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Using Biofeedback as a Treatment Tool when Managing Whiplash Associated Disorder Symptoms During Pregnancy

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Abstract

Background: Whiplash associated disorder (WAD) affects up to 980,000 people in the United States and typically occurs from motor vehicle accidents. **Case Description:** A 37-year-old female displayed whiplash affective disorder symptoms after being rear-ended in a car accident. She was 9 weeks pregnant and had pain in her low back, upper back, and neck. She had impaired muscle control and activation, which caused a muscle imbalance of overactivity in the upper trapezius, lumbar paraspinals, and iliopsoas. A treatment plan was constructed to correct motor/postural deficits secondary to whiplash symptoms. **Examination:** The patient demonstrated muscle increased tone at the bilateral upper trapezius and lumbar paraspinals with palpable trigger points. Postural deficits included forward head and anterior pelvic tilt with lordosis and a pivot point at the L5 vertebrae. **Intervention:** The patient was prescribed a progressive comprehensive physical therapy plan of care including neuromuscular re-education exercises designed for lumbar stabilization and restoring scapulohumeral rhythm. She also received manual therapy services in order to apply soft tissue mobilization to the upper trapezius. She continually required verbal/tactile cues until biofeedback was prescribed. **Discussion:** Although the patient likely benefited from the entire treatment program; the biofeedback intervention demonstrated acute improvements with reducing overactivation of the bilateral upper trapezius with shoulder exercises. This treatment was particularly valuable in this case considering both its efficacy in correcting movement impairments and being safe during pregnancy. Further research is required to investigate the efficacy of surface EMG in treating WAD symptoms for both acute and long-term outcomes.

Keywords: Physical Therapy; Rehabilitation; Whiplash Disorder; Cervical; Lumbar; Low Back Pain; Pregnancy; Biofeedback; muscle EMG; Neuromuscular re-education; Shoulder; Upper Trapezius

Background

Whiplash associated disorder (WAD) is an injury to soft tissues of the cervical spine caused by rapid acceleration and/or deceleration. The prevalence of this injury has increased the past 30 years, with at least 980,000 people in the United States or 300 of 100,000 inhabitants.[1] These typically occur in motor vehicle accidents but may also occur in other events that cause a rapid acceleration followed by deceleration, such as participating in a sporting event or a fall.[1] The diagnosis is made from the combination of mechanism of injury and symptom presentation, as there are no indications found by imaging studies.[1]

The symptoms are mostly found to be cervicalgia-related, but there can also be pain in other joints and the low back. [1-3] Some studies found that about 41-58% of people with WAD from a motor vehicle accident also have low back pain; most of the drivers wore seatbelts and had a history of low back pain.[3,4] However, 36% of the subjects with low back pain reported no history of low back pain prior to the motor vehicle accident.[3] This suggests that patients with WAD have a greater incidence of low back pain than the general adult population.[5]

The acquisition of low back pain from WAD is one of several controversial areas of research regarding WAD symptoms. Neck pain being caused by WAD is relatively more biologically plausible than low back pain, considering the lack of support of the neck, sites of acceleration/deceleration forces, and support at the trunk.[3] However, force vector and amplitude was not correlated with the onset of low back pain following an MVA.[3] This evidence suggests the impact severity is not a strong prognostic factor in the symptoms and there has been WAD-associated low back pain with low velocity impact.[3] These reports hint at a biopsychosocial contribution to WAD.[3] Other reports suggest severity of impact may be associated with increased joint position error with moderate to severe impacts.[3,6] Additional controversy and prognostic factors include the influence of litigation with the outcomes and the force direction of the impact.[7] Chronic symptoms have been shown to last for up to 2 years or more in 50% of patients involved in rear-ended motor vehicle accidents.[8]

