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Use Of Functional Strengthening, Balance Training, And Stretching In The Treatment Of A Patient Following A T11-L5 Spinal Fusion: A Case Report

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Use of Functional Strengthening, Balance Training, and Stretching In The Treatment Of A Patient Following a T11-L5 Spinal Fusion: A Case Report

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The patient signed an informed consent form allowing the use of his medical history and photo/video footage for this case report. He received information on the university's Health Insurance Portability and Accountability Act (HIPAA) policies.

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ABSTRACT

Background and Purpose: Lumbar spinal fusion surgery has been utilized to manage levels of low back pain and instability.[2] However, pain often persists post-operatively. Evidence supports the use of Transverse Abdominis recruitment in patients with LBP.[4] Research demonstrates strengthening the hip musculature may allow for improved outcomes for those who experience LBP.[6] There is limited research focusing on lower extremity strengthening, flexibility, and balance training in a patient following a T11-L5 spinal fusion.

Case Description: The patient was a 68-year-old male presenting to physical therapy eight weeks' status post T11-L5 spinal fusion with ~45 degrees forward-flexed posture, weak lower extremity musculature, and restricted muscle lengths. Post operatively, the patient smoked and did not engage in exercise prior to surgery. Interventions consisted of TA recruitment, lower extremity/glute strengthening, stretching, and balance training. Outcome measures included Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), Dynamic Gait Index (DGI), and Berg Balance Scale (BBS).

Outcomes: Results from initial evaluation to discharge: ODI 54% to 36%, NPRS 3-8/10 to 0-5/10, DGI 16/24 to 16/24, and BBS 43/54 to 43/56, demonstrating improved function and decreased pain, but similar balance scores.

Discussion: These interventions may be beneficial in improving functional strength and posture s/p spinal fusion. Cigarette smoking and lack of previous exercise may have contributed to lack of large improvements in balance and MMT, and inability for the patient to return to work. Further research is needed to report upon the outcomes of this approach in managing individuals with LBP after spinal fusion surgery.

BACKGROUND and PURPOSE

Low back pain (LBP) is a prevalent condition, resulting in more lost workdays and disability claims than any other health condition.[1] Approximately 67%-84% of people living industrialized countries have or have had episodes of LBP. [1] Because an estimated 40% of patients with acute LBP demonstrate functional limitations after three months, the importance of skilled physical therapy services to address these functional limitations cannot be underestimated.[1]

Lumbar spinal fusion surgery has been widely used to manage pain and spinal instability in patients suffering from LBP.[2] However, pain often persists post-operatively, attributable to factors including muscular weakness from spinal muscle dissection, decreased trunk extensibility, injury to the nervous system as a result to the pre-operative condition, and other adverse effects.[3] Research has suggested that interventions focusing on correct activation of the transverse abdominis (TA) during functional tasks decreases pain and functional disability in individuals experiencing LBP, even at 30-month follow-up.[4] This deep musculature is involved in the maintenance of intraabdominal pressure and provides a stabilizing effect on the lumbar spine due to the attachment to the thoracolumbar fascia.[4] The TA often does not contract prior to limb movement in patients with LBP, and as a result, the spine cannot achieve a safe orientation prior to the movement.[4,5] As a result, many exercise interventions target recruitment of this stabilizing musculature.[5]

The presence of LBP has been correlated with gluteus medius muscle weakness in patients with chronic LBP compared to healthy individuals.[6] Additionally, weakness of the gluteus maximus has been connected to people who experience chronic LBP. EMG fatigue analyses suggest that maximum voluntary contraction of the gluteus maximus is lower and

fatigue is achieved quicker in individuals with LBP compared to those without LBP.[7] Because of this evidence, proximal hip strengthening is often included in exercise interventions.

The aging process has been shown to characteristically modify optimal posture. Flexed postures frequently occur, which may involve increased thoracic kyphosis, forward head, and knee flexion.[8] Age-related hyperkyphosis may be described as an exaggerated anterior curve of the thoracic spine that has been associated with populations >55 years old and may contribute to ADL difficulty, decreased quality of life, and higher mortality rates.[9,10] It has been suggested that thorax correction exercises including theraband work to strengthen the back may significantly contribute to decreased kyphosis angles and forward head, as well as improved chest expansion.[10] Correspondingly, postural correction exercises to strengthen the back may be appropriate for the older population with severely flexed postures, as well as post-surgical patients who have undergone spinal fusions and demonstrate age-related postural changes.

