from fibro-adhesion formation by frequent repeated activity, then to correct it after it had developed. Gross evidence indicates that fibro-adhesions begin to develop in less than 24 hours after micro/macro trauma with restriction beginning in less than 3 days.

## **Response to Stretching a Relaxed Muscle**

Since 70% of the MUA technique involves stretching relaxed muscles, we need to understand the reactions and response to these stretches. Stretching the muscles, joints and joint capsules creates the biophysiological atmosphere for change to occur when static flexibility becomes dynamic flexibility. During stretching, we overcome definable barriers of elasticity which determine the boundaries which a muscle fiber has anatomically been limited to. Our primary interest is in creating a remodeling effect in muscles which are shortened from disuse, or from adhesion accumulation or both. Adhesions form in muscles fibers and cause joint restriction. If fixation from joint adhesion causes restriction, adhesions in muscle occurs as well.

## **Muscle Anatomy and the Physiology of Stretch**

The myofibril contains the contractile unit within the micro-myofibers of the striated muscle called the sarcomere. It is within the sarcomere Z band to Z band that the myofilaments Actin and Myosin contract. It is the body's ability to elongate the muscles fiber at the myofilament level that makes it possible to accomplish the return to normal flexibility that occurs during the MUA procedure. A sarcomere may shorten to 50% of its normal length during contraction and 120% of its length during maximal stretching. When contraction occurs, there is change in the permeability of the myofilament due to stretch reflex and neurological stimulus. Myosin attaches to Actin and there is movement inward

or outward to perform the desired function. This Myosin-Actin sliding action is accomplished by a cross bridging chemical attraction. We believe that when the adhesions form within the muscles fibers, this normal sliding effect does not occur or is restricted. **Stretching creates a natural homeostasis and alters the adhesion** (Straight Linear Force Stretching).

By using twilight sedation, the patient is placed in a relaxed physiological state that allows for the stretching of the myofibrils Actin and Myosin that leads to the elongation of the muscle. The stretch is performed to move the muscles for the “disuse” elastic phase, into the “disuse” plastic deformans phase. The normal muscle has an “elastic” range that is part of the normal muscle length when performing a function. With an injured area that has had disuse, the normal elastic range is greatly reduced and the muscle is shortened. Straight linear force produces the desired stretch into plastic deformans and is permanent. Stretching is done with constant linear force to elongate the muscle and to allow relaxation from the Golgi tendon response to ballistic stretching. To complete the elongation of the muscle takes several days and is the most important reason for post MUA Therapy.

## **Neurology and Anesthesia for MUA**

Ultra short acting anesthetics such as Brevitol and Diprivan (Propofol) act on the CNS to depress the reaction time to contract a muscle and/or respond to perceived pain. The most recent studies show that these anesthetics effect the reticular formation which act on the Gamma motor neurons. Gamma motor neurons innervate the contractile portions of the muscle spindle. It is thought that by depressing the response of internuncial neurons within the spinal cord, the normal transmission to alpha motor neurons is slowed which has a direct effect on the muscle activity during secondary contraction from pain. It is recognized that when the pathology of pain is effecting the paraspinal muscles there will be a reflex reaction of muscle spasm to protect the area from further damage via stimulation from alpha motoneurons in the anterior horn. Pain perception comes from abnormal mechanical response to stimulation of the type I, II & IV mechanoreceptors. By temporarily depressing this activity within the spinal cord via administration of sedative/hypnotics, one neural pathway for facilitation of paraspinal muscle spasm and pain is removed. Propofol and versed are true sedative/hypnotics. The patient perceives pain, but ligamentous and articular function remain intact but the patient does not remember.

## **Multi-Specialty Approach to Chronic Spinal Pain**

The prospective MUA patient is one who has undergone complete work ups including imaging studies and examination for their spinal pain including but not limited to orthopedics, neurology, pain management, physical therapy and chiropractic. These patients have often been through multiple modalities of treatment seeking to relieve their pain and restore normal function from pain medication/injections, physical therapy, spinal manipulation, massage, acupuncture etc. In this small population of patients that are non or minimally responsive to standard conservative care, MUA becomes the treatment of choice with a high degree of success in these patients.

