Biomechanical Changes of Acupuncture Treatment for Lower Back Range of Motion

A clinical study to bridge the concept of traditional Chinese acupuncture with western scientific evidence of the efficacy of acupuncture treatment

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Abstract

Acupuncture treatment remains one of the most common treatments for lower back pain. Yet, there is very little research to show that acupuncture will also improve mobility and function of the lower back. This study attempted to assess the effectiveness of an acupuncture treatment protocol on lower back pain and lower back range of motion. Three acupuncture treatments were provided for 21 participants (mean age: 44.6 +/- 10.9 years) reporting lower back pain averaging 6.8 years with an average 6.3 pain score. A lumbar motion monitor was used to record trunk kinematics in 3-dimensions - the sagittal, lateral and twist planes - before and after treatments.

Using pretest-posttest comparisons following three acupuncture treatments, 80.95% of oarticipants exhibited an increased sagittal range of motion. Changes in angular range of motion were statistically significant in 3-dimensions. However, lifting and lowering tasks were not statistically significant.

This study suggests that acupuncture treatments can increase a particpant's angular range of motion as well as to possibly improve the function of lifting tasks. Three acupuncture treatments may actually demonstrate the earliest improvement that may be expected for treating lower back pain.

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List of Abbreviations

Abbreviations of acupuncture names:

BL or UB - Urine Bladder meridian

CV or Ren - conception vessel

Du or Gv - governor vessel (meridian)

Fu 4 - group points included CV4, CV6 and St25

Gb - Gall Bladder meridian

Hwatojiaji- the 17 pairs of points named after the physician Hwato who discovered the points. These points are located along both sides of the spine processes. The points start from first thoracic of the spine to the fourth or fifth lumbar vertebra.

Liv - Liver meridian (channel)

K - Kidney meridian

Sp - Spleen meridian

St - Stomach meridian

Other Abbreviations:

Delta - differences between two tests

LMM - lumbar motion monitor

P - positive

Post – post-test

Pre - pretest 1

R. Ac - Registered Acupuncturist

R.O.M. - range of motion

TCM - Traditional Chinese Medicine

N - negative

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Chapter 1 Introduction

Acupuncture treatment has been used worldwide for pain management and remains one of the most common treatments for lower back pain in North America. While many patients have suggested that this treatment gives them relief from pain, there is very little evidence that acupuncture will also improve mobility and functioning of the lower back. Functional deficits in the thoraco-lumbar spine are often a result of pain during movement.

Some studies suggest that acupuncture treatment not only reduces pain (Ernst & White, 1998; Furlan et al., 2005; Kukuk, Lungehausen, Molsberger & Endres, 2005), but also improves emotional reactions, sleep quality, and even reduced social isolation (Carlsson & Sjolund, 2001; Harborow & Ogden, 2004). Other than treating lower back pain, acupuncture treatment improves other conditions, such as inflammation of the urine-bladder, chronic cystitis, knee joint pain, migraines and many more ailments (Alreak, Digranes, & Baerheim, 2002; Cerrato, 2003; Cummings, 2003). Studies have been undertaken to compare acupuncture with other treatments. In some studies, the researchers compared true acupuncture with electronic acupuncture treatments, or true acupuncture with calcium nerve blocker treatments (Cerrato, 2003). The true acupuncture treatments demonstrated better outcomes (Kerr, Walsh, & Baxter, 2003) in all such studies.

There is need for more information to ascertain if and how acupuncture works on musculo-skeletal issues. On the one hand, there is some research providing scientific evidence to suggest that acupuncture treatment does work (Cho, Chung, & Jones, 1998;

Dold, 1998; Langevi, Bouffard, & Badger, 2005), while some studies reported that acupuncture might not benefit lower back pain subjects (Sherman & Cherkin, 2003; van Tulder, Cherkin, Berman, Lao, & Koes, 1999).

Obtaining the scientific quantifiable evidence becomes crucial to understanding how acupuncture treatments indeed work. Cho et al. (1998) collected laboratory acupuncture data based on stimulating some acupuncture points under functional magnetic resonance imaging (fMRI). The results showed that, by stimulating acupuncture points, the visual cortex of the brain showed an increase in oxygen consumption. This association had been predicted in "Yellow Emperor," the Bible of Traditional Chinese Medicine, which was printed about 2000 years ago (Kaptchuk, 1983). However, this result had been criticized as being potentially scientifically fraudulent (Dold, 1998), a criticism that may reflect of lack of understanding of eastern medicine. Langevi et al. (2005) found a dynamic response of fibroblasts that changes in tissue length with acupuncture stimulation. These findings have important implications for understanding the effects of therapeutic treatment using mechanical stimulation on connective tissue elongation in order to promote positive physical changes.

The effectiveness of acupuncture treatment is based upon the quality and quantity (duration) of the treatment (Ceccherelli, Gagliardi, Barbagli, & Caravello, 2003; Zhang, 2004). Ceccherelli et al. (2003) suggested that 10 treatments had a better outcome than 5 treatments; most other studies suggest that 10-12 treatments are commonly utilized as part of experimental paradigms that evaluate acupuncture efficacy (Carlsson & Sjolund, 2001; Cerrato, 2003; Kerr et al., 2003; Kukuk et al., 2005). Also, the experience of an acupuncture practitioner is a part of the reality of acupuncture practice (Akimoto et al.,

2003; Cho et al., 1998), which can possibly influence the effectiveness of acupuncture treatment. There is a need for more evidence - based research that demonstrates how, where, or if acupuncture treatments do work

Acupuncture treatments are used as one kind of treatment to provide many presumably helpful solutions for lower back pain interventions, such as improvements in functional range of motion at the joint(s). It is important to be able to understand how acupuncture treatment works for lower back pain, as well as serve functions other than just to reduce the pain. Therefore, more scientific evidence-based research for acupuncture is necessary, which will provide further answers for those who claimed that there is not enough clinical evidence to demonstrate that acupuncture indeed works.

Biomechanics plays an important role in the understanding of lower back disorders. Kinematic, kinetic and electromyographic measures may reveal the presence of low back disorders and the eventual success of treatment regimes. While many scholars have focused on the effectiveness of acupuncture treatment alone for lower back pain, ergonomic specialists have been investigating the costs, prevention and intervention involving the mechanisms of lower back disorders under the work safety investigations umbrella.

The present study is focused on the efficacy of acupuncture treatment for lower back pain based on an investigation of functional range of motion changes. While scholars have been investigating the mechanics of lower back disorders, health practitioners offer various kinds of treatments for lower back pain, including acupuncture treatment and surgical procedures. It is possible that a benefit of acupuncture treatment for lower back pain is that it influences the actual mechanics involved with lower back

disorder. According to Ferguson, Gallagher, and Marras (2003), the mechanical lower back problem is one of the many causes for lower back pain. Therefore, the effectiveness of acupuncture treatment for lower back pain may be attributable to improving the biomechanical features. Also, it is crucial to obtain scientific quantifiable evidence to demonstrate that acupuncture treatment indeed works.

1.1 Purpose of the study

The purpose of this study is to assess the effectiveness of an acupuncture treatment protocol on lower back range of motion.

1.2 Hypotheses

It is hypothesized that following three acupuncture treatments over 8-12 days, there will be an increase in thoraco-lumber range of motion in three anatomical planes: sagittal, transverse and coronal. This allows for assessment of three motions related to each plane: bending (sagittal), lateral and twisting.

It is also hypothesized that following three acupuncture treatments over 8-12 days, the range of motion in the thoraco-lumbar spine will improve for a lifting and a lowering manual materials handling (MMH) task.

The statistical expressions for these null hypotheses are:

H_0: μ sag (pre) – μ sag (post) = 0

H_0: μ lat (pre) – μ lat (post) = 0

H_0: μ tw (pre) – μ tw (post) = 0

H_0: μ lift (pre) – μ lift (post) = 0

H_0: μ lower (pre) – μ lower (post) = 0

Where: sag = Sagittal plane movement, lat = Lateral movement and tw = Twist planar movements, Pre=the data set obtained prior to the first acupuncture treatment and Post = the data set obtained after the third acupuncture treatment and lift = the upward direction of the manual materials handling task and lower = the downward direction of the manual materials handling task.

Chapter2 Review of Literature

2.1 Acupuncture in the Western Medicine scene

While acupuncture has been around for about 4000 years, it only came to prominence in North America after the American President Richard Nixon visited the People's Republic of China (P. R. China) in 1972. A journalist on the Nixon trip suffered from appendicitis, abdominal pain that would have typically required surgical intervention in American mainstream medicine. Instead of having the surgery, he received an acupuncture treatment. A local doctor inserted acupuncture needles into the journalist's lower leg at a location known, as point St36. His pain was relieved instantly. This landmark story attracted many scholars and practitioners who have become interested in understanding how acupuncture treatment works.

2.2 Acupuncture and the health policy movement

Goch (1997) reported a number of positive initiatives and outcomes in alternative medicine. Conditions treated with acupuncture include migraines, post-operative pain sciatica, arthritis, asthma, infertility and anxiety. In 1997, 29 insurance companies reimbursed clinicians for acupuncture treatment in the United States.

Morey (1998), on behalf of the National Institution of Health (NIH), provided statistics that examined the directions for future research on the effectiveness of acupuncture, considering: 1) the role of acupuncture in the treatment of different conditions, 2) the biological effects of acupuncture, and 3) the issues that must be tackled in order to appropriately incorporate acupuncture into the health care system report.

2.3 Acupuncture research past and future

Hoh (1998) encouraged the official adaptation of a policy for acceptance of acupuncture therapy as a complimentary component of health care. The article delineated a number of theories as to how acupuncture works. Providing clear evidence as to the efficacy of acupuncture practice would help to remove public doubt as well as to lead to faster regulatory acceptance of acupuncture therapy.

Theories on the presumed acupuncture mechanism of action seem to depend on the clinical approach employed. Martindale (2001) reported that the traditional Chinese practitioner believes that acupuncture works by manipulating the body's energy. On the other hand, western scientists believe that inserting needles at acupuncture points stimulates the nervous system to release morphine-like substances that block the body's pain signals via neurotransmitters and neuro-hormones which affect such body dynamic systems as the circulation and immune response. Meanwhile, many clinical trials have produced inconclusive results that do not appear to support anecdotal claims for why acupuncture treatment works. Many research and clinical trials failed to generate demonstrative results because investigators may not have known the best ways in which to test acupuncture. In reality, the eastern and western philosophies might have far different approaches to acupuncture practice.

