Massage Therapists' Association of British Columbia

Clinical Case Report Competition

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First Place Winner

Gary Johnson

A massage therapy intervention for chronic low back pain without correction of a leg length discrepancy

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Conflict of Interest

The author was acquainted with the subject prior to this case study. To the author's knowledge, no conflict of interest exists.

Abstract

Objective: The objective of this case study is to determine the effectiveness of massage therapy for decreasing a subject's chronic idiopathic low back pain (LBP) without shoe lift correction of her structural leg length discrepancy (LLD).

Background: Studies differ in results when examining correlations between LLD and LBP. LBP is difficult to diagnose and so a high percentage of complaints are labeled idiopathic. Many authors claim success in treating individuals with chronic idiopathic LBP through functional rehabilitation.

Methods: Pre and post intervention assessments were utilized. Muscle energy procedures were applied, informed by their corresponding manual medicine assessment. Treatment also incorporated myofascial release and therapeutic exercise was assigned.

Results: The subject reported a decrease in pain and assessment showed improvement in motor control. The modified Oswestry low back disability questionnaire score improved from 34% to 17%. Segmental lumbar and pelvic assessment showed recurring dysfunction that might be attributed to the LLD.

Conclusion: Combining a shoe lift with this intervention may have increased its effectiveness.

Keywords: massage therapy, low back pain, leg length, muscle energy technique, myofascial release

Introduction

Most often low back pain (LBP) cannot be attributed to a single event injury which may partly be why 85% of low back disorders may be idiopathic (McGill, 2007). Idiopathic LBP is concluded after ruling out conditions with conventional orthopedic and neurological testing (DeStefano, 2011). However, "it is in these patients that the ability to identify and treat functional abnormalities of the musculoskeletal system has been found to be clinically effective`` (DeStefano, 2011, p.300). The most common pathogenesis of low back injury according to Stuart McGill is cumulative trauma resulting in tissue fatigue and decreased resistance to load. In addition to this, tissues become more sensitized due to repetitive loading caused by poor motor patterns (McGill, 2007).

Leg length descrepancy (LLD) was a consideration for this study. Grundy and Roberts reported even in as much as a 5cm difference chronic pain is rare (as cited in McGill, 2007, p. 9). McCaw & Bates (1991) have cited there are contradictions between studies of whether there is a correlation between LBP and LLD. They hypothesized that LLD may increase risk of osteoarthritis (OA) and if future research shows substantial increase in stress on the body due to LLD, shoe lift correction may be preventative (McCaw & Bates, 1991). A study showed that variable gait asymmetry is present with LLD of more than 2cm which may support this theory (Kaufman, Miller, & Sutherland, 1996).

Treatment of chronic pain differs from acute pain in that there may be a lack of evidence of tissue damage making diagnosis difficult. In addition, changes may have occurred in reflex pathways, worsening the prognosis. Because of this, the goal of manual therapy for chronic conditions is to improve musculoskeletal function (DeStefano, 2011). The solution may not lie in simply increasing range of motion (ROM). Burton, Tillotson, and Troup have associated increased spinal ROM with future back problems (as cited in McGill, 2007, p.11).

In this case, segmental vertebral motion restrictions were found. Table 1 outlines five theories for the cause of joint hypomobility (DeStefano, 2011). Temporary release of joint restriction with muscle energy technique (MET) was found to be useful because it indicates muscle hypertonicity (see fourth theory in Table 1). It is theorized that isometric contraction of a muscle with myofascial trigger points in a lengthened position pulls apart the myosin heads from actin which helps to relieve the energy crisis and excessive neurological stimulation (Simons, Travell, & Simons, 1999). In a study on rabbits by Onodera, Shirai, Miyamoto, & Genbun, prolonged facet joint hypomobility was shown to result in a decrease in mechanoreceptors at that segment level which may result in poor motor control. An increase in nociceptors occured in the segments above, which may be where pain manifests (as cited in DeStefano, 2011, p.109).

Table 1: Theories of Joint Hypomobility	
1	Entrapment of meniscoid in the synovial space
2	Lack of congruence of joint surfaces causing poor tracking
3	Change in synovial fluid and surfaces causing adhesion
4	Altered length and tone of muscle (neuromuscular)
5	Change in properties fascia, capsule, or ligament
DeStefano, 2011, p.68	

MET was applied to the deep muscles affecting vertebral segments which consists of multifidi, rotatores, and intertransversarii (DeStefano, 2011). A number of studies have shown success with applying MET to non-specific LBP (Wilson, Payton, Donegan-Shoaf, & Dec 2003; Salvador, Neto, & Ferrari, 2005; Day & Nitz, 2012). MET, when combined with motor control exercise in a pilot study has been more effective in patients with acute LBP than just the exercises (Wilson et al., 2003).