Providing this type of care where manual therapy can be performed under the care of a board certified anesthesiologist allows the manual therapy care doctor to engage and impact restrictive scar tissue that simply cannot be done in the office. This is the striking difference that MUA can offer to patients with chronic pain and what makes the difference where other treatments have had limited success. When performed in a controlled environment with certified MUA practitioners, MUA is a safe, effective and a

highly documented therapy for well selected candidates whose condition is known to be appropriately treated with manual therapy.

Here at Klass Chiropractic, P.C., we follow all standards and protocols in patient selection and care as deemed by the AAMUAP. If you have any questions regarding the material you have just read, you can contact me personally at 516.330.8810. If you would like to explore MUA further you can get more information about Dr. Gordon and the Gordon MUA Technique at <http://www.gordonmua.com/>.

## **Supportive Literature and Scientific Documentation References For MUA**

The following literature documents a small portion of the available reference for the scientific evidence that is used to teach the MUA procedure and by which trained practitioners support their position to use the MUA procedure on a select population of patients that have responded to MUA for the past 80 or more years.

Alexander GK. Manipulation under anesthesia of lumbar post-laminectomy syndrome patients with epidural fibrosis and recurrent HNP. J Am Chiro Assoc. 1993;June:79-81.

American Academy of Orthopaedic Surgeons, Position Statement, 9/20/2011, 6300 North River Road, Rosemont, IL 60018-4262

American Chiropractic Association. Spinal manipulation policy statement. Updated 2003. Accessed October 23, 2007. Available at URL address:  
[https://www.amerchiro.org/content\\_css.cfm?CID=1083](https://www.amerchiro.org/content_css.cfm?CID=1083)

American Medical Association. Current Procedural Terminology: CPT 2008, Professional Edition. AMA press Copyright 2007.

Amir-Us-Saqlain H, Zubairi A, Taufiq I. Functional outcome of frozen shoulder after manipulation under anesthesia. J Pak Med Assoc. 2007 Apr;57(4):181-5).

Anesthesia: evaluation by electromyography and clinical-neurologic examination of its use for lumbar nerve root compression syndrome. Journal of the American Osteopathic Association 1971;433-440.

Aspegren DD, et al. Manipulation under epidural anesthesia with corticosteroid injection: Two case reports. J Manipulative Physiol Ther. 1997;20(9):618-621.

Assendelft, W. J.J. Morton, S. C. Yu, E. I. Suttorp, M. J. and Shekelle, P. G. Spinal Manipulative Therapy for Low Back Pain: A Meta-Analysis of Effectiveness Relative to Other Therapies Ann Intern Med, June 3, 2003; 138(11): 871 - 881

Assendelft WJJ, Morton SC, Yu EI, Suttorp MJ, Shekelle PG. Spinal manipulative therapy for low-back pain. The Cochrane Database of Systematic Reviews 2005 Issue 4. In: The Cochrane Library, Issue 4, 2005.

Beers MH, Berkow R. Tendon problems. In: The Merck Manual of Diagnosis and Therapy, 17th ed. Ch 62, Section 5. Musculoskeletal and connective tissue and connective tissue disorders Pg 496. Copyright 1999 Merck and Co, Inc.

Ben-David B, Raboy M. Manipulation under anesthesia combined with epidural steroid injection. J Manipulative Physiol Ther 1994;17:605-9

Blomberg S, et al. A randomized study of manual therapy with steroid injections in low-back pain. European Spine Journal 1994; 3:246-254.

Board of Chiropractic Examiners; Oregon; ORS 684.010(2)(b); Manipulation under anesthesia (MUA) is within the scope of practice of a Chiropractor as long as proper training and practice are performed (similar to what Texas allowed); 1/28/92.