2.4 Evidence that acupuncture treatment is effective

Obtaining quantifiable scientific evidence has become crucial to proving that acupuncture treatments indeed work. The Dold report (1998) evaluated the evidence for

acupuncture regarding the use of Chinese acupuncture points that have been mapped over thousands of years. These points map to similar locations where certain nerves appear to be anatomically concentrated as identified through western medicine. The Dold report indicated that acupuncture and acupuncture research has been highly criticized. For example, the endorphin explanation contending that acupuncture stimulation releases body endorphins does not adequately explain the many claims that support the effectiveness of acupuncture. In one experiment reported by Dold (1998), Cho et al. (1998) compared the effects of acupuncture stimulation with stimulation using a flash of light, where the occipital lobes of 12 subjects were observed using functional magnetic resonance imaging (fMRI). They found that stimulating the acupuncture points on the UB (urine bladder) channel (which runs from head to foot) triggers activity in the visual cortex that can be viewed using fMRI. The experiment also discovered that the brain activity observed during acupuncture stimulation was nearly as strong as that elicited by a flash of light. The study observed two distinct reactions: one showed an increase in activity, while the other showed a decrease. In other words, some people experienced an increase in oxygen consumption in that part of the brain while other people experienced a decrease. However, due to lack of knowledge and understanding on what acupuncture treatments can do, this study was criticized as pseudoscience (Dold, 1998).

Since the Cho et al. (1998) study, similar studies have documented other acupuncture points that are related to specific regions of the brain, and physical effects that cannot be explained simply by endorphin theory of acupuncture efficacy. Langevi et al.'s (2005) research found that the dynamic cytoskeleton-dependent response of fibroblasts changed in tissue length with acupuncture treatment. Fibroblasts are

interstitial cells that produce collagen and proteins that facilitate the healing of a wound. These findings have important implications of our understanding of normal movement and posture, as well as having therapeutic implications for using mechanical stimulation on connective tissue elongation in physical changes.

In Akimoto et al.'s (2003) study of athletes, 21 subjects were divided into two groups, an acupuncture group (n=9), and a control group (n=12). The acupuncture points were Li4, St36, St6, Lu6 (Li- large intestines, St-stomach, Lu-lung channels) and were applied for a duration of 15-20 minutes. A licensed acupuncturist with 10-years of experience in acupuncture treatment performed the acupuncture. It was found that Salivary SlgA secretion rate was significantly higher in the acupuncture group than in the control group suggesting a strong immune response. The salivary concentration of cortisol was significantly lower in the acupuncture group. While engaged in athletic competition, fatigue was found to be higher in the control group than in the acupuncture group. Ratings of physical well being and mood state also were taken. Their results supported the effectiveness of acupuncture for the physical and mental well being of athletes.

2.5 Research in Acupuncture treatment and lower back pain

There have been a number of studies focusing on acupuncture for lower back pain. Some studies suggested that acupuncture treatment improved lower back pain (Carlsson & Sjolund, 2001), while others did not (Sherman & Cherkin, 2003; van Tulder et al., 1999). One study even suggested that the effect of acupuncture treatment was no different

than the placebo effect (Ernst & White, 1998). Another study suggested there were both positive, long-term and short-term effects for lower back pain where outcomes less than 6 weeks were reviewed as short term, and the outcomes greater than 6 weeks were reviewed as long term (Manheimer, White, Berman, Forys, & Emst, 2005). It has also been reported that acupuncture treatment was not only effective for pain relief, but also improved the quality of sleep and state of emotions (Akimoto et al., 2003; Carlsson & Sjolund, 2001), both which could contribute to the long-term recovery from low back pain.

In Carlsson and Sjolund (2001), 50 patients with chronic lower back pain participated in a blind placebo - controlled study. Patients were randomized to receive one of manual acupuncture, electro-acupuncture, or active placebo-electrical nerve stimulation. All groups received treatments once a week for 8 weeks. The study found that there was a significant improvement in returning to work, quality of sleep, and reduced analgesic intake in those subjects treated with manual acupuncture as well as for electro-acupuncture.

Ernst and White (1998) conducted randomized controlled trials with various forms of acupuncture on different kinds of pain. The study found that acupuncture treatment was better than control interventions for back pain. However, there was not enough evidence to show clearly whether acupuncture treatment effects are better than placebo effects.

Kerr et al. (2003) assessed the efficacy of acupuncture in the treatment of chronic lower back pain. Their study involved 60 subjects randomly divided into two groups, an acupuncture therapy group and an electronic nerve stimulation (TENS) group. The

treatments were weekly for six weeks. Forty-six patients completed this study. The results showed that there was no significant difference between the two groups for any of the outcomes measured at the end of treatment. However, a six-month follow-up suggested that the response was better in the acupuncture group.

Kukuk et al. (2005) studied (needling body) acupuncture. There were 249 cases, consisting of 10 sessions over a 10-week period. The study conducted a phone interview at three and six months after the last session of the acupuncture treatment. The conclusion showed positive changes in pain tolerability, with acupuncture having a long-term effect on pain improvement as well as with respect to cognitive and emotional pain coping.

In a study by Furlan et al. (2005), there were 35 randomized clinical trials for chronic lower back pain. This study suggested that acupuncture was more effective for pain relief and functional improvement overall than no treatment or sham treatment. However, the effect of the acupuncture treatment was only for the short term.

Manheimer et al. (2005) examined the effectiveness of acupuncture for treating lower back pain. Subjects with acute & chronic lower back pain were placed in randomized controlled trials. The subjects were divided into three groups: a (needle) acupuncture group, a sham acupuncture group, and one other sham treatment group. The study measured the following: the outcome of pain, functional status, overall improvement, return to work, and analgesic consumption. The results suggested that for short-term relief of chronic pain, acupuncture treatment was significantly more effective.

In Ceccherelli, Rigoni, Gagliardi, and Ruzzanta (2002)'s study, 42 patients with lumbar myofascial pain participated in a randomized double-blind study of superficial

and deep acupuncture treatment. The study divided the subjects into two equal groups: for Group A, the needle was applied to the skin to a depth of 2 mm; for Group B, the needle was applied more deeper into muscle tissue. There were a total of eight sessions of treatment with a three-month follow up. It was found that the pain reduction was greater in the group treated with deep acupuncture. This suggested that deep acupuncture stimulation had a better analgesic effect when compared with superficial stimulation.

In Ceccherelli et al. (2003)'s study, thirty-one patients with lower back pain were treated at identical acupuncture points. Sixteen patients had 5 weekly acupuncture sections, and 15 patients had 10 weekly acupuncture sessions. By the conclusion of the study, 10 sessions of acupuncture treatment seemed to obtain a better therapeutic effect than did 5 sessions of treatment for subjects with chronic lower back pain conditions.

Guerreiro, Nakamura, Cordeiro, and Kulay (2004) studied lower back pain in pregnancy. There were 61 cases randomly selected into two groups: an acupuncture group and no acupuncture group. The result of the study indicated that the acupuncture group seemed to alleviate lower back and pelvic pain during pregnancy so as to increase the capacity for some physical activities, and to diminish the need for drugs. As well, Wang et al. (2005) found that the majority of pregnant women who participated in their survey reported that they would accept complementary and alternative medicine therapy as treatment for lower back pain during pregnancy. Forty-four percent especially endorsed a willingness to try acupuncture.

A study by Watanabe (2005) indicated that acupuncture treatment could increase the rate of healing. Acupuncture treatment helped not only lower back pain but also

symptoms such as constipation, resulting in harmony of the body and improvements in constitutional symptoms.

In Itoh, Katsumi, and Kitakoji (2004)'s study, 35 subjects with chronic lower back pain were randomly divided into three treatment groups receiving either standard acupuncture, acupuncture to deep trigger acupuncture points, or acupuncture to superficial trigger acupuncture points. The purpose of their study was to evaluate the nature of trigger point stimulation on pain relief and quality of life. The study found that deep needling to trigger points might be more effective in the treatment of lower back pain than either standard acupuncture therapy or superficial needling to trigger points.

2.5.1 Clinical evaluation of lower back pain treatments

A number of studies have emphasized the importance of clinical trials evaluating lower back disorder for prevention or amelioration of lower back pain. Dillen, Sharmen, and Wagner (2005) suggested that lower back strength be examined in terms of lumbar flexion, rotation, and lateral bending. Miyamoto and Itoh (2005) suggested that physical examinations for back pain be used to evaluate movement flexibility in terms of lumbar bending forward, backward and twisting, using X-rays, CT Scans or MRI if necessary.

Snijiders, Hermans, Niesing, Soor, and Stoecart (2004) investigated lumbo-pelvic kinematics when in a slouch position. The study found that backward rotation of the pelvis combined with flexion of the spine during such slouching results in backward rotation of the sacrum with respect to the ilium, dorsal widening of the intervertebral disc L5-S1, and strain on ilio-lumbar ligaments when protection of back muscles against

lumbar flexion is absent. Lumbar backrest support almost eliminates lumbosacral and sacroiliac movement.

Sadovsky (2003) suggested the evaluation of lower back pain with the aid of imaging. According to Sadovsky, CT-computed tomography has better sensitivity for identification of herniated discs, central stenosis and nerve root impingement. Magnetic resonance imaging (MRI) is better for soft tissue problems, for characterizing spinal infections, bone metastases and other bone marrow infiltrative diseases. Bone scanning was reported to be useful in detecting infections, stress fractures, and symptomatic spondylosis.

2.5.2 Conditions other than lower back pain that have benefited from acupuncture

Alreak et al. (2002)'s study found that acupuncture was effective for prevention of uncomplicated recurrent lower urinary tract infections in adult women. They had 100 subjects who commenced the study, with 94 completions: 67 subjects had acupuncture treatment, and 27 subjects in the control group had no acupuncture treatment. The study also had 12-week and 6-month follow ups. The acupuncture points were: CV-03, CV-04, Bl-23 or Bl-28, Ki-3, Sp-6, Sp-9, St36 or Liv3. In the acupuncture group, there was a 50% reduction in subjects' residual urine after 6 months. There were no changes in the untreated group. The study also emphasized that in order for the acupuncture treatment to work, practitioners need to understand how to use acupuncture needles well.

In Cerrato (2003)'s study, 160 women participated in a six-month study in preventing migraines as part of a prophylactic treatment of migraine without aura. The subjects were divided into two groups: an acupuncture treatment group and a flurnarizine-

calcium channel blocker group. Flurnarizine-calcium channel blockers are commonly used in pain management. For the acupuncture group, acupuncture treatment was given weekly for the first two months then monthly for the next four months. The total treatment was about 12-13 sessions. The study found that both therapies significantly decreased the frequency of migraine attacks. The patients receiving acupuncture treatment reported significant reductions in pain intensity and fewer side effects than those on drug therapy.