There have been many studies focused on how WAD influences proprioception, posture, and kinesthetic awareness, demonstrating a theory that WAD influences sensorimotor incongruence which results in pain.[6,9,10] The superficial cervical muscles and lower back muscles have shown altered recruitment and activation patterns that occur near the time of the injury and can persist for at least 3 months.[6] One study compared WAD patients with healthy controls and found those with WAD had increased postural sway with balance tasks and increased EMG responses of the posterior neck and shoulder muscles with perturbations.[11]

Both WAD and pregnancy have been associated with increased low back pain and both have been studied extensively separately, yet how they may influence each other and how to manage the symptoms of WAD during pregnancy has not been published in the literature. Pregnancy has physiological, hormonal, and anatomical changes that occur throughout the three trimesters and can often be associated with low back pain. Because the anatomical changes throughout pregnancy are accompanied with postural changes and increased lordosis, there may also be am altered sensorimotor system. Similar to cervical symptoms of WAD, people with low back pain have also been associated with having symptoms of increased trunk stiffness and reduced capacity for dissipating kinetic forces.[12]

Treatment for WAD can be diverse and includes exercise and neuromuscular re-education. Although having WAD symptoms may discourage the patient from participating in physical activity, research has shown exercise may help reduce symptoms and speed the recovery process as compared to sedentary activity.[13] Therapeutic exercise has been shown to slightly improve pain at six months of treatment and has a greater therapeutic effect with higher pain ratings.[14,15] However, Griffin and colleagues argue that exercise is not effective in the treatment of chronic WAD.[16] Most of these studies used therapeutic exercises as treatment for WAD, but do not focus on neuromuscular reeducation with EMG biofeedback. Biofeedback can be a tool to help patients learn how to increase and decrease the tone of muscles hooked up to an EMG. One study demonstrated that using EMG biofeedback had improved inferior shift of the trapezius as compared to using verbal cuing alone, helping correct cervicoscapular posture.[17] Theoretically, this can be helpful in reducing the increased muscle tone seen in pregnancy and WAD. The purpose of this case study is to report the challenges of physical therapy treatment of WAD during pregnancy, describe symptoms related to sensorimotor incongruence in this case, and how EMG biofeedback may be a valuable resource in this specific patient population.

Case Description

A 37-year-old female presented to an outpatient physical therapy clinical one month after being involved in a motor vehicle accident. She was a passenger in the back seat of a car when another car rear-ended the car at about 20 mph.

The patient did not feel any symptoms after the accident, but still went to the emergency department just to check her health and the safety of her unborn child, as she was 9 weeks pregnant at the time. She began feeling the symptoms the next day with increased neck and low back pain. She experienced pain with turning her head, reaching overhead, holding her baby, getting groceries, and standing for prolonged periods of time. The pain did not radiate, but remained localized to the cervical, thoracic, and lumbar spine. Her pain was eased when lying on her back with a bolster for under her knees. She also reported pain relief following massage techniques.

Past medical history included a significant leg length discrepancy with the left leg being about an inch shorter than the right. As a result, she wore a heel lift in her right shoe to compensate for the leg length discrepancy. She had a 33.8-degree left scoliotic curvature, a previous pregnancy that was accompanied with low back pain, and also a history of cervical pain. Her previous pregnancy may have caused her diastasis recti that was less than two centimeters separation. Otherwise, her prior level of function included participating in activities of daily living and community ambulation with minor chronic low back pain. Now she is limited in her activities due to constant pain in her neck and low back. Her pain is aggravated with lifting and carrying objects, such as her bag or holding her baby.

She reported frequent interruptions with sleeping patterns at night because of her pain in the low back and neck. The patient believed that prior weakness in her spinal and shoulder muscles predisposed those areas for an injury, and the accident exacerbated those weak areas to contribute to her symptoms. Her WAD symptoms limited her productivity as a consultant because she found her pain limited her ability to participate in simple lifting tasks, sit for extended periods of time, and decreased her focus at work. Her goal with physical therapy was to find pain relief.