Thixotropy of fascia can occur with prolonged immobility causing restrictions which may alter the tensegrity needed for an aligned and stable spine (Coy, 2011; Brotsky, 2012). Abnormalities in fascia can not only cause restrictions, but can alter muscle reflexes and perpetuate dysfunctional movement due to its integration with mechanoreceptors (DeStefano, 2011). There is evidence that myofascial release (MFR) is effective at decreasing non-specific LBP and increasing fascial mobility (Tozzi, Bongiorno, & Vitturini, 2011).

Motor disturbances have been found in transversus abdominis in subjects with LBP by Richardson, Jull, Hodges, and Hides which has lead to the practice of activating only transversus abdominis through a drawing in maneuver (as cited in McGill, 2007, p.119). However, this will inhibit the obliques thereby removing the multidirectional stability provided by these muscles. McGill (2007), has done comparative studies that found measurably greater lumbar stability occurs with abdominal bracing (see Table 2, p.24 for a description).

"Gluteal amnesia" may contribute in some cases to LBP because with gluteus maximus inhibition or weakness the lumbar muscles must compensate (McGill, 2007, p.110). Furthermore, this muscle plays a key role in force coupling support of the sacroiliac joint (DeStefano, 2011).

Massage therapy that utilizes MET, MFR, and therapeutic exercise was expected to decrease the subject's LBP.

Subject Case History

The case study subject is a 36 year old female who was a massage therapy student at the time of treatment. Her previous occupations included yoga instruction, counselling, tree planting (1998-2004), and farming (2008-2011, involved lifting haybales and gardening). At ages 9 through 15 she was an elite trampolinist, competing at a national level. Some of her activities of daily living

(ADL) during the study were landscaping, yoga, driving (estimated total of 3 hours per day, 5 days per week), trail running, pilates, hiking, seated studying, and practicing massage as a student.

The subject presented with left side lumbar pain and tension greatest at L2 and L3 erectors that sometimes radiated to the left side of her sacrum. The pain varied in intensity and was described as tight with deep aching and often accompanied with brief intermittent spasms that were expressed as local and a “hit”, “zap”, or “shock” sensation. These spasms occurred at least once per day. The subject also reported the left side of her sacrum feeling “stuck” and “unstable”. Fear of lumbar spasm was associated with her feeling of instability.

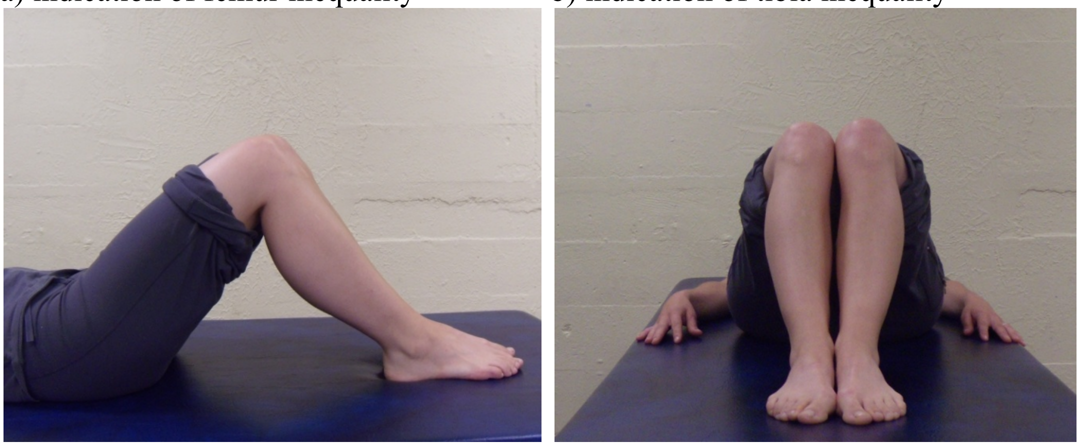
The LBP began in spring of 2009 with no known cause and insidious onset. Since there was no known injury she saw her doctor suspecting that she may have kidney trouble (this was ruled out). At that time she was working long hours farming, teaching yoga, and driving long distances. Aggravating factors for her condition included sitting, driving, biking, hiking, lifting, and shoveling. Relieving factors included core awareness, hot yoga, a break from school (less driving and sitting), and pilates classes (started June 20). Previous treatments included massage therapy and two chiropractic treatments. A radiograph analysis by her chiropractor showed an old T12 compression fracture which she guessed was due to a fall while tree planting. She had also fractured her left femur when she was 3 years old and has a noticeably long left leg she believed resulted from this.