Shaughnessy (2005) studied 570 patients with knee joint pain. These subjects were divided into 3 groups: Group 1- the traditional Chinese medicine (TCM) true acupuncture group; Group 2- the sham treatment condition without inserting acupuncture needles; and Group 3- the control group that received education sessions and educational materials only. The true acupuncture was found to decrease pain scores by an average of 40% and to improve knee function in patients who continued the treatment.

Using 49 cases referred from general practitioners in the United Kingdom, Harborow and Ogden (2004) examined the effectiveness of acupuncture treatment in a variety of clinical conditions, testing for indications of successful acupuncture treatment. The results showed that patients improved in energy level, pain measures, emotional reactions, sleep quality, and reduced social isolation. The study also found that the effectiveness of acupuncture treatment was not related to the category of health condition. The study suggested a role for acupuncture in general medical practice.

According to an online article (Health, 2005), cystitis is defined as inflammation of the urine bladder. It was found that alternative treatments such as acupuncture and Chinese medicine may be helpful in treating acute and chronic cases of cystitis.

2.6 Evidence against Acupuncture treatment

In Sherman and Cherkin's (2003) study, there were 10 randomized trails evaluating acupuncture as therapy for chronic lower back pain. The study found that the efficacy of acupuncture for treating this common problem remained unclear.

In a study by van Tulder et al. (1999), randomized controlled trials were used to assess the effectiveness of all types of acupuncture treatment that involved needling subjects experiencing nonspecific lower back pain. This study also was unable to conclude that acupuncture was effective in the management of back pain. These authors did not recommend use of acupuncture as a regular treatment for patients with lower back pain.

2.7 Quantity of acupuncture treatment

The quantity of acupuncture treatments likely has an impact the outcomes of the treatment regime. The duration and frequency of the treatment has been manipulated during various research studies. The following studies suggest that acupuncture treatments lasting 5 or more weeks can have a positive influence on treatment outcome (see Table 2.1).

Table 2.1 *Number of acupuncture treatments used*

Number of acupuncture treatment used		
Article	No of treatments	Effectiveness
Carlsson and Sjolund (2001)	Weekly for 8 weeks	Positive effect
Ceccherelli et al. (2003)	Weekly for 5 or 10 weeks	Positive (10 weeks better than 5 weeks)
Cerrato (2003)	Weekly for 8 months then monthly for 4	Positive effect
Kerr et al. (2003)	Weekly for 6 weeks	Positive effect
Kukuk et al. (2005)	Weekly for 10 weeks	Long- term effect

2.8 Measurement of lower back motions using a Lumbar Motion Monitor

The lumbar motion monitor (LMM) is a dynamic functional assessment tool that assesses thoracolumbar kinematics in three planes: flexion-extension movements in the sagittal plane, rotation about the longitudinal axis, and lateral bending within the frontal plane. Angular displacement, velocity and acceleration time profiles are collected and derived from each of the three planes (MacKinnon & Vaughan, 2005).

The LMM quantifies the dynamic lower back capacity of a person. It can provide detailed information on an individual's musculoskeletal status. It can also measure the severity of an initial injury and improvements that may result from treatment. However, there are limitations to this equipment. Its accuracy is +/- two degrees in each of the three planes (Ferguson et al., 2003). A detailed account on device calibration may be found in Marrras, Fathallah, Miller, Davis, and Mirka (1992).

2.8.1 Back disorder investigations with LMM

Ferguson et al. (2003) suggested that lower back disorders and lower back injury recovery are complex issues. There are factors that might influence recovery, such as

psychological, psychosocial, physical work place demands, other personal factors, and the often overlooked issues of the definition of recovery. Obtaining a quantified functional performance measurement might only provide one piece of the complex puzzle for understanding the musculoskeletal status of individuals with lower back disorders. Needless to say, it is important to prevent the occurrence of lower back disorders wherever possible. For example, physical training programs can improve muscle strength that can reduce the chance of muscle injuries (George & Delitto, 2005).

2.8.2 Investigation of risk factors for lower back disorder

A study by Matthews, MacKinnon, Albert, Holmes, and Patterson (2007) investigated a lifting task within a moving environment such as is present during sea-like conditions. The study found that the spine was under more stress during motion conditions than no motion conditions. The study suggested that spine stability was more difficult to achieve when handling the unstable loads. The study endeavored to explain the relationship between related muscle activity and thoraco-lumbar kinematics, comparing the lifting of unstable loads with stable loads in moving environments. They discovered that when the spine was in a stable condition, thoraco-lumbar kinematic activity increased; but it was not certain that the activity of selected trunk muscles increased. When the spine was in an unstable condition, thoraco-lumbar kinematics was not increased but the trunk muscle activities did increase. It was evident that the stability of the spine influenced the movement of thoraco-lumbar kinematics. This study demonstrated the important factor of instability when performing manual tasks, illustrating a relationship between spine stability, trunk muscle activities, and thoraco-

lumbar kinematics. Similarly, Holmes, MacKinnon, Matthews, Albert, and Mills (2008) demonstrated that motion conditions were associated with stability of thoraco-lumbar kinematics. During the motion conditions, increased local muscle activity seemed to correlate with a decrease in thoraco-lumbar velocities because trunk stabilization likely increased. Dynamic trunk motion with increased spinal activity has been associated with greater spine loading.

Davis and Marras (2000) suggested that trunk motion (during a lifting task) significantly reduces an individual's ability to produce force. When relating such lifting tasks to an unstable environment, the results suggest that a decrease in trunk motion, coupled with an increase in trunk muscle activation, puts a greater demand on the spine in order to maintain stability and balance. Because the lifting tasks were sagittal plane exertions, this decrease in trunk motion likely reflected a more cautious lifting strategy. Injuries likely occur when balance and stability are challenged.

2.9 Treating lower back pain with interventions other than acupuncture

Among lower back disorder interventions, surgical intervention is a traditional choice in western medicine that is used to improve stability of back movement. In one example of thoracolumbar kinematics, surgical procedures were conducted by Champain, Mazel, Mitulescu, and Skalli (2007), in which lumbar kinematics was investigated using lumbar dynamic (flexion-extension) X-ray films. The surgical procedure focused on structuring and maintaining intervertebral mobility of the lower back in order to correct the destructive state of intervertebral immobility, where range of motion (ROM) quantified the residual motion. The criteria used to interpret the results were as follows:

0-3 degrees intervertebral mobility was assessed as solid fusion, 3-5 degrees low mobility was assessed as double fusion, and finally, mobility equal or superior to 5 degrees was assessed as pseudoarthrosis. The smaller the intervertebral mobility, the greater the range of motion will be on the spine as a whole body movement.

2.10 Summary

Acupuncture has been used in the treatment of lower back pain. Many studies suggest that the treatment not only reduces pain and increases range of motion (Ernst & White, 1998; Furlan et al., 2005; Kukuk et al., 2005), but also improves emotional reactions, sleep quality, and even can reduce social isolation (Carlsson & Sjolund, 2001; Harborow & Ogden, 2004). In some studies, researchers compared true acupuncture with electronic acupuncture treatments, as well as true acupuncture with calcium nerve blocker treatments (Cerrato, 2003). The true acupuncture treatment was found to demonstrate a better outcome in all those studies (Kerr et al., 2003).

Aside from treating lower back pain, there are other conditions such as inflammation of the urine bladder, chronic cystitis, knee joint pain, migraines, and many others (Alreak et al., 2002; Cerrato, 2003; Cummings, 2003), which are also able to benefit from acupuncture treatment.

Quantitative not qualitative evidence of successful acupuncture treatment is further needed to support the assertions that acupuncture works (Cho et al., 1998; Dold, 1998). Cho et al. provided the first quantifiable laboratory data to demonstrate that acupuncture treatment worked on improving brain oxygen consumption. Meanwhile,

others reported that acupuncture might not benefit lower back pain subjects (Sherman & Cherkin, 2003; van Tulder et al., 1999).

There are other factors that influence the outcomes of acupuncture treatment. Some researchers pointed out that effectiveness of acupuncture treatment might be based upon practitioner's experience, capabilities and techniques used during the treatment of a variety of body conditions affecting overall general body health which is an important concept in traditional Chinese medicine (Akimoto et al., 2003; Cho, et al., 1998), variations in practitioners, approaches might encompass a short period of time of treatment as compared with a longer period of treatment (Ceccherelli et al., 2003), use of shallower needles versus deeper needle acupuncture (Ceccherelli et al., 2003; Itoh et al., 2004), and variations in the quality of the acupuncture practice itself (Zhang, 2004). Meanwhile, as previously stated, the relationship between treatment expectations and outcomes of acupuncture treatment is uncertain and complex (Sherman et al., 2010).

Keeping the spine stable appears to be the key issue in investigating lower back range of motion. In surgical procedures, in order to have the maximum lower back range of motion, an effort is made to keep or maintain only 2-3 degrees of sagittal range of motion between each spine vertebrae.

In work safety intervention, human injury prevention, and in ergonomic human factor investigations involving manual labor and the moving of heavy objects, these situations often place the spine in unstable conditions. Therefore, when workers try to make adequate and sufficient thoraco-lumbar kinematic movements, they tend to make the back movements at slower speeds as part of reducing the body's exertion so that the spine tries to maintain stability.

Today acupuncture treatment is recognized as the one kind of treatment among many approaches to lower back pain interventions. It is important to be able to understand how acupuncture treatments work for lower back pain subjects, other than just to reduce the pain. Therefore, to respond to claims that there is not enough clinical evidence available to prove that acupuncture indeed works, this research will focus on the acupuncture treatment for lower back pain using biomechanical measurements in an effort to provide quantifiable evidence that acupuncture treatment does work.

Chapter 3 Methodology

3.1 Introduction

Many patients have suggested that acupuncture gives them relief from lower back pain. However, there is very little evidence to support that acupuncture will also improve mobility and functioning of the lower back. As a part of traditional Chinese medicine, acupuncture involves inserting very fine needles to the physical human body at specific points. These points are connected with 20 invisible lines that are called channels or meridians. It is believed that inserting needles into these points can treat various conditions such as chronic pain, migraine headaches, and stress (Cerrato, 2003; Harborow and Ogden 2004). More than thirty-three conditions are considered to benefit from acupuncture treatment as listed by the Qui, et al. (1993) (translated Chinese acupuncture text book). It is also believed that inserting acupuncture needles into those special points would release endorphins. The body's natural endorphins are opium-like pain medication, which could block pain information from travelling to the body from the brain. In the North American market, acupuncture treatment has been used for many severe pain conditions such as joint pain, back pain and headaches. This study will endeavour to demonstrate that the effectiveness of acupuncture treatment for lower back pain may be measurable in terms of improving lower back range of motion in as little as three treatments within an 8-12 day time period.