Boonen A, van den HR, van TA, et al. Large differences in cost of illness and wellbeing between patients with fibromyalgia, chronic low back pain, or ankylosing spondylitis. *Ann Rheum Dis* 2005;64:396–402.

California Board of Chiropractic Examiners; Rules and regulations; revised June 2010; Board ruling, 318.1 Standard of care Regarding manipulation Under Anesthesia (MUA); specific rules guiding a Chiropractor in the performance of MUA; MUA is within the scope of practice if the referenced rules are followed; June 2010.

Cremata E, Collins S, Clauson W, Solinger AB, Roberts ES. Manipulation under anesthesia: a report of four cases. *J Manipulative Physiol Ther.* 2005 Sep;28(7):526-33.

Dagenais S, Haldeman S. Chiropractic. *Prim Care.* 2002 Jun;29(2):419-37.

Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. *Spine J* 2008;8:8–20.

D’Amato MJ, Bach BR. Loss of motion. In :DeLee: DeLee and Drez’s Orthopaedic Sports Medicine, 2nd edition. Copyright 2003, Saunders. Section J. Anterior cruciate ligament injuries.

Dan NG, Saccasan PA. Serious complications of lumbar spinal manipulation. *Med J Aust.* 1983;2(12):672-673.

Davis CG. Chronic cervical spine pain treated with manipulation under anesthesia. *J Neuromusculoskeletal Syst.* 1996;4:102-115.

Department of Community health; Scope of Practice: Is Manipulation Under Anesthesia within the scope of practice; Michigan board ruling; With proper training, a Chiropractor may practice MUA; 2/26/11.

Division of Professional Licensure; the state of Massachusetts; Manipulation under anesthesia or MUA is within the scope of Chiropractic practice in the Commonwealth of Massachusetts as defined by MGL, Chapter 112, Sections 89-97; November 4, 2004.

Dreyfuss P, et al. MUJA: Manipulation under joint anesthesia/analgesia: A treatment approach for recalcitrant low back pain of synovial joint origin. *J Manipulative Physiol Ther.* 1995;18:537-546.

Druss BG, Marcus SC, Olsson M, Pincus HA. The most expensive medical conditions in America. *Health Aff (Millwood)* 2002;21: 105–11.

Dudek N, Trudel G. Joint contractures. In: Frontera: Essentials of Physical Medicine and Rehabilitation, 2nd ed. Ch 117. Copyright 2008 Saunders.

ECRI Institute. Health Technology Information Service. Evidence Reports. (2003, February). Manipulation under anesthesia for low-back pain. (66 articles and/or guidelines)

Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States, 1990–1997: results of a follow-up national survey. *J Am Med Assoc* 1998;280:1569–75.

Ekman M, Johnell O, Lidgren L. The economic cost of low back pain in Sweden in 2001. *Acta Orthop* 2005;76:275–84.

Ekman M, Jonhagen S, Hunsche E, Jonsson L. Burden of illness of chronic low back pain in Sweden: a cross-sectional, retrospective study in primary care setting. *Spine* 2005;30:1777–85.

Ettema, G, Huijing, PA: Architecture and elastic properties of the series elastic element of muscle-tendon complex; from Multiple Muscle Systems, Biomechanics and Movement Organization. Springer-Verlag. New York; Berlin; Heidelberg; London; Paris; Tokyo; Hong Kong. Jack Winters, Editor. 1990: 57-68

Farrell CM, Sperling JW, Cofield RH. Manipulation for frozen shoulder: long-term results. *J Shoulder Elbow Surg.* 2005 Sep-Oct;14(5):480-4.

Fortune 500 [www.cnnmoney.com](http://money.cnn.com/magazines/fortune/fortune500/2007/full_list/index.html) Available at: [http://money.cnn.com/magazines/fortune/fortune500/2007/full\\_list/index.html](http://money.cnn.com/magazines/fortune/fortune500/2007/full_list/index.html) 2007.