Although there is abundant evidence regarding exercise interventions for patients suffering from LBP, there is limited research investigating the efficacy of treatment focusing on core and lower extremity strengthening, stretching, and balance training for forward-flexed individuals s/p spinal fusion. The purpose of this case report is to describe the management and functional improvement of a patient with high levels of LBP, severe postural impairments, and elevated fall-risk after a thoracolumbar spinal fusion, while utilizing the principles of core and lower extremity strengthening, stretching, and balance training.

CASE DESCRIPTION: PATIENT HISTORY and SYSTEMS REVIEW

The patient was a 68-year-old male presenting to physical therapy eight weeks' s/p posterior instrumented T11-L5 thoracolumbar spinal fusion with pedicle screws. He was

diagnosed with lumbar spondylosis and multiple levels of spinal segment instability prior to surgery. The patient remained in the hospital for three nights postoperatively, received two weeks of subacute rehabilitation at a skilled nursing center, and was discharged home and received home care physical therapy until his sixth week post-surgery. At the time of the examination, he denied feeling lower extremity pain, numbness/tingling, gross weakness, bowel/bladder changes, or saddle paresthesia. See Table 1 for the results of the systems review.

The patient's past medical history included a pulmonary embolism four years ago, COPD, and a history of smoking. Postoperatively, he smoked two packs of cigarettes per day. X-rays were performed ~1 month postoperatively and demonstrated good healing as per patient report. At the time of the initial evaluation (IE), his medications included Coumadin 2.5 mg 3x/week and Oxycontin 10 mg as needed. The patient did not engage in any form of exercise preoperatively and was not working at the time of the IE. One year prior to surgery, he was working full time as an established guitar teacher at a prestigious performing arts college. The patient lived alone in a single level apartment and relied on his daughter as his main support system. He used a rolling walker in the community, as he had for at least a year preoperatively, but chose to not use an assistive device at home.

At the IE, the patient could tolerate five minutes of walking and two minutes of standing before needing to sit. He described an intermittent, aching LBP rated 3-8/10 on the Numeric Pain Rating Scale (NPRS). Additional functional limitations included the inability to lay supine, stand up straight, walk, or cough, without aggravating his symptoms. His goals for physical therapy were to stand up straight, restore his normal tolerance to walking/standing >20 minutes, and to return to work as a guitar teacher. The patient verbalized and documented his consent to participate in this case report.

CLINICAL IMPRESSIONS 1

At IE, it was hypothesized that, in addition to postoperative impairments resulting from a thoracolumbar spinal fusion, the case involved differential diagnoses of sacroiliac disease, quadratus lumborum/paraspinal strain, hip joint pathology, or disc/facet dysfunction at other spinal segments. The patient was a strong candidate for this case report because of the unique combination of levels fused and his motivation to improve his posture. Examination included pain, ROM, muscle length, posture, gait, and pain assessments, as well as manual muscle testing (MMT), palpation, deep tendon reflexes (DTR), dermatome testing, and administration of the Oswestry Disability Index (ODI). Utilization of these tests and measures was beneficial in the identification of musculoskeletal impairments related to the patient's pain, activity limitations, and functional limitations.

EXAMINATION- TESTS and MEASURES

The ODI [appendix 1] is a widely used condition-specific outcome measure that tracks functional disability changes in individuals who present with LBP and has been shown to have good long term test-rest reliability and validity.[12] At the IE, the patient's ODI indicated 54% disability.

The patient lacked the ~45 degrees of lumbar extension that would allow him to achieve an upright posture, and remaining motions were not tested due to post-surgical precautions and pain levels. Posture was assessed in standing; postural deviations included a severely forward flexed trunk, rounded shoulders, protracted scapulas, hyperextension of upper cervical spine, increased flexion of lower cervical spine, and bilateral knee flexion contractures of ~20 degrees with bilateral genu varum while in standing.[9,10] Subsequently, the patient's gait was observed as

he walked with a rolling walker; he ambulated with a severely flexed posture at the trunk, a step through pattern with a narrow base of support, and decreased knee extension at terminal swing phase/heel strike.

MMT was utilized to assess the patient's strength; it has been shown to have good concurrent validity and reliability.[13] The patient demonstrated weakness in all lower extremity as assessed through MMT and functional strength assessment [Table 2].