Assessment

Leg length was assumed to be structural due to history of fracture; visual assessment while standing and with the Weber-Barstow maneuver (see figure 1). No functional causes such as innominate rotation were found. Overall leg length difference was measured by having the subject stand on a deck of large cards to level the pelvis then the cards were measured to be 7mm. The best way to measure leg length inequality is with a radiograph. Clinical measurements by comparison can have up to 10mm examiner error (Hertling & Kessler, 2006).

With this subject prolonged sitting rather than standing increased pain (there were no signs of structural inequality of the pelvis) and she was fit and healthy without this particular pain before its onset. Therefore, there did not seem to be enough indication for shoe lift correction of the LLD. As well as possible LLD contributing factors, the subject's history of elite childhood athletics may suggest a risk of OA (Caine & Golightly, 2011).

Figure 1: Weber-Barstow visual assessment of leg length. (Magee, 2008)
a) indication of femur inequality b) indication of tibia inequality



Orthopedic assessment was focused on the lumbar spine, hip, and pelvis with the goal of identifying joint, ligament, muscle, and neurological dysfunction. Functional assessment of spinal segments showed dysfunctional non-neutral/type 2 restrictions. In addition, symptoms were reproduced in the contraction phase of MET for L4 and restrictions were reduced afterward. The painful contraction of deep segmental muscles in this instance and their subsequent lengthening may indicate that myofascial trigger points were causing segmental dysfunction and LBP (Simons et al., 1999). Subsequently, lumbar assessment for type 2 dysfunctions and Magee’s back rotators test (to challenge these muscles) were chosen as important outcome measures (Destefano, 2011; Magee, 2008).

It was observed through palpation during hip extension that there was delayed activation of gluteus maximus and overactivity of the lumbar musculature (K. Matichuk, personal communication May 2012; S. Larke, personal communication June 1, 2012; Magee, 2008; McGill, 2007; DeStefano, 2011). Afterwards, weakness of gluteus maximus was discovered with a manual muscle test (MMT). Despite judging the gluteus maximus activation and lumbar segmental control to be most clinically significant for measuring outcomes, the other assessments that took place in the initial assessment were performed at the end of the treatment plan to see if any change occurred.

Treatment Plan

The major therapeutic goal of the study was to decrease LBP. Goals that guided therapy were to decrease joint dysfunction and increase stability. Complete resolution of symptoms may not be realistic. Prognosis for chronic pain is not as good as acute pain because of alterations in the nervous system (DeStefano, 2011).

The ideal treatment frequency was to intervene before recurrence of symptoms thereby interrupting the pain-tension cycle (Simons et al., 1999). The obstacle to this was scheduling for both parties. Actual frequency was 1 to 2 times each week over a 6 week period for a total of 8 (1 hour) treatments.

Treatment Description:

MET with lumbar segment and pelvic assessment was applied at the beginning of every treatment, following the treatment procedure outlined by DeStefano. Each stage of MET affects the accuracy of assessment and treatment in subsequent stages (DeStefano, 2011).

1. Lumbar Spine
2. Symphysis Pubis
3. Hip Bone Shear (Innominate Upslip)
4. Sacroiliac Dysfunction
5. Iliosacral Dysfunction

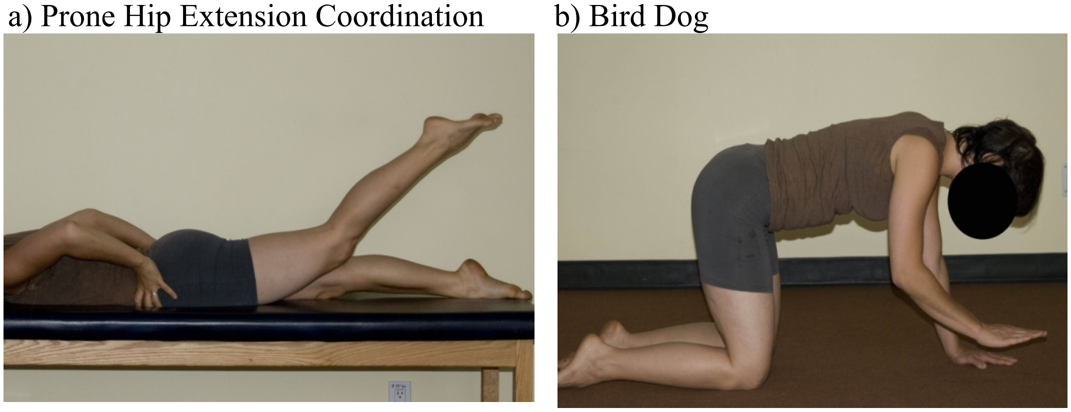
(DeStefano, 2011, p.352)

MFR followed using direct stack and load in the earlier phase of each treatment because of its three dimensional focus (Coy, 2011; Brotsky, 2012). Myofascial trigger point pressure release was applied as palpation and subject feedback indicated and once tissues had softened and warmed up (Simons et al., 1999). Before MFR, compressions were used on lumbar musculature to help increase circulation. Thermaphore heat was placed over the client's pelvis for the same effect and to keep the subject warm while the lumbar area was treated first. Treatment concluded with general Swedish strokes to help with circulation.