3.2 Participants

This study was carried out at a local acupuncture clinic in St. John's NL, Canada.

The twenty-one participants, aged 19-60 years, had no known health complications such as severe heart problems, diabetes, or bleeding disorder. Through self-report, all female volunteers reported not being pregnant. Participants self-reported to be suffering from lower back pain at their first visit. This study was given formal approval by the Memorial University of Newfoundland Human Investigations Committee.

3.3 Equipment

3.3.1 Lumbar Motion Monitor (LMM)

As shown in Figure 3.1, the lumbar motion monitor (LMM) is an electronic device, used as a dynamic functional assessment tool, to assess the thoracolumbar kinematics in three planes: flexion-extension movements in the sagittal plane (forward – backward), rotation about the longitudinal axis (twist) and lateral bending within the frontal plane (side bend) (Ferguson et al., 2003; MacKinnon & Vaughan 2005; Matthews et al., 2007; Holmes et al., 2008).

Figure 3.1 LMM attached to subject with lower back pain.

Angular displacement- time profiles derived from each plane were collected. It can provide a detailed means for obtaining information on a person's thoraco-lumbar spine orientation with respect to time. The greater angle of movement indicates the greater range of motion. The measurement error of the LMM is established at plus or minus two degrees in each of the three movement planes (Ferguson et al., 2003). Marras et al. (1992) provide a detailed description of the calibration of the LMM.

3.3.2 Restraining the motion of the lower limbs

To isolate and study only thoraco-lumbar back movement, a device was designed to limit the participant's hip movements during the lumbar range of motion testing (see Figure 3.2). There are two parallel vertical bars joined with three horizontal bars at the top. This apparatus is connected to a wooden board on the bottom. The height of the top bar can be adjusted to accommodate the height of each participant's hips by using the superior iliac spine as the reference point. During the data collection, an adjustable strap was used to secure the participant's hips to the top of the bar.

Figure 3.2 Device to stabilize the lower body

3.3.3 Acupuncture needles

Acupuncture needles (sizes) that were 0.22mm (in diameter) and 40mm (in length) were used in this study (Tai Chi needle distributed by Hi-Med Health Care products Inc, Vancouver, Canada).

3.4 Study design

3.4.1 Independent variables

The independent variables are acupuncture treatments (three treatments) and the type of lower back movements during constrained planar motions and a functional lifting and lowering test. Each participant had a total of four visits. During the first visit, the participant provided their relevant personal medical information for the research, and were informed about the procedure, familiarized with and practiced the planar motions and the lifting and lowering tasks, as well as use of the LMM. For the subsequent three

visits, each participant received identical acupuncture treatments within a two-week period.

3.4.2 Dependent variables

Dependent variables were the ranges of motion (ROM) measured by the LMM for the three lower back planar motions and the functional lifting and lowering MMH conditions. The ranges of motion were the difference between the base-line measurements that were taken before the first treatment and the measurement taken after the third acupuncture treatment (R.O.M. see figure 3.3 (a), 3.3(b), and 3.3(c)).

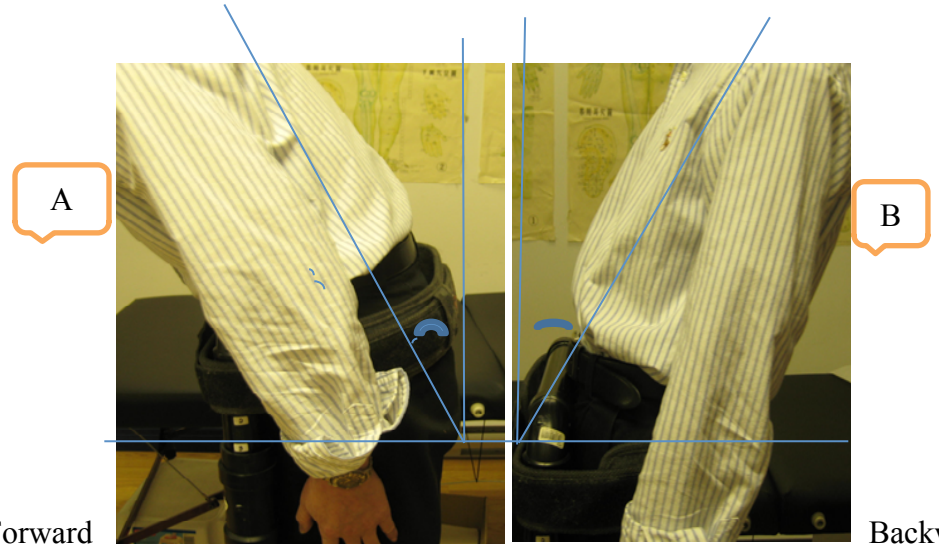

Figure 3.3 (a): Sagittal range of motion (A+B) in this task

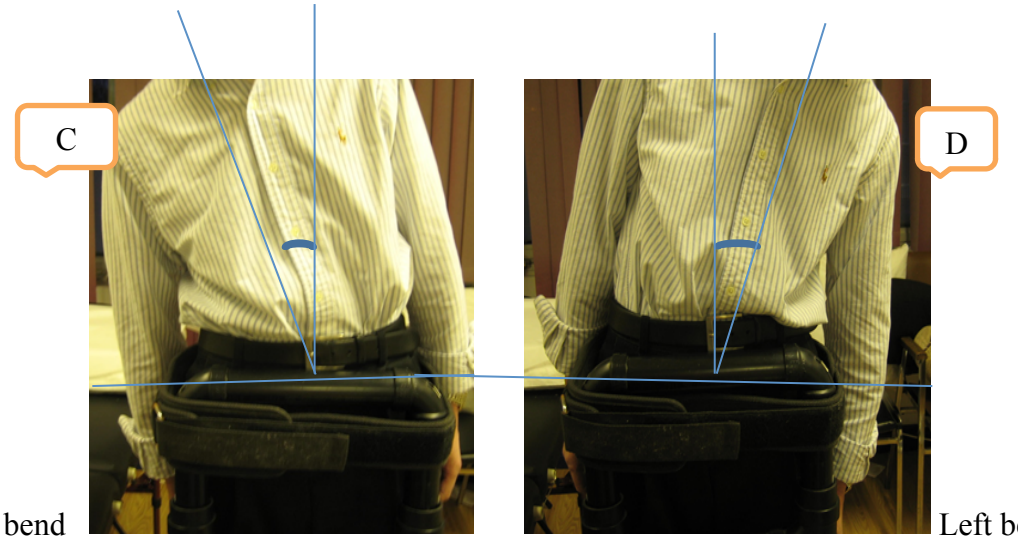

Figure 3.3 (b): Lateral (side bend) range of motion (C+D) in this task

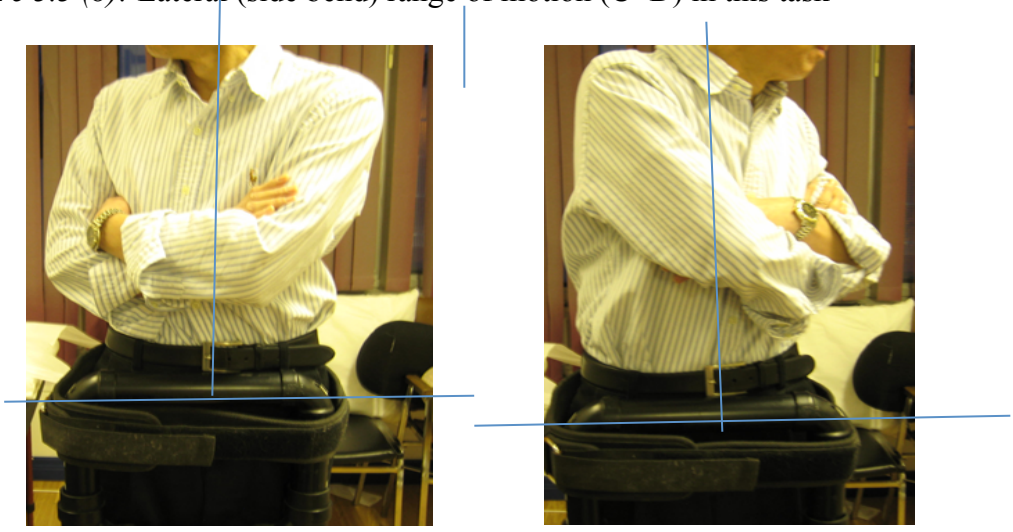

Figure 3.3(c): Twist range of motion in 3-dimensions.

3.5 Procedure -Acupuncture intervention and tasks

3.5.1 Acupuncture points

The acupuncture points used for each participant were: BL40, BL60; Du 20; GB30, GB31; Fu4; Hwatojiaji; Liv3; K3; Sp6, Sp9; St36, St41 (The points were divided

into Group1- BL40, BL60, GB30,Hwatojiaji and Group2- Fu4, GB31, Liv3, K3, Sp6, Sp9, St36, St41). The points were selected to treat back injuries commonly incurred within the St. John's population. (See Figure 3.4 for location of points).