Although the patient was able to achieve a neutral position during hip flexor muscle length assessment, severe restrictions were noted bilaterally. Hamstring length was tested in 30 degrees of long sit due to positional restrictions. The patient's 90/90 hamstring length was 45 degrees from 0 bilaterally, suggesting severe hamstring tightness. Hip flexor restrictions may cause a forward flexed posture at the trunk, limit hip extension ROM, and increase anterior pelvic tilt, while tight hamstrings can place strain on the low back and bring the pelvis into a posterior tilt. [5,14,15]

The patient's DTR and dermatomes were assessed to rule out neurological issues that may have been present pre-surgery or may have arisen post-surgery. DTRs were absent bilaterally, which was not a cause for concern. Dermatome testing, using light touch, yielded unremarkable results.

Palpation was performed in a side-lying position due to the patient's inability to assume a prone or supine position. Mild tenderness and increased "mushy" soft tissue consistency of bilateral thoracolumbar paraspinals/quadratus lumborum and upper glutes were noted, likely due to muscle atrophy/disuse.[16]

CLINICAL IMPRESSIONS 2

The patient presented to physical therapy s/p spinal fusion, which was required as the result of lumbar spinal instabilities. Because the patient was unable to work as music teacher due to difficulty ambulating and standing greater than three minutes, his primary PT diagnoses were impaired posture, impaired core/lower extremity strength, and low back pain. The ICD-10 chosen was M53.2X6 "Lumbar Spinal Instabilities". The observed impairments and functional limitations, including high pain levels, significant disability as measured by the ODI, forward flexed posture, gait deviations, and limited ROM were consistent with post-surgical impairments of a T11-L5 spinal fusion.

There were no "red flag" concerns that required referral to other health care professionals or further consultation at the IE. The patient agreed to attend follow-ups with his doctor regarding the healing of the fusion and incision. Given the patient's eagerness to achieve postural and functional improvements, his motivation to resume his career, and his numerous impairments that could be addressed with physical therapy, he remained a good candidate for this case report. The patient was willing to work hard and agreed to be compliant with his home exercise program (HEP).

The patient presented with a fair prognosis in terms of proper post-surgical healing, decreasing LBP, and improving posture, strength, and balance. Potential barriers to achieving optimal improvements included the patient's habit of smoking two packs per day postoperatively, as well as his lack of previous exercise. In a study comparing cigarette smoking to smoking cessation on fusion rate after spinal fusion surgery, 26.5% of patients who continued to smoke postoperatively had a nonunion compared to a nonunion rate of 17.1% for cessation, and 14.2% for patients who were nonsmokers.[11] Although further research is warranted, if the patient had quit smoking prior to the surgery, it may have improved the ability of T11-L5 to heal

optimally. A study investigating the prognostic factors for the reduction of ADLs following vertebral fractures suggested that a lack of regular exercise may be associated with reduced ability to perform ADLs.[17] Although the patient was not post vertebral fracture, he had never engaged in regular exercise and was expected to experience similar difficulties.

After confirming post-surgical precautions with the physician, it was decided that physical therapy frequency would consist of two visits per week for six weeks. At the eighth visit, all tests and measures would be re-administered to see if the patient could benefit from further treatment. Aerobic exercises, balance training, core/lower extremity strengthening, stretching exercises, and gait training would be included in the plan of care. The Berg Balance Scale (BBS) and Dynamic Gait Index (DGI) were planned to be administered to quantify observable balance impairments. See table 3 for short/long term goals.

INTERVENTION

Coordination and communication with the patient's surgeon regarding specific post-surgical protocol and precautions were utilized to develop an effective and safe treatment plan. Aside from a 25-lb weight lifting precaution, the surgeon did not ask for further precautions to be followed. At the first daily visit, the patient was educated on how to assume a thirty-degree long-sit position at home so that the initial HEP could be performed [Table 4].

Procedural interventions focused on therapeutic exercise. A manual stretching program for hamstring and hip flexor muscle lengthening was appropriate to reduce unnecessary stress on the spine, correct pelvic position and forward posture, and improve ease of functional activities. The patient's hamstring tightness may have influenced his lumbopelvic rhythm and contributed to postural impairments and compensatory movements. Forward bending is repetitively utilized

during many ADLs, and restricted hamstring length had the potential to increase the risk of injury from mechanical stressors to the patient's spine.[15] In order to maximize patient safety and comfort, manual hip flexor stretching was performed in side-lying and manual hamstring stretching was performed in modified supine position with the head of the bed at 30 degrees. Standing pectoralis stretching in a door frame was initiated at the 11th visit and added to the HEP on the 12th visit in order to promote opening of the chest wall and decrease forward shoulders.