Clinical Impression #1

The patient expressed having WAD symptoms impacting her cervical, thoracic, and lumbar spine. She was pregnant at the time of the accident, had a visit to the Emergency Department, and is involved in litigation. Litigation matters have been associated with poorer outcomes in WAD.[4,7] Her pregnancy may have contributed to her low back pain and resulted in increased her stress from the accident. High stress levels have shown to increase tone/tightness in spinal musculature. She reported increased pain with repetitive lifting tasks, which may be related to having increased tone of upper trapezius and neck extensors with lifting tasks.[11]

WAD and pregnancy have likely increased her chances of having increased tone or even a muscle strain in the muscles surrounding the spine. Therefore, her paraspinals and relevant spinal musculature was examined with palpation to find trigger points and tightness which may be associated with increased muscle tone. Other differential diagnosis examined included sacroiliac dysfunction, muscle length, swelling, leg length (to ensure the heel lift is still an adequate size), joint mobility, postural assessment, scapulohumeral rhythm. She likely did not have a disc herniation as her pain began the day following the accident and presented more like WAD.

Examination

The low back examination showed that the patient had great flexibility of the hamstrings and piriformis. Her manual muscle strength scores of lower extremities were 5/5, indicating she did not have lower extremity muscle weakness. Palpation tenderness was found at the right piriformis, both paraspinals at L5, sacrum, L4 and L5 spinous processes. With lumbar extension, she demonstrated a pivot point at L5. All other movement of the lumbar spine was within normal limits. However, her resting posture had an observable anterior pelvic tilt, genu recurvatum, and lumbar lordosis. Special tests included Gillet's, single limb stance, leg length discrepancy, active straight leg raise; which all tested negative except the single limb stance on the right leg was held for just 5 seconds. With both static standing and gait assessment, her heel lift was still appropriate in correcting the leg length discrepancy.

Examination of the thoracic spine and upper extremities revealed increased bilateral upper trapezius tone and forward neck posture. When she raised her shoulders in flexion or abduction, the upper trapezius observably contracted, and her forward head posture was exacerbated. She had increased tightness of bilateral iliopsoas and upper trapezius. Palpable trigger points were present in bilateral posterior cervical musculature and was localized to the site of her reported pain. Her manual muscle tests scores indicated weakness in bilateral serratus anterior with a 4/5 score. She had full range of motion all around, her joint play had normal mobility.

Clinical Impression #2

The examination revealed the patient had increased muscle tone; this may have been altered following the accident, causing abnormal nerve activation patterns. The inappropriate muscle activation in combination with poor posture demonstrated the patient has impaired neuromuscular control. Therefore, the prescribed treatment plan was to relax and retrain the overactive muscles of the upper trapezius/paraspinals, while also re-educating the patient how to appropriately activate these muscles in order to achieve a normal resting tone. By achieving adequate muscle balance and activation with normal tasks of the upper extremity, the patient may experience a normal muscle tone and decreases in pain.

The patient also demonstrated postural deficits of anterior pelvic tilt, increased lordosis, forward head, rounded shoulders. She did not respond well to verbal cues to correct posture evident by her quick reversal to her poor resting posture; therefore, the plan was to use neuromuscular re-education in an attempt to correct faulty posture. Her presentation of diastasis recti may contribute to her postural deficits. Her anterior abdominal wall will likely progressively stretch again with her current pregnancy—therefore, she was planned for retraining transversus abdominus activation in order to help stabilize the lower back. Exercises designed to actively stretch tight musculature (such as the pec minor, iliopsoas, and posterior cervical muscles) were included to promote optimal mobility. Her treatment plan included heat, manual techniques to release the upper trapezius, therapeutic exercises, and EMG biofeedback to retrain the shoulders. The above interventions were chosen as they are safe to use during pregnancy.