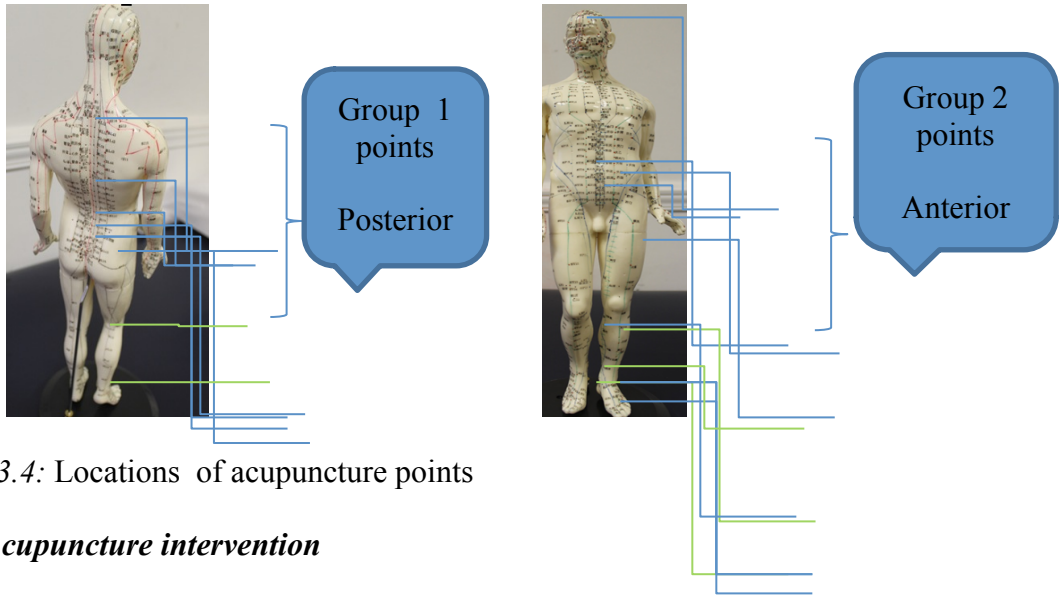

Figure 3.4: Locations of acupuncture points

3.5.2. Acupuncture intervention

During the acupuncture intervention, the participant was asked to remove their excess clothing, except underwear, and women were asked to put on (paper) examination gowns with an opening at the back. The participant was lying face down for Group 1 points (posterior). The skin was cleaned with alcohol (70% solution) at the location of the acupuncture points. Individually packaged acupuncture needles were taped to the skin and inserted deeply. Needle insertions took about five minutes and were left for 10-12 minutes before removal. Insertion points were swabbed with alcohol after removal. Each participant then turned to a face-up position for needle insertion of Group 2 points (anterior). The needles were left in the position for 10 minutes before removal. During the whole procedure soft music was played in the background in order to relax the patient. The practitioner who performed the acupuncture treatment wore surgical gloves. The

entire procedure (dry-needle, bilateral acupuncture treatment) took 40-minutes. All treatments were performed by the same acupuncturist with 20 years of experience in the practice of acupuncture.

3.5.3 Movement measurements with LMM

During the first visit before the acupuncture treatment was applied and immediately following the third acupuncture treatment, each participant was required to undertake specific movements while being monitored by the LMM. The LMM measured and recorded the amount of maximal movement (i.e., with no resistance) of the participant's lower back in the three anatomical planes. Each motion was collected, in random order and each condition was repeated three times.

After the three-dimensional measurements of the free planar movements were recorded by the LMM, the participant was asked to lift a 2.2 kg box to waist level from a chair seat located 25 cm above the ground, and then to lower the box back to the chair. During both the lifting and lowering tasks, the participant's planar movements were recorded concurrently using the LMM. This lift/lower activity was repeated three times.

3.6. Statistical analysis

Repeated measures were used for each planar motion data set and the lifting and lowering functional test. Pairwise t-test comparisons were used to determine statistical significance. The data collected before the first acupuncture treatment was compared to the data collected immediately after the third acupuncture treatment in relation to sagittal, lateral and twist planes. Only the maximal angular range of motion at each plane -sagittal,

lateral and twist- in free movement and as well as in lifting and lowering tasks were used for final data analyses.

Chapter 4 Results

4.1 Participant description

There were 8 males and 13 females in this study. The mean age was 44.6 +/- 10.9 years. On average, the participants reported suffering from lower back pain for 6.8 years, with a pain scale score of 6.3 (0 is no pain and 10 are the worst pain) as reported during the intake and screening process. Seventeen participants were either self-referred or referred by family or friends (80.85%). Two participants were referred from local chiropractors (9.52%) and two were referred from family physicians (9.52%).

4.2 Three-dimensional measurement of planar lower back movements

Individual data for the planar movements and the lifting/lowering activity can be found in Appendix 1. Data included in the Results section figure are aggregate in format.

4.2.1 Sagittal plane movement

There was a statistically significant change in sagittal (sg) maximal angular ROM after the third acupuncture treatment in comparison with pre-treatment measures ($p=0.0204$). There was a 4.35 degrees increase in sagittal maximal angular ROM (see Figure 4.1). This represented a 12.55 % positive change when the post-test was compared with pre-test.

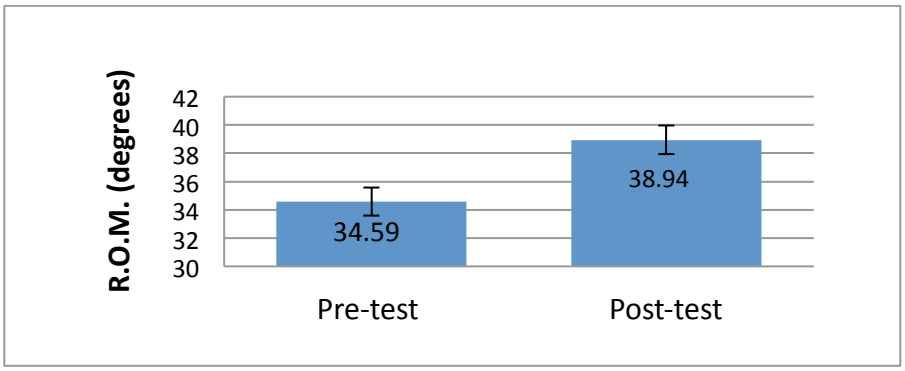

Figure 4.1: Change in range of motion (R.O.M.) between pre- and post-treatment for sagittal plane movement.

4.2.2 Lateral plane movement

There was a statistically significant change on lateral maximal angular ROM after the third acupuncture treatment when compared with pre-treatment (p=0.0009), with a 4.18 degree increase in lateral maximal angular ROM, representing a 10.36% change when the post-test was compared with pre-test (see Figure 4.2).

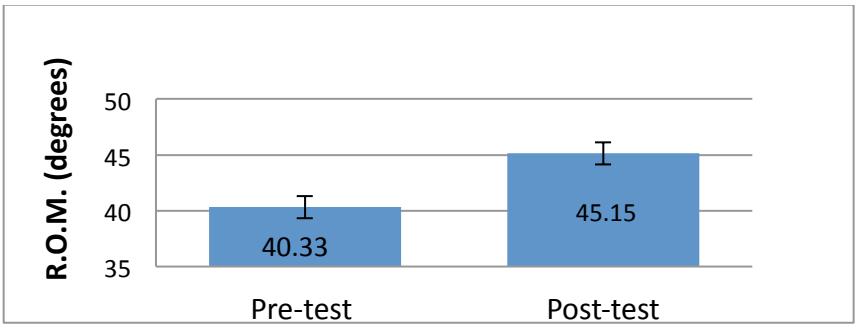

Figure 4.2: Change in range of motion (R.O.M.) between pre- and post-treatment for lateral plane movement.

4.2.3 Twist plane movement

There was a statistically significant improvement on twist maximal angular ROM after the third acupuncture treatment when compared with pre-treatment (p=0.01738),

with a 5.81 degree an increase in twist maximal angular ROM, an increase of 8.16% when the post-test was compared with pre-test (see Figure 4.3).

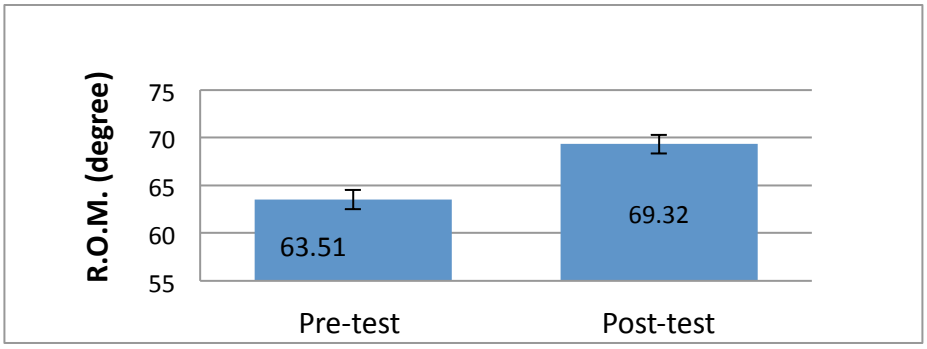

Figure 4.3: Change in range of motion (R.O.M.) between pre- and post-treatment for twist plane movement.

4.3 Measurement of lifting and lowering tasks in three-dimensions

4.3.1 Lifting task

There was no statistically significant change on maximal ROM in the sagittal (p=0.6), lateral (p=0.38) and twisting (p=0.13) plane directions. Figures 4.4 through 4.6 illustrate the mean participant ROM for these planes.

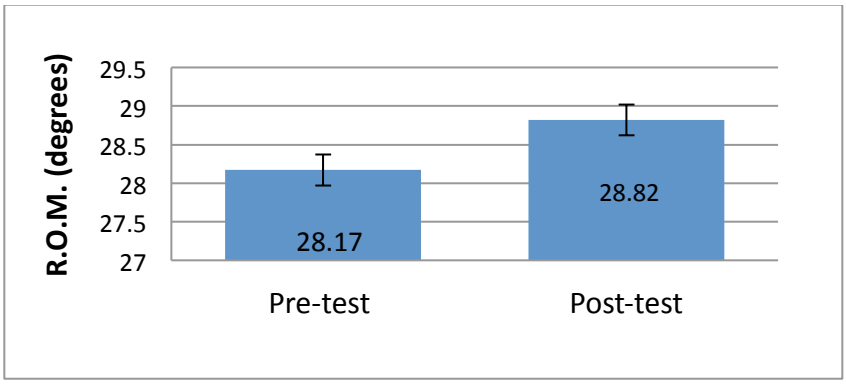

Figure 4.4: Change in range of motion (R.O.M.) between pre- and post- treatment for sagittal movement in lifting tasks.

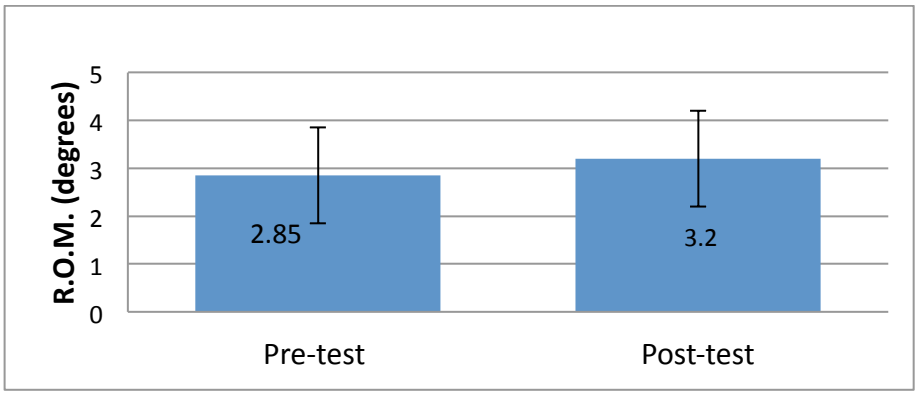

Figure 4.5: Change in range of motion (R.O.M.) between pre- and post-treatment for lateral movement in lifting tasks.