The recumbent bike was initiated on the third visit in order to introduce light aerobic training, increase blood flow to the extremities and trunk, and activate the core and lower extremity musculature. Research suggests that exercise training in the individual with COPD is beneficial in improving in oxygen uptake and endurance time, reducing symptoms of COPD, and increasing oxidative capacity.[18] Although the patient only rode the recumbent bike for 10 minutes at each visit, he was educated on the importance of utilizing a gym membership to reduce his COPD symptoms and make steadier improvements.[18]

Core stabilization exercises involving Transverse Abdominis (TA) recruitment in 30 degrees of long sitting were introduced at the first follow-up visit in order to increase patient activity tolerance and global impression of recovery.[19] The patient was educated on how to recruit this muscle while performing functional activities in order to protect the spine. Posterior pelvic tilts in conjunction with hip adduction strengthening was also introduced at the first follow-up visit in order to increase lumbopelvic stability and blood flow in patients.[3] These exercises were added to the patient's HEP [Table 4].

Glute strengthening, such as clamshells, standing hip abduction, sit to stand, step ups, lateral theraband walks, and standing hip extension were included to target musculature that was weak during MMT and functional analysis at the IE. Gluteus maximus and medius functional

strengthening was included to help the patient control movements of the torso, hips, and legs, and improve performance of functional activities. Progression of these exercises was gradual, as the patient demonstrated slow improvements in standing endurance and aerobic capacity and required frequent rest breaks [Table 4].

Postural reeducation including rows, shoulder extensions, bilateral shoulder external rotation, chin tucks, and angels and chicken wings against a foam roller was initiated to improve activation, endurance, and muscle length of the postural muscles. Although a completely vertical posture was unattainable, the goal for this intervention was to allow the patient to improve upright posture with tactile feedback from the foam roller, while focusing on decreasing rest breaks [Table 4].

During the sixth visit, the patient scored a 43/56 on the BBS and a 16/24 on the DGI, which was predictive of fall risk in the elderly. Balance training has been shown to be crucial in reducing fall risk and rate of falls in older adults.[2] Because of this evidence, the patient's fall risk scores, and observable poor weight shifting strategies, balance training was incorporated into the patient's procedural interventions [Table 5].

Because the patient was adamant about trying aquatic therapy, visit 17 and 18 compromised aquatic therapy sessions focusing on all lower extremity strengthening that had been previously initiated on land. After these two sessions, the patient received a HEP of all pool exercises.

OUTCOME

Over the course of 18 physical therapy treatments, the patient demonstrated mild subjective and functional improvements, which were supported by the ODI and the NPRS [Table 2]. Although the DGI (16/24) and BBS (43/56) were unchanged from the initial measure, the patient

was able to maintain balance with perturbations at his trunk, reach beyond his base of support in varying directions, and improve his hip and ankle strategies during weight shift. He demonstrated a more upright posture during ambulation, but continued to have decreased knee extension during terminal swing/heel strike. Unfortunately, he was unable to return to work.

The patient demonstrated mild postural improvements in scapular retraction as well as decreased rounded shoulders, forward head, and forward flexed trunk to ~15 degrees. Although scapular retraction/depression MMT were not performed at the IE, the patient's scapular retractors/depressors were 4-/5 by the final visit. The patient's iliopsoas muscle lengths improved to moderate restrictions, and his 90/90 hamstring lengths improved to ~20 degrees from 0 degrees. By the final visit, the patient reported improved tolerance to lying flat on his back and decreased difficulty with transferring from his recliner to standing and negotiating stairs, but no significant difference in standing or walking tolerance. Please see Table 2 for MMT and functional strength improvements.

DISCUSSION

The effectiveness of various physical therapy treatment approaches for patients suffering from LBP has been thoroughly demonstrated in the literature. However, there is limited research available that investigates the efficacy of treatment focusing on lower extremity strengthening, flexibility, and balance training in an individual following a thoracolumbar spinal fusion with associated postural impairments. It has been suggested that balance training is effective in improving proactive and reactive balance strategies as well as improving performance on balance outcome measures.[2] Research also shows that a lumbopelvic stabilization training program including posterior pelvic tilts in conjunction with lower extremity movement increases

lumbopelvic stability and blood flow in patients with chronic non-specific LBP.[3] Additionally, gluteus medius weakness in people with chronic LBP in comparison to healthy controls has been suggested to be prevalent.[6] The plan of care incorporated interventions that coincided with this evidence in order to yield the best possible outcomes.