WAD symptoms can be commonly treated with electrical stimulation, but this is contraindicated during pregnancy. Due to her pregnancy, she was unable to be positioned in prone limiting her ability to target thoracic muscles against gravity. Positioning adjustments were made to accommodate her optimal care. For example, the upper trapezius release was performed in sitting in another effort to help the muscle relax and decrease the overactive tone. Additionally, heat can be applied in supine to both the cervical spine and lower back in an effort to help the muscle relax and decrease pain. In particular, the target intervention of surface EMG could be used in standing or sitting to mimic the same positions she was in when she felt the symptoms.

The model of this particular clinic was to use interferential current in combination with heat therapy when treating WAD symptoms, however, electrical current is contraindicated during pregnancy. Therefore, this patient was appropriate for the target intervention of surface EMG biofeedback as it is not contraindicated in pregnancy and can be used to facilitate decreased tone of the upper trapezius. EMG biofeedback was planned to treat the impairments of postural deficits, pain with movement, trigger points, and overactivation of the upper trapezius with flexion or abduction of the shoulder by correcting faulty movement patterns. The patient was educated on EMG biofeedback; however, she wanted to be conservative with her pregnancy and wanted to complete her own research prior to using it in a treatment session.

Intervention

Initial intervention for the patient occurred a month after her motor vehicle accident. The first treatment focused on retraining core and paraspinal muscles to appropriately activate in order to protect her spine during movements and decrease her low back pain. Specifically, this intervention was designed to train the transversus abdominus to act as a back brace to take pressure off her spine with physical activities that increased her pain. For example, the patient was educated on how to activate the transversus abdominus with the cues of “bringing her belly button inwards,” and to “keep breathing.” This allowed the patient to contract the transversus abdominus, without closing her glottis and building up too much pressure to cause a Valsalva maneuver. Once she was able to achieve tranversus abdominus contraction, lumbar dynamic stabilization was trained by maintaining the contraction with pelvic tilts and lifting a limb off the mat in supine/quadruped.

During her second physical therapy visit, she brought in a new physician order to evaluate her “shoulder pain.” However, upon examination the patient’s symptoms were localized to her cervical vertebral joints, rather than the four joints of the shoulder. This suggested that the patient’s main source of symptoms was her cervical, thoracic, and lumbar spine. When treating the cervical and thoracic spine, there was some overlap with treatment of the scapulothoracic joint of the shoulder, including trapezius and rhomboid neuromuscular re-education and strengthening. In particular, the intervention was designed to reintroduce activation of the lower trapezius and decrease activation of the upper trapezius.

The remaining eight visits either focused on the cervical/thoracic area, lower back, or included interventions that treated both areas. All of the treatment sessions are detailed in the **appendix**. The patient was able to perform all of her exercises on the flow sheet but required patient education and verbal/tactile cues to help guide correct scapulohumeral rhythm with upper extremity exercises. This was particularly important in limiting upper trapezius involvement and increasing lower trapezius activation. Additionally, she needed feedback and education on correct form/posture with low back and core exercises. Therefore, some interventions were designed to help her find and maintain correct form; this included performing squats on her knees while holding a PVC pole vertically from her coccyx to her occipital protuberance as this provided mechanical feedback to maintain a neutral spine while activating the gluteal muscles. As the visits continued, her care consistently required verbal and tactile feedback with exercises, as she retained old motor and postural habits. Although she reported decreased pain, she continually showed poor posture and upper trapezius over-activation. In order to teach the patient correct motor habits, she was instructed in the benefits of EMG biofeedback and how it could be incorporated into her treatments.

The patient was educated on the safety of this technology during pregnancy, that EMG biofeedback machines only record inherent electrical activity of the nervous system which corresponds with muscle activation. She was educated that this is different from electrical stimulation which introduces an electrical current to the nervous system from an extrinsic source. Because the EMG biofeedback machine does not introduce a current but only records the action potentials within the muscle, it was safe for pregnancy. She reported wanting to research this on her own to confirm it was safe for her. She was encouraged research surface EMG and pregnancy contraindications in order to confirm the safety of the treatment, efficacy of the technology, and enhance the overall therapeutic alliance.