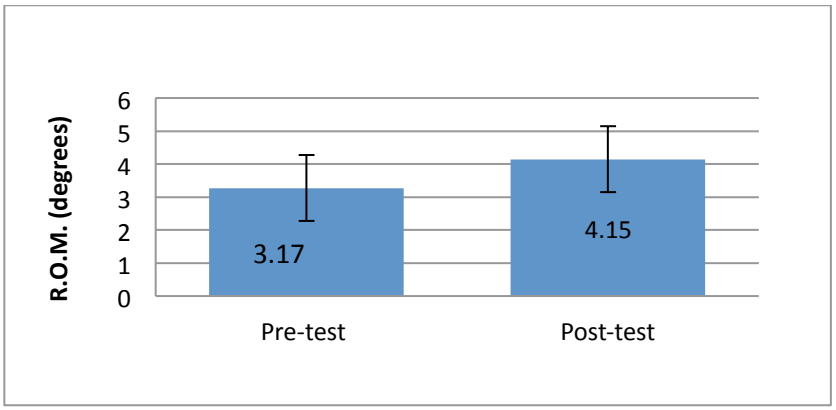

Figure 4.6: Change in range of motion (R.O.M.) between pre- and post-treatment for twist movement in lifting tasks.

4.3.2 Lowering task

There was no statistically significant change on maximal ROM in the sagittal ($p=0.63$), lateral ($p=0.54$) and twisting ($p=0.62$) directions. Figures 4.7 through 4.9 illustrate the mean participant ROM for these planes.

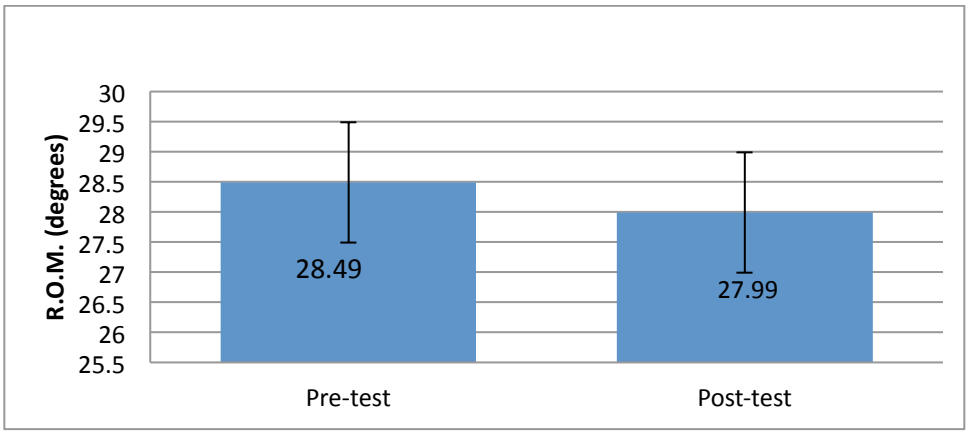

Figure 4.7: Change in range of motion (R.O.M.) between pre- and post-treatment for sagittal movement in lowering tasks.

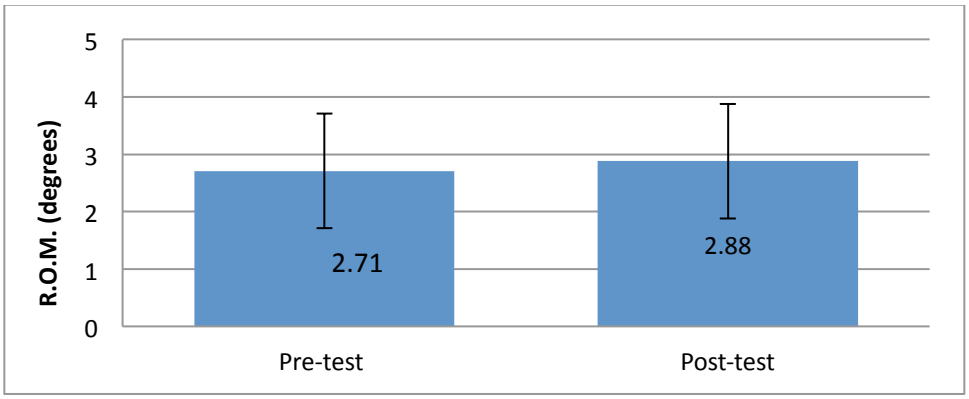

Figure 4.8: Change in range of motion (R.O.M.) between pre- and post-treatment for lateral movement in lowering tasks.

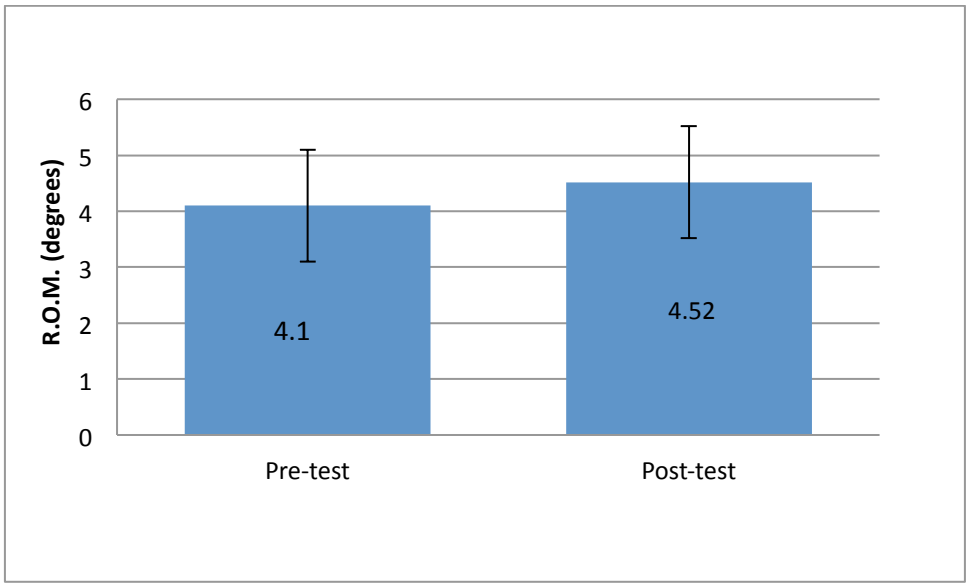

Figure 4.9: Change in range of motion (R.O.M.) between pre- and post-treatment for twist movement in lowering tasks.

Chapter 5 Discussion and Conclusions

5.1 Introduction

Lower back pain is one of the common conditions for North American people who seek acupuncture treatment. While some research suggested that acupuncture treatment helps to reduce pain (Ernst & White 1998; Furlan et al., 2005; Kukuk et al., 2005), there has been little research to support that acupuncture treatment improves the range of motion of the lower back in participants expressing pain in this part of the anatomy. This research aimed to measure the range of motion changes in the lower back after three acupuncture treatments.

Acupuncture treatment has been suggested as an effective means to treat patients. Having developed from Eastern culture, the concept of acupuncture is far different from how it is often understood within a North American culture. In the Eastern tradition, acupuncture treatment is based on an understanding of well-established acupuncture meridians as opposed to the western emphasis on human anatomy and physiology. The present research endeavoured to reconcile the two approaches. It is a complex matter to establish effective, individualized treatment decisions.

The key to understanding how acupuncture works is to understand the conditions that can benefit from acupuncture treatments. The present research found that there was a measurable effect due to the acupuncture treatment protocol that was used. Statistically significant differences were found in sagittal, lateral and twist planes of the range of motion for the lower back after three acupuncture treatments over a period of 8-12 days.

Obtaining quantifiable scientific evidence is crucial to supporting the hypothesis that acupuncture treatment indeed works from a biophysical perspective.

5.2 Evidence of improved range of motion

During each phase of the testing, the participant's range of motion was measured during the pre-treatment (Visit 1) and post-treatment (visit 3) sessions. In order to improve test-retest reliability, while equipping the participant with LMM, the inferior anterior iliac spine was used as an anatomical reference point to orientate the LMM harness.

Many studies on acupuncture treatment for lower back pain focused on the effects for pain relief (Ernst & White 1998; Furlan et al., 2005; Kukuk et al., 2005), and improved emotional reactions, sleep quality, and even reduced social isolation (Carlsson & Sjolund 2001; Harborow & Ogden, 2004). The present research took a different approach from the previous studies; this study was specifically focused on measuring the range of motion of the lower back segment in the sagittal, lateral and twist planes of participants who suffered from lower back pain. Because the range of the motions were found to change in the present research, that would suggest that the back pain relief should be associated with improved range motion measures.

Research by Langevi et al. (2005) may provide insight into how range of motion improvement can help resolve lower back pain issues. They found that acupuncture stimulation actually releases the fibroblasts in the interstitial tissues between muscles. The fibroblasts would appear to change in tissue length, illustrating a more detailed response after the acupuncture treatment. The fibroblasts, in tern, help in the process of wound

healing, and this could possibly help to relieve the pain in the lower back as a result of tissue length changes. Such a mechanism of operation could explain why the range of motion changes can possibly improve lower back function and reduce lower back pain.

This study reports that after three acupuncture treatment, there were on average 4-5 degrees of increased motion in the three of each motion sagittal lateral and twist. This finding provides some evidence that the lumbar spine obtained greater mobility of the movement after the acupuncture treatment. Increases in range of motion helps to reduce the likelihood of incurring or having recurring, lower back injuries.

Understanding the mechanism of lower back pain and lower back disorder is important. Lower back pain is often caused by mechanical musculoskeletal injuries due to activities as lifting, shoveling snow, car accidents, falling down, bulging discs, spondylosis and abdominal tumor, which reduce lower back flexibility. This study focused on the participant's self- identified lower back pain (western medicine). Meanwhile, according to the TCM (Chinese) acupuncture book (Qiu et al. 1993), lower back pain is often caused by mechanical injuries, too much sexual activity, weak kidney function (TCM) and anxiety (stress) (Kartchuk, 1983). Mechanical injuries could lead intervertebral tissue and bone degeneration changes. Then, both intervertebral tissue and to bone degeneration could create nerve impingement, which could cause pain. Therefore, giving acupuncture treatment to localized problem areas could improve local blood flow and possibly release fibroblasts that improve injured muscles or tissues and, possibly, improve degenerative bone disease.