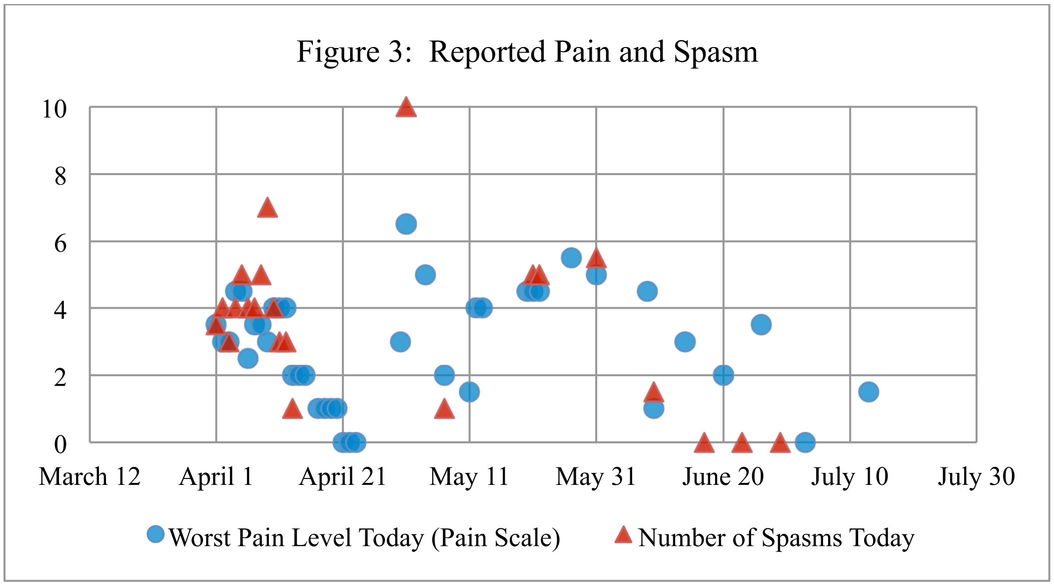
The subject's symptomatic response after each treatment and time restrictions influenced which areas MFR was applied to. MFR treatments from June 8 to June 20 focused on posterior lumbar musculature with reduction in pain lasting only one or two days. On June 22 this part of treatment focused almost entirely on iliopsoas with the subject reporting no reduction in pain. From June 26 to July 17 MFR treatment was consistently applied to the posterior lumbar and pelvic musculature (particularly the piriformis) with much better symptomatic improvement.

Instruction and consultation regarding homecare followed manual therapy. Abdominal bracing for stability and core awareness (McGill, 2007), and moving her car seat forward to reduce sacroiliac stress (S. Larke, personal communication June 1, 2012) were prescribed as ADL modifications. A supine gluteal activation exercise was practiced June 8 to 14 (McGill, 2007). This was progressed to a prone hip extension muscle coordination exercise to practice the proper sequence of muscle contraction (gluteus maximus, contralateral lumbar, then ipsilateral lumbar) (R. Brandes, personal communication June 14, 2012; DeStefano, 2011). Following this line of thought, the “bird dog” exercise (McGill, 2007, p.228) was given to achieve similar goals, which were improving muscle coordination for stability and having more congruence with the back rotators test. These were performed 2-3 times each week from June 20 to July 31. See Table 2 in the appendix for description of homecare.

Figure 2: Homecare Exercises
a) Prone Hip Extension Coordination   b) Bird Dog



Outcomes



The subject recorded pain levels and spasm frequency in table format for the study which was converted to a graph (Figure 3) (please note that graph plots are only the days when symptoms were recorded). The subject is a student and much of what aggravated her low back was associated with school. Spring break occurred in the last two weeks of April and during this time she reported having no pain. School then continued from May 1 to August, reintroducing the same aggravating factors. Without giving numbers or specific dates, she recorded having almost no back pain and spasm in the last three weeks of July. A modified Oswestry LBP Disability Questionaire was filled because it can reliably detect a change in patient's condition (Davidson, 2002). Initial score was 36% on June 8, which lowered to 17% on July 18. However, sitting still remained a major aggravator.