Stretching, lower extremity strengthening, and balance training in an individual who is s/p T11-L5 spinal fusion may yield modest outcomes. The patient demonstrated fair improvements in MMT measurements and muscle length, good functional strength improvements, and mild improvements in balance. The most significant improvement was seen in the patient's decreased forward flexed posture from ~45 degrees to ~15 degrees.

Among the numerous negative effects of cigarette smoking, there is an apparent adverse influence on the spine. Cigarette smoking has been shown to inhibit lumbar spinal fusion and adversely affect the outcome of returning to work compared to nonsmokers or patients who quit smoking after surgery.[11] Despite the patient's functional improvements, he was unable to return to work due to persistent positional limitations, moderate pain levels, and low standing endurance of ~3 minutes. A study that compared return-to-work rates in smokers and quitters who had undergone a spinal fusion showed that 53.4% of nonquitters returned to work, but 46.6% remained disabled. In contrast, those who quit smoking for greater than six months after surgery had a 74.6% return to work rate, and 25.4% remained disabled.[11] Although one cannot infer a cause and effect relationship between modest outcomes in therapy and smoking in the patient who is recovering from an extensive spinal fusion, is likely that the patient's excessive smoking contributed to his inability to return to work and fair improvements demonstrated throughout the course of therapy. This patient's lifestyle choice presents as a confounding variable that may have influenced the validity of this case report's finding.

In addition to smoking, the patient's lack of previous exercise may have contributed to modest improvements. Research speculates that patients with regular exercise are less affected by disuse atrophy during initial phases after spinal fracture.[17] Although the patient did not present post spinal fracture, disuse atrophy was likely due to postoperative protocol and lack of exercise habits previously. It has also been suggested that regular exercise should be encouraged to prevent reduced ADL after vertebral fracture, particularly for elderly individuals.[17] Perhaps if the patient had exercised prior to his spinal fusion, it would have prevented his reduced ADL tolerance postsurgically. As a result of this confounding variable, one cannot infer the same modest results with a patient who exercised preoperatively.

The patient's lack of improvement in BBS and DGI scores may have been due to his knee flexion contractures/osteoarthritis and venu garum, contributing to his fall risk. A more comprehensive approach to balance training focusing on knee alignment and range of motion may have improved outcomes. Additionally, the patient may have been able to achieve a more upright posture by the final visit if he did not use his rolling walker, which encouraged a flexed forward posture. However, without using his rolling walker, the patient's fall risk increased. Using an assistive device to address fall risk was deemed more important than an upright posture for this individual.

The results of this case report suggest that therapy consisting of stretching, lower extremity strengthening, and balance training may be beneficial additions to the plan of care in a patient who is s/p multilevel thoracolumbar spinal fusion with associated marked postural impairments. As with any case report, one cannot infer cause and effect between lower extremity strengthening, balance training, and stretching, and the clinical improvement of the patient. However, the significant functional improvements and decreased forward flexed posture

suggest that these interventions were likely a contributing factor for his clinical improvement. Further research is warranted to determine the most effective therapeutic protocol for patients presenting with LBP after a spinal fusion surgery.

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444 **TABLES and FIGURES**

Table 1. Systems Review

Cardiovascular/Pulmonary	**Impaired cardiorespiratory function due to deconditioning and chronic productive, effective cough present at rest and during exercise.**
Musculoskeletal	**Impaired strength, flexibility, posture, gait, and ROM.**
Neuromuscular	**Impaired due general unsteadiness/need to hold onto various objects for support during IE.**
Integumentary	**Impaired. Central thoracolumbar surgical incision T11-L5 healed well, except proximal 2 inches covered by dry exudate. No signs and symptoms of infection or redness.**
Communication	**No impairments noted.**
Affect, Cognition, Language, Learning Style	**No impairments noted. Primary language: English.**

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446 **TABLE 2. ODI, NPRS, and Strength Examination Results at Initial Evaluation and Final**
447 **Visit**