Francis R. Spinal manipulation under general anesthesia: A chiropractic approach in a hospital setting. *J Am Chiro Assoc.* 1989; Dec:39-41.

Francis R. 1991 Manipulation under anesthesia. *Am Chiropr* Dec;24, 26-7.

Francis R, Beckett RH. 1994 Spinal manipulation under anesthesia. *Adv Chiropr Mosby Publishers* Vol.1:325-40.

Francis R. 1995 Spinal manipulation under anesthesia: a review of chiropractic training programs and protocols. *Am Chiropr* Sep-Oct;27, 37.

Frymoyer JW, Cats-Baril WL. An overview of the incidences and costs of low back pain. *Orthop Clin North Am* 1991;22:263–71.

Garden F. Contractures. In: *Frontera: Essentials of Physical Medicine and Rehabilitation*, 1st ed. Ch 103. Copyright 2002 Hanley and Belfus.

Greenman, PE: Manipulation with the patient under anesthesia. *J. Amer. Osteopathic Assoc.*, 92(9):1159 -1167, Sept. 1992.

Goetzel RZ, Hawkins K, Ozminkowski RJ, Wang S. The health and productivity cost burden of the “top 10” physical and mental health conditions affecting six large U.S. employers in 1999. *J Occup Environ Med* 2003;45:5–14.

Gordon RC. Commentary: manipulation under anesthesia. *J Manipulative Physiol Ther.* 2001 Nov-Dec; 24(9):603-11.



Gordon R, Rogers R, West D, Matthews R and Miller R. 2002 Manipulation under Anesthesia: An Anthology of Past, Present and Future Use. In: Pain Management, A Practical Guide for Clinicians 6th Ed. Weiner R, editor, CRC Press, New York.

Gordon, et al Guidelines for the practice and performance of manipulation under anesthesia; Chiropractic and manual Therapies, 2014, 22:7.

Griffen LY. Frozen shoulder. In: DeLee: DeLee and Drez's Orthopaedic Sports Medicine, 2nd ed. Ch 13 The female athlete. Copyright 2003 Saunders.

Guidelines for Chiropractic Quality Assurance and Practice Parameters: Proceedings of the Mercy Center Consensus Conference, Burlingame, CA, January 25 - 30, 1992. S Haldeman et al (eds.), Gaithersburg, MD: Aspen Publishers, Inc. Copyright 1993.

Guyton, AC: *Textbook of Medical Physiology*; 7<sup>th</sup> Edition. WB Saunders. Philadelphia 1986: 113-116.

Hamdan TA, Al-Essa KA. Manipulation under anaesthesia for the treatment of frozen shoulder. Int Orthop. 2003;27(2):107-9. Epub 2002 Sep 13.

Hansson EK, Hansson TH. The costs for persons sick-listed more than one month because of low back or neck problems. A two-year prospective study of Swedish patients. [see comment]. Eur Spine J 2005;14:337-45.

Harris, James D. "history and Development of Manipulation and Mobilization." In John V. Basmajian (Ed.) Manipulation, Traction and Massage. Baltimore: Williams & Wilkins. Copyright 1985.

Herzog J. Use of cervical spine manipulation under anesthesia for management of cervical disk herniation, cervical radiculopathy, and associated cervicogenic headache syndrome. J Manipulative Physiol Ther. 1999 Mar-Apr;22(3):166-70.

Hughes BL. Management of cervical disk syndrome utilizing manipulation under anesthesia. J Manipulative Physiol Ther. 1993;16:174-181

Hutubessy RC, van Tulder MW, Vondeling H, Bouter LM. Indirect costs of back pain in the Netherlands: a comparison of the human capital method with the friction cost method. Pain 1999;80(1-2): 201-7.

Guo HR, Tanaka S, Halperin WE, Cameron LL. Back pain prevalence in US industry and estimates of lost workdays. Am J Public Health 1999;89:1029-35.