With the exception of left rotation, gross lumbar ROM did not increase (see Table 3 in the appendix). However, the subject's pain decreased over the duration of the treatment plan which may be congruent with research that refutes correlation between ROM and pain levels (McGill, 2007). When assessing segmental function of the lumbar spine, earlier observations of positional restrictions were of a random arrangement (see Table 4 in the appendix). A buckling effect of spinal segments may occur due to dysfunctional motor control and a lack of balanced stiffness (McGill, 2007).

In later observations, most vertebral segments had right sided positional restrictions which in hindsight may have been a group dysfunction occurring in relation to sacral dysfunction (DeStefano 2011). On the dates June 20 to July 13 the sacrum was restricted in a left facing position as either an anterior torsion or a posterior torsion. Sometimes the seated flexion test results were incongruent with four point sacral motion for determining the type of dysfunction. In such cases, MET was based on the latter because "the major criterion for sacroiliac dysfunction is identified with the patient in the prone position" (DeStefano, 2011, p.352).

Table 6 indicates improvement in core stability by rotatores and multifidi (Magee, 2008). She commented that this action is similar to a yoga pose she used to teach that involved standing on one leg. Being able to do this made her hopeful to regain her previous abilities.

Table 6: Back Rotators Test (Magee, 2008, p.546)		
	June 8	July 18
Grade	2	5
In quadruped position:	Unable maintain neutral pelvis with single arm lift	Able to raise contralateral arm and leg while maintaining neutral pelvis for 20 seconds

The reason for decrease in some ranges of hip motion is not known (see figure 4 in the appendix). Lumbar motion was not prevented which may have altered results. A decrease in hip extension is of most interest for treatment effectiveness because in the initial assessment lumbar musculature activated too soon. It is speculated that the gluteus maximus became more active and the lumbar less active. Palpation of musculature with this movement showed some improvement in motor control, especially when repeated (Table 7). A similar result occurred with MMT in which repetition increased gluteus maximus activation (see Table 8 in the appendix).

Table 7: Prone Hip Extension Order of Muscle Contraction				
	June 8		July 18	
	Left	Right	Left	Right
Gluteus Maximus	3	3	2 (1)	2 (1)
Contralateral Lumbar	2	1	1 (2)	1 (2)
Ipsilateral Lumbar	1	2	3 (3)	3 (3)
(Repetition of the test is in parenthesis)				

Discussion and Conclusion:

Massage therapy seems to have been effective at decreasing pain and increasing stability for this subject. Intervention bias occurred in this study when the subject started pilates classes. However, the education gained from the massage therapy intervention may have enhanced these exercises. For example, abdominal bracing was used and she commented that massage therapy had increased her body awareness.

Three modalities were used to fully test the effectiveness of intervention without a shoe lift. Suggested research is to determine the effectiveness of treating similar subjects with MET, MFR, or therapeutic exercise in isolation.

The subject's symptoms improved during the course of this study without shoe lift correction of her LLD. Recording positional restrictions of lumbar segments shows that although pain decreased and her abilities improved, dysfunction was of ongoing recurrence (Table 4). It would be interesting to see if this dysfunction would resolve if treatment continued over a longer duration.

However, such observations can be attributed to having a shorter right leg because it would result in an increased time in a left gait stance. This causes the sacrum to be in a left facing position longer (as observed in the majority of treatments) with the lumbar rotated right to compensate (DeStefano, 2011). In further research, a study of 12 subjects with radiograph assessed LLD concluded that gradual increase in shoe lift can decrease LBP (Golightly, Tate, Burns, &

Gross, 2007). Comparing the effectiveness of massage therapy to shoe lift correction with similar subjects may be useful research. It is now hypothesized that a combination of the two may have the best outcome.

References

Brotsky, A. (2012). *Myofascial Release Basic II* [Class handout]. Myofascial Release Term 6, West Coast College of Massage Therapy, Victoria, Canada.

Burton, A. L., Tillotson, K. M., & Troup, J. D. G., (1989). Prediction of Low Back Trouble Frequency in a Working Poplulation. *Spine, 14,* 939-946.

Caine, D. J., & Golightly, Y. M. (2011). Osteoarthritis as an Outcome of Paediatric Sport: An Epidemiological Perspective. *British Journal of Sports Medicine 45*, 298-303. doi:10.1136/bjsm.2010.081984

Coy, J. (2011). *Fascia Man* [Class handout]. Manual Skills Term 2, West Coast College of Massage Therapy, Victoria, Canada.