There were no statistically significant changes found in range of motion during the lifting tasks in this study. It might be suggested that three acupuncture treatments

might not be enough treatments for lower back pain participants in relation to more complex, multi-segment tasks such as lifting and lowering. Perhaps patients with chronic low back pain had developed movement strategies related to lifting and lowering loads that minimized back mobility, developing a protective strategy for the lumbar spine. Lifting and lowering tasks require arm and leg movements that were not measured in this study.

Notwithstanding the lack of statistical changes in the lower back function during lifting and lowering tasks, the present study of acupuncture treatment for lower back disorders demonstrated greater positive angular ROM changes. The mean increases in ROM changes ranged from 4.34- 5.81 degrees. The results of the present study were also greater than would be predicted by equipment error alone, estimated at +/- 2 degrees (Ferguson et al., 2003). Therefore, this research demonstrates a therapeutic effect after three acupuncture treatments.

5.3 Possible confounding effects from the acupuncture treatment

Researchers point out that lower back issues are complex. Ferguson et al. (2003) suggested that the measuring mechanical lower back function may only examine one aspect of a complex issue related to individuals with lower back disorders. There are many factors that may influence recovery, including psychological, psychosocial, physical work place demands, personal factors and the often overlooked issue of the definition of recovery as described in Qiu, et al. (1993). Traditional lower back pain acupuncture treatment selects local lumbar points, such as Bl 23 and distance points Bl 40. Therefore, in the present research, acupuncture points were selected from those

commonly used points to treat local mechanical issues in the lower back. Since emotional matters were also one of factors related to lower back pain (Ferguson et al., 2003), K3 specially was selected for restoring kidney energy and reducing emotional stress in term of TCM theories (Kartchuk, T., 1983; Qiu, et al., 1993). St36 was selected from Akimoto et al. (2003) for fatigue and BL60 from Cho et al. (1998) for sciatica related problems.

We do not know if the acupuncture treatment change the participant's lower back function but improve their emotional and/or psychological well-being. It is interesting to note that this type of acupuncture treatment may also be used to induce improved emotional reactions, sleep quality, and even reduced social isolation (Carlsson & Sjolund, 2001; Harborow & Ogden, 2004).

In this study, the participant's sleep quality or emotional state was not measured, however, since acupuncture treatment had been reported to effect emotional and fatigue states (Akimoto et al., 2003), there were fewer points such as K3/Sp6/St36/UB60 (see Figure 3.4) which were selected based on the TCM theories and included in the protocol for this project. These points could be related to improved sleep quality, stress, and chronic fatigue other than just to treat subjects for mechanical back pain (Qui et al., 1993; Chu, Yeh, & Wood 1979). In fact, such improvements to other physiological aspects may be the reasons for improved range of motion in the lower back.

Cho et al. (1998) using a UB/BL 60 combination found that there was increased oxygen uptake in the brain. Acupuncture treatment was used for sciatica pain which is a condition somewhat related to the clinical population in this study. Therefore, UB 60 was selected in present experiment. St.36 is one of those recommended points used in many conditions in the acupuncture treatment. In Akimoto et al.'s (2003) research, by using the

points Li4, St36, St6 (Sp6), and Lu6, they found there were improvements in reducing fatigue. Their results supported the effectiveness of acupuncture for the physical and mental well-being of athletes. Hence, St.36 was selected for treating the chronic conditions.

5.4 Placebo effects

Building the trust between the practitioner and patient is important for participants who suffer from chronic conditions. Many patients who request acupuncture treatment have already experienced some failure in trying other western therapies. On some level, these patients lose their confidence about healing or that they can trust being healed. By undergoing three acupuncture treatments to make the patient feel better, this focused treatment could impact the participant by giving them positive outcomes and improving their quality of life and perhaps improved physical health outcomes.

This research was focused on biomechanical matters related to the outcome of the acupuncture treatment. Placebo effects might have played a role in the present study on acupuncture treatment outcomes. Sherman et al. (2010) suggested that the relationship between expectations and outcomes may be more complex than previous believed.

5.5 Treatment protocols and practitioner experience considerations

There are other factors that influence the successful outcomes of acupuncture treatment. Some researchers pointed out that effectiveness of acupuncture treatment might be based upon the practitioner's experience, technique and capabilities during the treatment (Akimoto et al., 2003; Cho et al., 1998). There was an 85% positive outcome in Akimoto et al. (2003) and Cho et al. (2003) reported an 92% positive outcome after treatment and, in both studies the practitioners had over 10 years' experience in

acupuncture treatment. In the current study, the acupuncturist has had 20 years of acupuncture study and was very familiar with the treatment of lower back pain through acupuncture therapies.

The depth of needle insertion has also shown to be related to treatment outcomes, with deeper needle stimulation being more effective (Ceccherlli et al., 2003; Itoh et al., 2004). In this study, 40mm needle lengths were used in order to make the treatment more effective. The quantity and quality of the acupuncture practice and strong needling contribute to making treatment more effective (Zhang, 2004). In the present study, the practitioner's experience in practicing acupuncture therapy and needling with DerQi (where patient reports a special sensation often described as heaviness and numbness, etc.) would likely contribute to making this experiment more successful.

Typically, when a short time period of treatment is compared with a longer time period, the longer period of treatments tends to result in a better outcome (Ceccherelli et al., 2003). In most acupuncture studies, the average number of treatments are about 8-12 treatments over period of about 5-10 weeks. The longer duration of the treatments could have created a better physical outcome. Some studies suggested that a positive outcome can be achieved in a minimum of 1-3 treatments when the practitioner is knowledgeable and experienced (Akimoto et al., 2003; Cho et al., 1998; Zhang, 2004).

This study did show data in support of the efficacy of acupuncture treatments for improving lower back range of motion within patients having chronic lower back pain after only three treatments. If more treatments had been offered, it may have results in even more improvement physically and potentially psychologically as well. As a result, obtaining positive results after only 3 treatments might be an indicator or "quality

signature" of an experienced practitioner. Further studies maybe need in order to identify if less treatments being needed are associated with the greater experience of some practitioners for positive outcome to occur.

Conclusions

The traditional Chinese medicine emphasizes the human body as a whole system. In this experimental protocol, the acupuncture treatment points from Chinese acupuncture points to address localized mechanical problems, St36 for energy, Sp6 and K3 for reducing emotional stress and improving energy were selected. In this experiment, the LMM was used to test the range of motion outcomes after the acupuncture treatment. This opens a window to looking at how acupuncture treatment can be effective in terms of biomechanical changes.

This study reports the measureable effect of acupuncture treatment for lower back pain in which the participant had measurable and positive changes in trunk kinematics. This study suggests that acupuncture treatments can possibly increase a participant's angular range of motion in the sagittal, lateral and twist planes. Because the kinematics changes are greater after the third treatment than the first, it may suggest that the acupuncture treatments have possible positive accumulative effects with as little as three treatments provided within 10-12 days. Acupuncture treatment may be the quickest as well as the most economically feasible treatment for lower back disorder interventions from a social economic perspective. However, further longitudinal study is required to substantiate this claim.

Chapter 6 Limitations and Recommendations

6.1 Future direction

The next study will focus on the relationship between expectation for acupuncture and effectiveness of the acupuncture treatment.

It will also be very interesting to investigate each acupuncture point how the nerve transmitting occur, and how the group points effect in the nerve transmitting in the lab setting.

Also we did not complete the directly measure the relationship between the pain relief and range of motion changes. In future research, it would be interesting to be able to more clearly delineate the relationship between range of motions and pain relief.

In this research, we have the limited knowledge to identify the functions of each individual point in terms of western medical science such as which nerve a given acupuncture point might affect and which chemicals might be released. Up to now, there has been no adequate explanation as to how acupuncture treatment work, the present research was able to record statistically significant changes in three-dimensional range of motion after three acupuncture treatments for lower back pain participants with LMM. Future research could involve target why patients initiate treatment, as well as to more accurately assess outcomes both physically and emotionally.

There is a need for more open dialog between the professions, and a greater communications about what is misunderstood and can be achieved with acupuncture.

6.2 Limitations

6.2.1 Learning effects

By stimulating participants with acupuncture needles, we might train the body to respond in a specific way, and therefore, we cannot eliminate the leaning effects after manual acupuncture stimulation.

6.2.2 Error due to the apparatus

We also cannot eliminate the error due to the apparatus**.**

6.2.3 Population limitations

This study may not include the entire population. The population was selected only in St. John's NL, Canada. The limited number of participants and limited individuals may have had a better response with this acupuncture treatment, such as the economic and geographic background of participants may also have some influence to the outcome of this research.

6.2.4 Study design and Information limitations

Because this study was 100 % privately support and volunteer work, the findings and workable staff were limited for data collections.

Many acupuncture study found that acupuncture treatment is able to reduce stresses and sleep disorder. Due to lack of funds and staff, we were not able to complete some of the data collections as well as pain scales and activity recordings.

Even though, acupuncture is part of Traditional Chinese Medicine (TCM), the main focus of this research is on the biomechanics aspect of acupuncture treatment, and this aspect is the first time draw in attention on the academic society. It becomes simple

and easer that this study did not include classifying the conditions associated with the participants based on TCM perspective (classification).

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"Inner Classic of the yellow Emperor (Huang-di-Nei-jing), includes the Simple Questions (Su Wen) and the Spiritual Axis (Ling Shu). The earliest book on Chinese medical theory, known in the tradition, this probably compiled around 100 B.C., The Su Wen or Simple Questions deals mostly with theoretical concepts and medical cosmology, while the Ling Shu or Spiritual Axis is primarily concerned with acupuncture and moxibustion." (Kaptchuk, T. 1983,p453-454)

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Appendix 1

Individual data for free, planar movements, lifting and lowering tasks are presented in this Appendix.