Haldeman S. The neurophysiology of spinal pain syndromes. Modern Development in the Principles of Chiropractic. New York: Appelton-Century Crofts; Copyright 1980:119-142.

Hashemi L, Webster BS, Clancy EA. Trends in disability duration and cost of workers' compensation low back pain claims 1988-1996. J Occup Environ Med 1998;40:1110-9.

International Academy of Manipulation Under Anesthesia Physicians. Guidelines available at URL address: <http://www.muaphysicians.com/historical.html>

Jonsson D, Husberg M. Socioeconomic costs of rheumatic diseases. Implications for technology assessment. *Int J Technol Assess Health Care* 2000;16:1193–200.

Kapral MK, Bondy SJ. Cervical manipulation and risk of stroke. *CMAJ*. 2001 Oct;165(7):907-8.

Kim HS, Choi JW, Chang SH, Lee KS, Oh JY. Treatment duration and cost of work-related low back pain in Korea. *J Korean Med Sci* 2005;20:127–31.

Kisner and Colby: *Stretching From Therapeutic Exercise Foundations and Techniques*. 2<sup>nd</sup> Edition. F A Davis. Philadelphia. 1990:109-120.

Kivimäki J, Pohjolainen T, Malmivaara A, Kannisto M, Guillaume J, Seitsalo S, Nissinen M. Manipulation under anesthesia with home exercises versus home exercises alone in the treatment of frozen shoulder: a randomized, controlled trial with 125 patients. *J Shoulder Elbow Surg*. 2007 Nov-Dec;16(6):722-6. Epub 2007 Oct 10.

Kohatsu, W. (2007). Low back pain. In D. Rakel (Ed.), *Integrative Medicine*. (2nd ed., pp. 692-693). Philadelphia: W. B. Saunders, Company.

Kohlbeck FJ, Haldeman S, Hurwitz EL, Dagenais S. Supplemental care with medication-assisted manipulation versus spinal manipulation therapy alone for patients with chronic low back pain. *J Manipulative Physiol Ther*. 2005 May;28(4):245-52.

Kohlbeck FJ, Haldeman S. Medication-assisted spinal manipulation. Technical report. *Spine J*. 2002 Jul-Aug;2(4):288-302.

Kotlke, FJ: *Therapeutic Exercise to Maintain Mobility*. Handbook of Physical Medicine and Rehabilitation. Kruser, Kotlke, Elwood (Eds.). Philadelphia. WB Saunders, Inc. 1971:389-401.

Lind BK, Lafferty WE, Tyree PT, Sherman KJ, Deyo RA, Cherkin DC. The role of alternative medical providers for the outpatient treatment of insured patients with back pain. *Spine* 2005;30:1454–9.

Long DM, BenDebba M, Torgerson WS, et al. Persistent back pain and sciatica in the United States: patient characteristics. *J Spinal Disord* 1996;9:40–58.

Luo X, Pietrobon R, Sun SX, Liu GG, Hey L. Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. *Spine* 2004;29:79–86.

Magit D, Wolff A, Sutton K, Medvecky MJ. Arthrofibrosis of the knee. *J Am Acad Orthop Surg*. 2007 Nov;15(11):682-94.

Mapel DW, Shainline M, Paez K, Gunter M. Hospital, pharmacy, and outpatient costs for osteoarthritis and chronic back pain. *J Rheumatol* 2004;31:573–83.

Maniadakis N, Gray A. The economic burden of back pain in the UK. *Pain* 2000;84:95–103.

Meeker W. C. and Haldeman, S. Chiropractic: A Profession at the Crossroads of Mainstream and Alternative Medicine *Ann Intern Med*, February 5, 2002; 136(3): 216 - 227.

Mercier LR. Frozen shoulder. In Ferri: *Ferri's Clinical Advisor 2007: Instant Diagnosis and Treatment*, 9th ed. Copyright 2007.