Biofeedback Treatment Session

After educating the patient and having her research the safety of biofeedback during pregnancy, she was excited to try this treatment. The *Chattanooga Vectra Genisys 4 Electrotherapy System* was used with four *Richmar Multistim* cloth electrodes. The electrodes were placed at bilateral upper trapezius, two placed just medial to the acromion and two electrodes placed lateral to C5 on the upper trapezius. Biofeedback display was shown with split-screens showing two feedback monitors: the left and right sides of the upper trapezius. The display included two separate line graphs, one on each split screen. The line graphs had Y values representing voltage, the x-axis representing time, and the screen refreshed every 10 seconds as the line graph moved along the x-axis in real time.

To begin, the patient was to rest a minute in order to find the baseline electrical activity recorded from the surface EMG from the four electrodes. After resting and blinded to the biofeedback machine, the electrical activity was quickly analyzed to place a horizontal visual marker on the line graph, just above her resting tone at 25% max voluntary contraction. Therefore, the horizontal marker was a cue for visual feedback for the patient to better understand when she was volitionally increasing activity in the bilateral upper trapezius. This treatment strategy was based on the concept of using the visual feedback at both rest and during active movements to intrinsically provide neuromuscular re-education in real time and hope this intervention was more efficacious than verbal/tactile feedback.

In order to place this marker in the target location, the patient was asked to maximally shrug her shoulders and the marker is placed at 25% of the peak of the activation of the shrug from the lowest marker at baseline. The treatment was operated by setting the marker relative to her baseline, and not by objective values of voltage because the voltage can be affected by the placement/quality of the electrode's contact with the skin. The biofeedback was done solely visually, however, the marker could also be auditory with a buzzer sounding if the EMG recording surpassed the marker, representing that the electrical activity recorded at the electrodes had increased.

The patient was then educated that the line graph represented the intrinsic electrical potentials used to activate upper trapezius muscles and how it changes over time. She was educated to keep the live line graph below the horizontal marker in order to limit the voltage recorded at electrode sites, essentially decreasing the activation of the upper trapezius. The patient was given a period of time to learn how to increase and decrease the voltage at rest. Her first few minutes indicated that she had little control on the upper trapezius activation, considering the line graphs were inconsistently moving both up past the marker and coming back down. After a few minutes, she demonstrated improvement, as the line graph remained consistently under the marker at rest. Keeping the sEMG value below the marker with volitional activity is a requirement in order to advance to using resistance exercise. This ensured that she has the ability to correctly use biofeedback prior to adding resistance.

After successfully maintaining sEMG values, exercise progressed by instructing the patient to lift her arms in forward flexion and over her head while keeping the upper trapezius activation below the same marker. Feedback indicated high electrical activity surpassing the marker placed by student physical therapist during the first few repetitions. Following several minutes of practice, the patient learned how to lift her arms into shoulder flexion with decreased voltage recorded by the sEMG in the bilateral upper trapezius. Within the treatment session, she was able to maintain sEMG activation below the marker for 90% of the time with shoulder flexion. Along with having decreased electrical activity, the patient reported that she enjoyed the intervention and felt less tightness in her shoulders with overhead movement.

After demonstrating the ability to decrease the electrical activity recorded by the electrodes with shoulder flexion, tubing resistance was added with new exercises. She used the blue tubes with shoulder flexion, shoulder scaption, and rows. The increased resistance initially corresponded with an increase in sEMG activity, however, the patient also demonstrated the ability to decrease muscular activation by the second and third sets. Finally, she performed a functional exercise of lifting her personal bag from the ground, in order to relate to daily tasks completed outside of the clinic. Again, she reports decreased pain when lifting her bag with biofeedback, minimizing the tone of the upper trapezius, and appeared more relaxed and confident with lifting her bag. The biofeedback treatment required 40 minutes to complete.