Day, J. M., & Nitz, A. J. (2012). The Effect of Muscle Energy Techniques on Disability and Pain Scores in Individuals with Low Back Pain. *Journal of Sport Rehabilitation 21*(2). Retrieved from http://ovidsp.tx.ovid.com/sp-3.6.0b/ovidweb.cgi?&S=GGEJFPGJFBDDBMADNCPKFEDCGCALAA00&Complete+Reference=S.sh.40%7c5%7c1

DeStefano, L. A. (2011). *Greenman's Principles of Manual Medicine* (4^{th}). Baltimore, MD: Lippincott Williams & Wilkins.

Golightly, Y. M., Tate, J. J., Burns, C. B., Gross, M. T., (2007). Changes in Pain and Disability Secondary to Shoe Lift Intervention in Subjects with Limb Length Inequality and Chronic Low Back Pain: A Preliminary Report. *Journal of Orthopaedic and Sports Physical Therapy, 37*(7). Retrieved from http://www.jospt.org/members/getfile.asp?id=2842

Gross, R. H., (1983). Leg Length Discrepancy in Marathon Runners. *American Journal of Sports Medicine, 11,* 121-124. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6869652

Grundy, P. F., & Roberts, C. J., (1984) Does Unequal Leg Length Cause Back Pain? A Case Control Study. *Lancet,* August 4, 256-258.

Hertling, D., & Kessler, R. M. (2006). *Management of common musculoskeletal disorders: Physical therapy principles and methods* (4th). Philadelphia, PA: Lippincott Williams & Wilkins.

Kaufman, K. R., Miller, L. S., & Sutherland, D. H. (1996). Gait Asymmetry in Patients with Limb-Length Inequality. *Journal of Pediatric Orthopaedics* 16(2). Retrieved from http://journals.lww.com/pedorthopaedics/Abstract/1996/03000/Gait_Asymmetry_in_Patients_with_Limb_Length.2.aspx

Kendall, F. P., McCreary, E. K., & Provance, P. G. (1993). *Muscles, testing and function: With posture and pain* (4th). Baltimore, MD: Williams & Wilkins.

Magee, D. J. (2008). *Orthopedic physical assessment* (5th). St. Louis, MO: Saunders Elsevier.

McCaw, S. T., & Bates, B. T. (1991). Biomechanical Implications of Mild Leg Length Inequality. *Spine, 25*(19). Retrieved from http://journals.lww.com/spinejournal/Abstract/2000/10010/Differences_in_Repositioning_Error_Among_Patients.11.aspx

McGill, S. M. (2007). *Low back disorders: Evidence-based prevention and rehabilitation* (2nd). Champaign, IL: Human Kinetics

Myers, T. W. (2009). *Anatomy trains: Myofascial meridians for manual and movement therapists* (2nd). Edinburgh: Churchill Livingstone Elsevier,

Onodera T., Shirai Y., Miyamoto M., & Genbun Y., (2003). *Journal of Orthopaedic Science. 8*(4), 567-76. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12898312

Richardson, C., Jull, G., Hodges, P., Hides, J. (1999). *Therapeutic exercise for spinal segmental stabilization in low back pain.* Edinburgh: Churchill Livingstone.

Salvador, D., Neto, P. D., & Ferrari, F. P., (2005). Application of muscle energy technique in garbage collectors with acute mechanical lumbar pain. *Fisioterapia e Pesquisa 12*(2). Retrieved from http://ovidsp.tx.ovid.com/sp-

3.6.0b/ovidweb.cgi?&S=GGEJFPGJFBDDBMADNCPKFEDCGCALAA00&Complete+Reference=S.sh.40%7c4%7c1

Simons, D. G., Travell, J. G., & Simons, L. S. (1999). *Travell & Simon's myofascial pain and dysfunction: The trigger point manual* (2nd). Baltimore, MD: Lippincott Williams & Wilkins.

Tozzi, P., Bongiorno, D., Vitturini, C. (2011). Fascial Release Effects on Patients with Non-Specific Cervical or Lumbar Pain. *Journal of Bodywork & Movement Therapies 15*(4). Retrieved from http://ovidsp.tx.ovid.com/sp-3.6.0b/ovidweb.cgi?&S=GGEJFPGJFBDDBMADNCPKFEDCGCALAA00&Complete+Reference=S.sh.46%7c4%7c1

Wilson, E., Payton, O., Donegan-Shoaf, L., & Dec, K. (2003). Muscle Energy Technique in Patients with Acute Low Back Pain: A Pilot Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy 33*(9). Retrieved from http://ovidsp.tx.ovid.com/sp-3.6.0b/ovidweb.cgi?&S=GGEJFPGJFBDDBMADNCPKFEDCGCALAA00&Complete+Reference=S.sh.40%7c1%7c1