Michaelson MR, Dreyfuss PH. Manipulation under joint anesthesia/analgesia: a proposed interdisciplinary treatment approach for recalcitrant spinal axis pain of synovial joint origin. *Advances in Chiropractic* 1997; 4:41-68.

Michaelson MR. Manipulation under joint anesthesia/analgesia: a proposed interdisciplinary treatment approach for recalcitrant spinal axis pain of synovial joint origin. *JMPT* 2000; 23:127-129.

Mychaskiw MA, Thomas J. Direct costs of back pain in the United States: a national estimate. *Value Health* 2002;5:508-9. Ref Type: Abstract.

Mychaskiw MA, Thomas J. Indirect costs due to back pain in the United States. *Value Health* 2002;5:136. Ref Type: Abstract.

Namba RS, Inacio M. Early and late manipulation improve flexion after total knee arthroplasty. *J Arthroplasty*. 2007 Sep;22 (6 Suppl 2):58-61. Epub 2007 Jul 26.

National Academy of Manipulation Under Anesthesia Physicians (NAMUAP). National Guidelines. Copyright 2009. Available at URL address:  
[http://www.muaonline.com/pages/mua\\_phys\\_corn\\_national\\_namua.htm](http://www.muaonline.com/pages/mua_phys_corn_national_namua.htm)

Nirschl RP, Willett SG. Adhesive capsulitis. In; Frontera: *Essentials of Physical Medicine and Rehabilitation*, 1st ed. Ch 12. Copyright 2002.

Noble, Meridith, MS, et al. (February, 2008). "Long-Term Opioid Therapy for Chronic Noncancer Pain: A Systematic Review and \*Meta-Analysis of Efficacy and Safety". *Journal of Pain and Symptom Management*, Volume 35, No.2.

Ongley MJ, et al. A new approach to the treatment of chronic low back pain. *The Lancet* 1987; July 18:143-146.

Palmieri NF, Smoyak S. Chronic low back pain: a study of the effects of manipulation under anesthesia. *J Manipulative Physiol Ther* 2002;25(8):E8-E17

Pai S, Sundaram LJ. Low back pain: an economic assessment in the United States. *Orthop Clin North Am* 2004;35:1-5.

Pariente GM, Lombardi AV Jr, Berend KR, Mallory TH, Adams JB. Manipulation with prolonged epidural analgesia for treatment of TKA complicated by arthrofibrosis. *Surg Technol Int*. 2006;15:221-4.

Quraishi NA, Johnston P, Bayer J, Crowe M, Chakrabarti AJ. Thawing the frozen shoulder. A randomised trial comparing manipulation under anaesthesia with hydrodilatation. *J Bone Joint Surg Br.* 2007 Sep;89(9):1197-200.

Ricci JA, Stewart WF, Chee E, Leotta C, Foley K, Hochberg MC. Back pain exacerbations and lost productive time costs in United States workers. *Spine* 2006;31:3052–60.

Ritzwoller DP, Crounse L, Shetterly S, Rublee D. The association of comorbidities, utilization and costs for patients identified with low back pain. *BMC Musculoskelet Disord* 2006;7:72.

Rizzo JA, Abbott TA III, Berger ML. The labor productivity effects of chronic backache in the United States. *Med Care* 1998;36:1471–88.

Rogak Blog: In the Matter of Arbitration between Bronx Chiropractic Services PC and Maya Assurance Company; Case No. 412010056585; Andrew M. Horn, arbitrator.

Schmidt CO, Raspe H, Pflugsten M, et al. Back pain in the German adult population: prevalence, severity, and sociodemographic correlates in a multiregional survey. *Spine* 2007;32:2005–11.

Shekelle P. G., Adams A H, Chassin M R, Hurwitz E L and Brook R H, Spinal Manipulation for Low-Back Pain *Ann Intern Med*, October 1, 1992; 117(7): 590 - 598.

Sheridan MA, Hannafin JA. Upper extremity: emphasis on frozen shoulder. *Orthop Clin North Am.* 2006 Oct;37(4):531-9.