Outcomes

To assess her progress, several outcome measures were obtained including Oswestry Low Back Pain Questionnaire, Quick DASH, and numeric pain rating (Table 1). The minimal detectable change of the Oswestry for low back pain is 11.75%.[18] The Quick DASH minimal clinical important difference (MCID) is 10 for the neck and upper extremities.[19] Although her improvements in outcomes for the Oswestry do not meet the minimal detectable change by a difference of 1.75%, and the Quick DASH score also narrowly missed the MCID by 1 point, the patient's decrease in pain of 4 points on the 0-10 numeric rating scale exceeds most reported MCIDs for pain of approximately 2.

The patient's subjective report resulted in a positive response to the biofeedback treatment. The biofeedback worked acutely, according to the patient, by helping her reduce activation the upper trapezius with shoulder movements. The patient perceived the muscle imbalance when lifting overhead and was able to notice an improvement when lifting with biofeedback. Her report was supported with observable contraction of the upper trapezius with shoulder exercises and this pattern diminished during biofeedback. The patient also reported decreased pain with movement, increased confidence of movement, and feeling of satisfaction with the treatment.

Table 1. *Outcomes Before and After Biofeedback.*

Test:	**Oswestry**	**Quick DASH**	**Pain (0-10)**
Evaluation:	32% (mod disability)	45.45	6
Post-Biofeedback	22% (mod disability)	36.36	2

Discussion

The purpose of this case study is to detail the use of sEMG biofeedback as a treatment for WAD symptoms during pregnancy. This case report suggests that some WAD cases present with impairments of posture and muscle imbalance. In this case, treatments were designed to reestablish muscle balance by decreasing the activation where muscles were overactive and increasing activation in areas where there was little activation. In addition to the upper trapezius, the patient also had treatments to increase activation of the transversus abdominus, lower trapezius, and soft tissue release of the iliopsoas and upper trapezius. With the progression of her exercise program, the patient revealed her lack of consistency to accurately respond to verbal and tactile cues. This was most evident when she lifted her shoulder in flexion and had overactivity in bilateral upper trapezius. Therefore, biofeedback was prescribed for neuromuscular re-education to tone in bilateral upper trapezius. The session of biofeedback resulted in an acute decrease in pain and an observable reduction of overactivity of the upper trapezius with shoulder flexion. These sessions were guided from a student therapist providing treatment to the patient under a supervising therapist. The student therapist's clinical rotation concluded shortly after the biofeedback treatment session. As a result, biofeedback was only utilized during one session, with the supervising therapist taking over subsequent sessions. The patient likely benefited from additional physical therapy interventions provided prior to and after the biofeedback session. Therefore, long term treatment of biofeedback is necessary to better understand the therapeutic effect at both the shoulders and potentially her low back. This patient also likely benefitted from other physical therapy interventions prior to using the biofeedback machine and was continued to be treated under the supervising therapist as the student therapist's clinical rotation reached its end.

Potential Mechanisms

The patient had repeated difficulty with proper mechanics; however, biofeedback quickly restored a movement pattern which decreased upper trapezius activation and pain. This therapeutic effect may have biologic plausibility from several different mechanisms related to the biofeedback. One mechanism may be related to the concept of pain and overactivation of muscles. EMGs were found to be increased in low load tasks in patients with WAD.[6] If that increased muscle activity is a source of pain, then decreasing the muscle activity may help alleviate the pain.

Also, tactile cueing may not be as efficacious as biofeedback. Previous studies have researched the effects of EMG biofeedback for treatments of posture. One study found that EMG was more effective than verbal cues in assisting people with inferiorly shifting the trapezius while typing.[17]

Along with increased neck muscle activity, WAD patients were also found to have increased postural sway.[11] This suggests their sensation may be altered, which may affect tactile cues.