Appendix: Tables and Figures

Table 2: Homecare Exercises	
Exercise	Description
Abdominal Bracing	• Locate neutral spine • Stiffen torso (anchor ribcage to pelvis) • Palpate muscles for even contraction • Maintain breathing and neutral spine, do not hollow abdomen • Practice 3 times a day, vary intensity and position (sit or stand) • Goal is to maintain light (10%) contraction in all activities
Gluteus Max. Activation	• Supine feet on floor • Contract gluteus maximus without pelvic tilt or hamstrings (palpation) • Hold each contraction 8 seconds or 2 breaths; 10 reps; 2x/day
Prone Hip Extension Muscle Coordination (Figure 2a)	• Prone hip extension while maintaining neutral pelvis • Aim to contract gluteus max 1st, then contralateral lumbar 2nd • Slow reps with complete relaxation between • Stop if cannot maintain neutral pelvis, or pain occurs • Aim for 10 reps each leg 1x/day
Bird Dog (Figure 2b)	• Quadruped position (on hands and knees) • Neutral spine, abdominal brace • Raise opposite hand and knee off floor one inch while maintaining neutral spine and breathing (beginner stage) • Hold 8 sec or 2 breaths; aim 10 reps each; 1x/day • Stop if cannot maintain neutral spine and pelvis or pain
• Holding contractions more than 8 seconds results in muscle hypoxia that may be counterproductive McGill, 2007; DeStefano, 2011	

Table 3: Lumbar Range of Motion

	Initial Assessment	Final Assessment	Measurement Notes
Flexion	5cm / 40˚	4cm/40˚	Tape measure gapping between spinous processes (SPs) T12 and S1. Degrees were visual estimate.
Extension	4cm/10˚	2cm/10˚	Tape measure appoximation between (SPs) T12 and S1. Degrees were visual estimate.
Left Side-bend	49.5cm/20˚	49cm/20˚	Tape measure 3rd finger to floor. Degrees were visual estimate.
Right Side-bend	49.5cm/20˚	51cm/20˚	
Left Rotation (includes thoracic)	27˚	40˚	Goniometer placed at sternum measuring difference between sagittal plane of upper and lower body
Right Rotation (includes thoracic)	35˚	35˚	

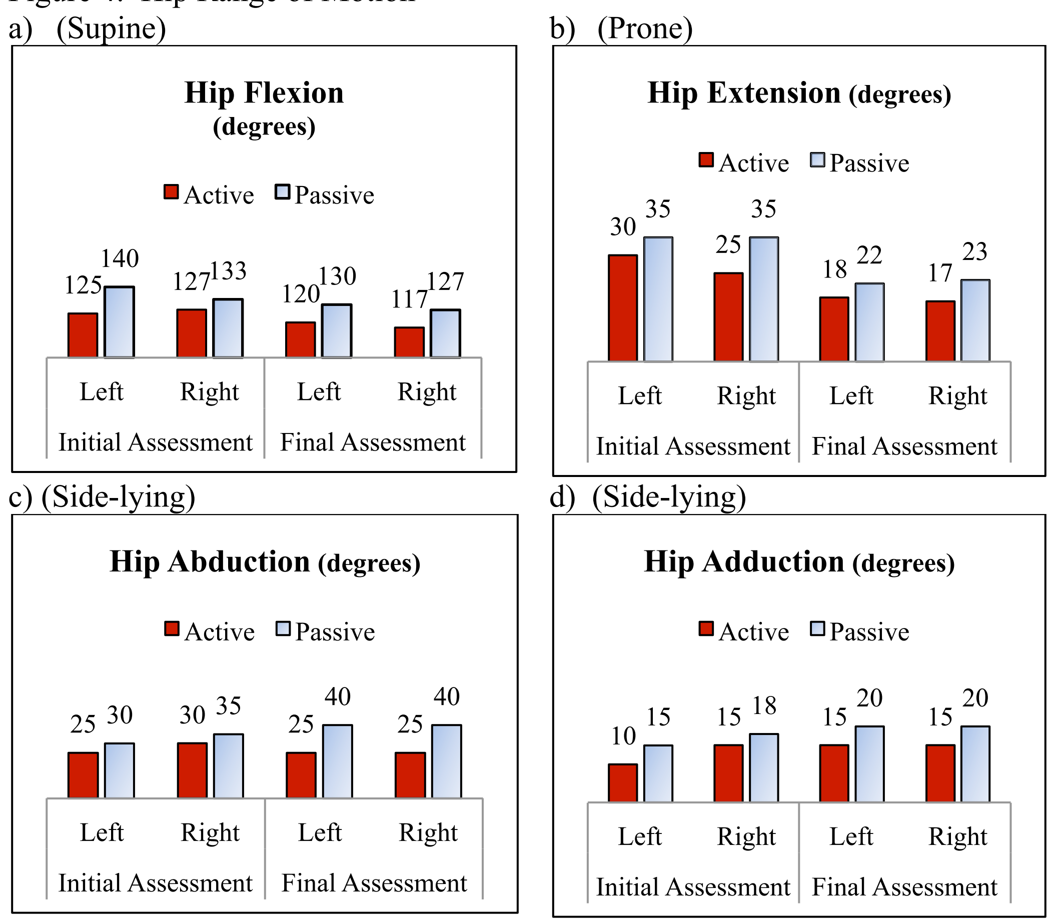
Table 4: Positional Restrictions of Vertebral Segments (Type 2 Dysfunctions)										
	May 11	June 8	June 14	June 20	June 22	June 26	July 3	July 13	July 17	July 18
T12	-	-	-	-	FRS-left	ERS-Right, FRS-right	ERS-right, FRS-right	-	ERS-right, FRS-right	-
L1	-	ERS-right	-	-	ERS-left	FRS-right	FRS-right	-	ERS-right	ERS-right, FRS-right
L2	ERS-right	ERS-right	-	-	-	-	-	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right
L3	-	ERS-left	ERS-left	ERS-left	-	ERS-left	ERS-left	ERS-right, FRS-right	ERS-right, FRS-right	-
L4	FRS-right, ERS-left	ERS-left	ERS-left	ERS-left, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right
L5	FRS-right	ERS-right	ERS-left, FRS-left	ERS-left, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-right, FRS-right	ERS-left, FRS-right
E=extension, F=flexion, R=rotation, S=side-bent (segments without restriction are marked negative) See next page for translation to examiner observation and motion restriction										