Shinohara S, Okada M, Keira T, Ohwada M, Niitsuya M. Prognosis of accidental low back pain at work. *Tohoku J Exp Med* 1998 Dec;186:291–302.

Siehl D. Manipulation of the spine under general anesthesia. *J Am Osteopath Assoc.* 1963 Jun;62:881-7.

Stevenson C, Ernst E. Risks associated with spinal manipulation. *Am J Med.* 2002 May;112:566-71

Stewart WF, Ricci JA, Chee E, Morganstein D, Lipton R. Lost productive time and cost due to common pain conditions in the US workforce. *JAMA* 2003;290:2443–54.

Swenson, R and Haldeman, S. Spinal Manipulative Therapy for Low Back Pain, *J. Am. Acad. Ortho. Surg.*, July 1, 2003; 11(4): 228 - 237.

"Tennessee Professional Corporations Act"; T.C.A. 48-101-610(d)(3); the Board of Chiropractic Examiners; Manipulation under anesthesia (MUA) is within the scope of practice of a Chiropractor as long as they follow the referenced rules and provide the service in the prescribed professionally licensed facility; February 21, 2008.

Van ZJ, van KM. Low back pain: from algorithm to cost-effectiveness? *Pain Pract* 2005;5:179–89.

Vogt MT, Kwok CK, Cope DK, Osial TA, Culyba M, Starz TW. Analgesic usage for low back pain: impact on health care costs and service use. *Spine* 2005;30:1075–81.

Walker BF, Muller R, Grant WD. Low back pain in Australian adults: the economic burden. *Asia Pac J Public Health* 2003;15:79–87.

Walker BF, Muller R, Grant WD. Low back pain in Australian adults. Health provider utilization and care seeking. *J Manipulative Physiol Ther* 2004;27:327–35.

Wang JP, Huang TF, Hung SC, Ma HL, Wu JG, Chen TH. Comparison of idiopathic, post-trauma and post-surgery frozen shoulder after manipulation under anesthesia. *Int Orthop*. 2007 Jun;31(3):333-7. Epub 2006 Aug 23.

Wardwell, Walter, *Chiropractic: History and Evolution of a New Profession*. St.Louis, Mo., Mosby Year Book, Copyright 1992.

Watson PJ, Main CJ, Waddell G, Gales TF, Purcell-Jones G. Medically certified work loss, recurrence and costs of wage compensation for back pain: a follow-up study of the working population of Jersey. *Br J Rheumatol* 1998;37:82–6.

Weinstein JN, Lurie JD, Olson PR, Bronner KK, Fisher ES. United States' trends and regional variations in lumbar spine surgery: 1992–2003. *Spine* 2006;31:2707–14.

West, D.C., C.C.R.D., Mathews, M.D., Miller, PA-C, Kent, M.D. "Effect of Management of Spinal Pain in 200 Patients Evaluated for Manipulation Under Anesthesia." *J. Neurol Oethop Med Surg*. (1998) 18: pp. 31-42.

West, D. T., Mathews, R. S., Miller, M. R., & Kent, G. M. (1999). Effective management of spinal pain in one hundred seventy-seven patients evaluated for manipulation under anesthesia. *Journal of Manipulative and Physiological Therapeutics*, 22 (5), 299-308.

Williams DA, Feuerstein M, Durbin D, Pezzullo J. Health care and indemnity costs across the natural history of disability in occupational low back pain. *Spine* 1998;23:2329–36.

Wyoming Fifth Judicial District; Hunter, Patrick, District Judge: August 3, 1994; RE: Consolidated Park County Civil Case Worker's Compensation Cases Appealed From the Offices of Administrative Hearing; CV#18140-Charles L. Stickney, et al; CV#18141 Eunice L. Dunn, et al; CV#18142-Joy E. Helmey et al; CV#18143-Julie Ivie, et al; and CV#18144-William L. Messick et al.