Another area of research with WAD patients included the idea of sensorimotor incongruence. These patients have been tested with a different type of visual biofeedback—a mirror. The mirror is used to create dissonance in what the brain is perceiving through vision and the motor output of controlling the arm. The WAD patients had increased symptoms or altered sensations with disturbing visual input as compared to the controls, however a similar experiment found that there was no effect when measuring pain thresholds.[20,21] These studies have further explored the altered sensory disturbances in WAD patients, but sensorimotor incongruence has not been consistently shown to be a direct cause of the patient's symptoms.[10] However, perhaps WAD is associated with sensorimotor incongruence/proprioception impairments which may cause postural deficits or muscle imbalance. As proprioceptive changes may occur with WAD, then resting postural deficits may occur that may cause abnormal stretching/shortening of muscles.[20] In addition, this case included pregnancy which involves the hormone relaxin, further creating joint laxity which may alter proprioception.[22] If there is increased laxity of ligaments supporting joints, then there may be altered mechanoreception at some of these joints, further contributing to sensorimotor incongruence.

There has been research on the altered activation and sensation patterns in WAD patients, but more research needs to be completed on the effect of sEMG as a therapeutic tool in restoring normal muscle activation patterns in this patient population.

Conclusion

The purpose of this case study was to report the acute use of biofeedback treatment in a pregnant patient with whiplash symptoms. WAD symptoms historically are most associated with neck pain, but have also been linked with low back pain, muscle spasms and sensory deficits.[13] The patient presented with these impairments, most notably an overactivation of the bilateral upper trapezius with shoulder flexion. Her pain was initially constant but was exacerbated during activities of daily living that required movements of shoulder flexion. The model of that clinic was to treat WAD patients with interferential current, however this was contraindicated as she was pregnant. After several visits of physical therapy, the patient had a reduction in severity of the pain, but still had pain with movements and overactivity of the upper trapezius. By using a single treatment session of biofeedback, the patient reported a further reduction in pain and was able to decrease tone of the upper trapezius with shoulder flexion. This treatment session was well received by the patient and was not contraindicated for her pregnancy. Further research must be done on the treatment of WAD with biofeedback for long term outcomes.

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Appendix: Exercise Flow sheet

Session number	1	2	3	4	5	6	7	8	9	10
Intervention:										
Heat (low back and neck)	10'	10'	10'	8'	10'	10'	10'	10'	10'	10'
Pelvic Tilts (TA)	2x10			1x10	2x10	2x10		1x10	1x10	1x10
Heel lifts supine (TA)	2x10				2x10	2x10	2x10	1x10		3x10
Knee lifts quadruped (TA)	1x10						2x10			
Stationary Bike	10'					5'	5'	10'	10'	
Sidelying Hip Abduction				1x10					2x10	3x10
Hip Abudction (machine)			1x15 30#		2x10 30#	2x10 30#	2x10 25#			
Hip Extension (machine)			1x15 50#							
Bridging					2x10			1x15	1x10	
Marching on ball			2x20	1x10				3x10	3x10	
Knee Squats							3x10	2x10	3x10	
Arm perturbations							3x1'			
Triceps (tube/cybex)							3x10 10#			
Single limb stance				5x30" foam	5x30"					
Anti-rotation 45-90-120										3x10 B
Foam Roller Thoracic stretch		3x30"							3' & 3'	
Arm Bike		15' level 3	10'	10'	10'	6'	5'			
Rows (tube)		2x15 blue	2x15	2x10 blue		2x10 blue			2x10 blue BF	
Shoulder flexion (tube)		1x10 blue	2x10 blue			2x10 blue			2x10 blue BF	
Shoulder scaption (tube)			3x10 blue	1x10 blue		2x10 blue			2x10 blue BF	
Shoulder horizontal abduction (tube)				1x10 blue						
Soft tissue mobilization (UT)		5'	8'	8'		8'	8'	8'	8'	8'
Soft tissue mobilization (iliopsoas)										8'
Suboccipital distraction		5'								
Upper trapezius myofascial release		5'								
Trunk rotation supine										2x10
Hip Flexor stretch										3x10" B
Bag lift									2x10 BF	