Table 5: Guide to Type 2 Dysfunction Terminology (DeStefano, 2011 p.70)		
Observation:	Motion Restriction:	Position:
Right facet does not open with flexion (right TVP does not rise and is more prominent)	Flexion, left rotation, left sidebending (written as "**Flex +R**" in treatment notes)	Extended, right rotated, right sidebent (**ERS-Right**)
Left facet does not open with flexion (left TVP does not rise and is more prominent)	Flexion, right rotation, right sidebending (**Flex +L**)	Extended, left rotated, left sidebent (**ERS- Left**)
Left facet does not close with extension (left TVP does not lower and right TVP is more prominent)	Extension, left rotation, left sidebending (**Ext +L**)	Flexed, right rotated, right sidebent (**FRS-Right**)
Right facet does not close with extension (right TVP does not lower and left TVP is more prominent)	Extension, right rotation, right sidebending (**Ext +R**)	Flexed, left rotated, left sidebent (**FRS-Left**)

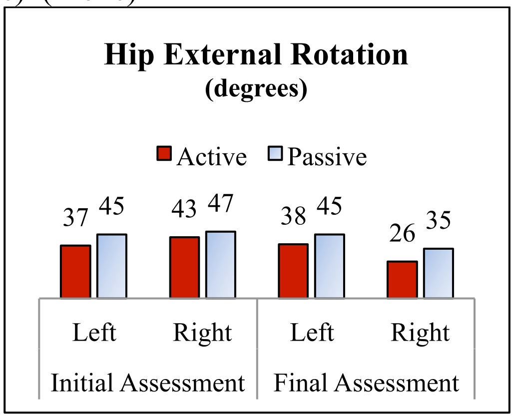
Table 8: Manual Muscle Tests of the Hip (Magee, 2007; Kendal, 1993)				
Muscle/Muscle Group Tested	May 11		July 18	
	Left	Right	Left	Right
Iliopsoas	4	4	4	4.5
Gluteus Medius	4	4	5	4.5
Adductors	4.5	4.5	4.5	4.5
Hip Internal Rotation	4.5	4.5	4	4.5
Hip External Rotation	5	5	4.5	4.5
Gluteus Maximus	3	3	3 (4)	3 (4)
Parenthesis indicate results from assessing a second time Static resistance was applied No pain occurred				

A goniometer was used to measure each hip motion using a vertical or horizontal plane for a baseline. The other axis for flexion and extension was between the greater trochanter and lateral epicondyle of the femur. The axis for adduction was the medial border of the thigh and for abduction it was the lateral border. The axis used for hip rotation was the anterior border of the tibia.

Figure 4: Hip Range of Motion



e) (Prone)



f) (Prone)