Table 4.1 *Free planar movements*

Sagittal, Lateral, Twist Angular Planar Movement Data											
Sub	Pre-Sag	Pre-Lat	Pre-Tw		Post-Sag	Post-Lt	Post-Tw		Delta-Sag	Delta-Lt	Delta-Tw
1	31	32.7	69.6		37.2	39.5	78.9		6.2	6.8	9.3
2	35.5	53.2	90.9		47.8	62.2	93.1		12.3	9	2.2
3	25.1	31.2	52.9		33.7	38.6	48		8.6	7.4	-4.9
4	26.4	37.1	52		26.4	40.5	60.3		0	3.4	8.3
5	64.4	64.6	81.3		68.8	64.2	91.2		4.4	-0.4	9.9
6	32.7	47	57.3		40.9	45.8	64.8		8.2	-1.2	7.5
7	27.6	52.3	85.8		30	55.8	87.5		2.4	3.5	1.7
8	8.2	26.3	58.8		24.4	33	77.9		16.2	6.7	19.1
9	50.4	41	51.7		58.5	49.5	60.43		8.1	8.5	8.73
10	21.9	27.8	56.2		27.2	29.1	28.5		5.3	1.3	-27.7
11	24.4	21.3	49.9		22.4	26.1	56.2		-2	4.8	6.3
12	21.1	32.6	59.6		35.1	40.6	59.2		14	8	-0.4
13	45.8	45.3	63.5		42.7	39.3	66.2		-3.1	-6	2.7
14	30.6	43.5	61.7		18.9	54.7	61.5		-11.7	11.23	-0.2
15	18.12	31.5	64.8		22.1	34.4	69.2		3.98	2.87	4.4
16	33.1	38.9	59.6		38.3	48.5	74.1		5.2	9.6	14.5
17	65.84	38.1	83.2		61.7	42.2	90.7		-4.14	4.1	7.5
18	52.9	64.6	75.8		39.8	59.3	77.4		-13.1	-5.3	1.6
19	32.1	30	60.6		46.7	49.3	77.3		14.6	19.3	16.7
20	29.8	33.8	11.4		40.6	38.6	33.6		10.8	4.8	22.2
21	49.5	54.2	87.2		54.5	56.9	99.7		5	2.7	12.5

Table 4.2 *Lifting tasks in three dimensions*

Lifting -pre-post-delta-angular-data-											
Sub	Pre-Sag	Pre-Lat	Pre-Tw		Post-Sag	Post-Lat	Post-Tw		Delta-Sag	Delta-Lat	Delta-Tw
1	21.09	3.05	2.63		23.97	1.34	6.46		2.88	-1.71	3.83
2	16.53	2.79	1.57		19.2	2.49	2.81		2.67	-0.3	1.24
3	34.25	1.72	2.77		29.78	2.12	2		-4.47	0.4	-0.77
4	26.43	2.72	2.57		24.85	3	2.37		-1.58	0.28	-0.2
5	31.03	2.45	3.35		47.71	5.5	4.71		16.68	3.05	1.36
6	18.35	2.99	3.67		18.8	1.46	3.82		0.45	-1.53	0.15
7	34.13	2.64	2.41		39.9	3.41	5.91		5.77	0.77	3.5
8	15.54	1.88	4.37		21.91	2.57	4.43		6.37	0.69	0.06
9	23.63	3.39	1.23		25.01	5	5.77		1.38	1.61	4.54
10	17.3	1.45	1.69		15.14	1.66	1.74		-2.16	0.21	0.05
11	30.71	4.52	3.93		28.95	1.55	2.13		-1.76	-2.97	-1.8
12	37.67	1.69	3.63		36.45	3.13	1.85		-1.22	1.44	-1.78
13	26.46	2.37	1.43		27.09	1.94	4.38		0.63	-0.43	2.95
14	45.58	3.57	3.91		33.86	2.78	6.29		-11.72	-0.79	2.38
15	14.45	3.79	8.09		19.28	4.67	1.63		4.83	0.88	-6.46
16	23.3	2	2.84		19.84	1.95	2.79		-3.46	-0.05	-0.05
17	50.52	2.72	3.95		48.76	4.25	7.05		-1.76	1.53	3.1
18	39.93	3.27	4.49		34.33	2.7	4.59		-5.6	-0.57	0.1
19	29	3.22	2.09		29.23	3.75	3.05		0.23	0.53	0.96
20	28.12	1.13	2.66		32.04	1.54	3.4		3.92	0.41	0.74
21	27.58	6.58	5.31		29.18	8.7	10.04		1.6	2.12	4.73

Table 4.3 *Lowering tasks in three dimensions*

Lowering-tasks- angular-data-Sagittal-Lateral-Twist											
Subject	Sag-pre	Lat-pre	Tw-pre		Sag-post	Lat-post	Tw-post		Sag-Delta	lat-Delta	Tw-Delta
1	17.63	1.13	5.26		17.51	1.4	2.7		-0.12	0.27	-2.6
2	13.67	2.04	3.54		15.56	1.36	2.91		1.89	-0.68	-0.6
3	35.94	1.62	2.69		27.57	0.93	1		-8.37	-0.69	-1.7
4	24.13	2.38	2.9		21.36	2.89	2.67		-2.77	0.51	-0.2
5	42.35	3.23	4.1		48.38	3.86	4.65		6.03	0.63	0.55
6	21.88	2.17	5.03		19.11	2.37	4.27		-2.77	0.2	-0.8
7	35.12	2.76	2.69		40.02	3.66	8.21		4.9	0.9	5.52
8	11.9	1.43	5.3		19.33	3.3	4.45		7.43	1.87	-0.9
9	25.6	2.96	2.15		24.19	3.39	3.14		-1.41	0.43	0.99
10	18.69	4.09	4.98		16.18	2.07	2.21		-2.51	-2.02	-2.8
11	27.22	3.24	4.22		26.6	1.59	2.59		-0.62	-1.65	-1.6
12	38.27	1.96	2.76		36.65	2.62	4.51		-1.62	0.66	1.75
13	27.35	1.76	1.96		28.14	2.13	4.54		0.79	0.37	2.58
14	40.88	3.41	4.17		33.28	3.59	10.42		-7.6	0.18	6.25
15	15.41	4.03	2.58		17.06	4.54	2.76		1.65	0.51	0.18
16	21.04	2.53	11.27		24.13	1.87	7		3.09	-0.66	-4.3
17	50.5	2.58	4.77		49.54	5.84	5.99		-0.96	3.26	1.22
18	39.96	3.75	5.4		33.7	1.65	5.58		-6.26	-2.1	0.18
19	36.05	2.62	2.8		27	1.75	2.75		-9.05	-0.87	-0
20	29.45	1.96	3.4		34.2	2.46	5.23		4.75	0.5	1.83
21	25.22	5.16	7.15		28.25	7.26	7.32		3.03	2.1	0.17

Appendix 2 Consent form

Faculty of Medicine, Schools of Nursing and Pharmacy of Memorial University of Newfoundland; Eastern Health; Dr. H. Bliss Murphy Cancer Centre

Consent to Take Part in Health Research

TITLE: Effect of acupuncture treatment upon pain incidence and biomechanical function

INVESTIGATOR(S): **X. Hong Liu and Dr. Scott MacKinnon**

You have been invited to take part in a research study. It is up to you to decide whether to be in the study or not. Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This consent form explains the study.

The researchers will:

- **Discuss the study with you**
- **Answer your questions**
- **Keep confidential any information which could identify you personally**
- **Be available during the study to deal with problems and answer questions**

If you decide not to take part or to leave the study this will not affect your normal treatment.

1. Introduction/Background:

Acupuncture treatment has been used worldwide for pain management and remains on of the most common treatments for lower back pain in North America. While many patients have suggested that this treatment gives them relief from pain, there is very little evidence that acupuncture will also improve upon mobility and function of the lower back.

2. Purpose of study:

To assess the effectiveness of acupuncture treatment protocol on lower back pain and lower back range of motions.

3. Description of the study procedures and tests:

During your first visit we will describe the study and your commitments as a volunteer participant. At this time we will record a medical history. Then the amount of motion that your lower back can move through will be measured using a device called a Lumbar Motion Monitor. This device will be strapped to your back using two harnesses – one around your shoulders and one around your hips. Following these measurements, you will be asked to lift a box weighing 5 lbs from the floor to a table top. You will be asked to lift and lower this 5 times. Following the collection of these measures, we will schedule 3 return visits, at which time acupuncture treatments will be provided.

During the next three visits, you will:

1. Be measured for back motions and lifting/lowering technique
2. Undergo a standardized acupuncture treatment
3. Again be measured for back motions and lifting/lowering techniques

Throughout the course of the study you will be asked to maintain a pain log. This log will ask you to report, using a standardized scale, the amount of pain you feel in your lower back. We will also ask you to relate any activities you undertook that might be responsible for the occurrence and severity of the low back pain.

4. Length of time:

Four visits are required in total. Each visit will last about 1 hour in order to collect the data and administer the acupuncture treatment to you. You will also be asked to complete an activity and pain log throughout the 7-8 day data collection period.

5. Possible risks and discomforts:

While the insertion of the acupuncture needles, as part of this study, may cause a little discomfort, any discomfort will only last for a few seconds.

You will be asked to do some activities that require you to move your lower back. This may cause some discomfort. You will do these tasks at your own pace and through a range of motion you feel comfortable.

6. Benefits:

It is not known whether this study will benefit you.

7. Liability statement:

Signing this form gives us your consent to be in this study. It tells us that you understand the information about the research study. When you sign this form, you

do not give up your legal rights. Researchers or agencies involved in this research study still have their legal and professional responsibilities.

8. Confidentiality:

Only Drs. MacKinnon and Liu will have access to your personal information and data collected during this study. If these data are presented at a conference or in an academic journal all references to your name will be removed.

9. Questions:

If you have any questions about taking part in this study, you can meet with the investigator who is in charge of the study at this institution. These persons are: Hong Liu 685-9944/ 753-1150 or Dr. Scott .MacKinnon (737-7249).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Office of the Human Investigation Committee (HIC) at 709-777-6974
Email: hic@mun.ca

Signature Page

Study title: Effect of acupuncture treatment upon pain incidence and biomechanical function

Name of principal investigator: Scott MacKinnon and Hong Liu

To be filled out and signed by the participant:

Please check as appropriate:

I have read the consent [and information sheets]. Yes { } No { }

I have had the opportunity to ask questions/to discuss this study. Yes { } No { }

I have received satisfactory answers to all of my questions. Yes { } No { }

I have received enough information about the study. Yes { } No { }

I have spoken to X. Hong Liu and she has answered my questions Yes { } No { }

I understand that I am free to withdraw from the study Yes { } No { }

- at any time
- without having to give a reason
- without affecting my future care as a patient

I understand that it is my choice to be in the study and that I may not benefit. Yes { } No { }

I agree to take part in this study. Yes { } No { }

_____ _____

Signature of participant Date

_____ _____

Signature of witness Date

To be signed by the investigator:

I have explained this study to the best of my ability. I invited questions and gave answers. I believe that the participant fully understands what is involved in being in the study, any potential risks of the study and that he or she has freely chosen to be in the study.

_____ _____

Signature of investigator Date

Telephone number: _____