Tests and Measures	*Initial Evaluation Results*		*Final Visit Results*		
ODI	54% disabled		36% disabled		
NPRS	3-8/10 NPRS		0-5/10 NPRS		
Manual Muscle Testing	***Muscle***	**Left** **Right**	***Muscle***	**Left**	**Right**
	Iliopsoas	4/5 4/5	*Iliopsoas*	4/5	4/5
	Quadriceps	4-/5 4-/5	*Quadriceps*	4+/5	4+/5
	Hamstrings	4-/5 4-/5	*Hamstrings*	4+/5	4+/5
	Hip External Rotators	4-/5 4-/5	*Hip External Rotators*	4/5	4/5
	Hip Internal Rotators	4/5 4/5	*Hip Internal Rotators*	4/5	4/5
	Hip Abductors	3/5 3+/5	*Hip Abductors*	4-/5	4-/5
	Extensor Hallucis Longus	4+/5 4+/5	*Extensor Hallucis Longus*	4+/5	4+/5
	Note: Gastrocnemius not tested		Note: Gastrocnemius not tested		

	secondary to observable balance impairments	secondary to observable balance impairments
Functional Strength Analysis	• Fair eccentric quadriceps control during stair descent • Slow initiation of STS, multiple attempts needed, use of upper extremities needed • ~30 degrees hip ER side stepping	• Good eccentric quadriceps control during stair descent • One attempt to achieve a full standing position during STS, less use of upper extremities, smoother transition • ~15 degrees hip ER during functional side stepping

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TABLE 3: SHORT TERM AND LONG TERM GOALS FOR PHYSICAL THERAPY

Short Term Goal 1:	Increase lower extremity strength ½ to 1 grade grossly within 3 weeks from 1st visit
Short Term Goal 2:	Will report low back pain no greater than 0-5/10 NPRS within 3 weeks from 1st visit
Short Term Goal 3:	Will improve functional tolerance to walking >10 minutes within 3 weeks from 1st visit
Short Term Goal 4:	Will report 70% compliance to HEP (performed at least one time per day 5/7 days per week) with prescribed therapeutic exercise for home within 3 weeks from 1st visit.
Long Term Goal 1:	Will report 100% compliance to HEP (performed 7/7 days per week) with prescribed therapeutic exercise for home within 6 weeks from 1st visit
Long Term Goal 2:	Will achieve 4+/5 lower extremity strength grossly within 6 weeks from 1st visit
Long Term Goal 3:	Will report low back pain no greater than 0-3/10 NPRS within 6 weeks from 1st visit
Long Term Goal 4:	Will restore normal tolerance to walking/standing >20 minutes within 6 weeks from 1st visit
Long Term Goal 5:	Will achieve a score of ≤ 30% disabled on the Oswestry Disability Index within 6 weeks from 1st visit

TABLE 4: STRENGTHENING AND HEP PROGRESSIONS

Visit	Strengthening	HEP
Visit 1-4	❖ TA recruitment education and performance, 10' ❖ PPT's in 30 degrees of long-sitting, 5" holds 20x, and with hip adduction ball squeeze 5" 20x ❖ Side-lying clam shells with yellow theraband 2x10 B ❖ Standing hip abduction at parallel bars 2x10 B ❖ Sit to stand (STS) from high box (2 feet) 2x10 **Visit 2** *as previously added plus initiated below:* ❖ 4" step-ups, 3x10 B at parallel bars ❖ Standing hip extension 2x10 B at parallel bars ❖ Toe raises B 3x10 at parallel bars ❖ Heel raises B 3x10 at parallel bars **Visit 3** as previously added plus initiated/progressed below: ❖ 6" step ups 2x10 B, Std. hip extension 3x10 B**,** D/c toe/heel raises to HEP **Visit 4** *as previously added plus initiated/progressed below:* ❖ Std. hip abd. at parallel bars 3x10 B ❖ 6" step ups 3x10 B ❖ Std. quadriceps stretch on middle box (1.5 feet) with UE support on chair 30"x3 B ❖ Seated rows using red theraband (RTB) 2x10 ❖ Shoulder extension using RTB 2x10 B ❖ Standing chin tucks 5" x10 ❖ Seated B shoulder ER using RTB 2x10	o Posterior pelvic tilt 5" hold 20x o Posterior pelvic tilt 5" hold with 5" adduction soft ball squeeze 20x ***Visit 2 added:*** o B Toe raises 3x10 at kitchen counter o B Heel raises 3x10 at kitchen counter ***Visit 4 added:*** o Quadriceps/iliop soas stretch on chair with UE support 30"x3 B every day o Supine hamstring stretch using belt with HOB elevated to 30 degrees 30"x3 B every day
Visit 5-8	**Visit** *5 as previously added plus progressed below:* ❖ STS from high box 3x10 ❖ Seated rows using RTB 3x10 ❖ Shoulder extension using RTB 3x10 B **Visit 6** *as previous added.* **Visit 7** *as previously added plus progressed below:* ❖ STS from low mat 3x6 ❖ Std. rows/shoulder ext. green theraband (GTB) 2x15 ❖ Std. hip abd. with yellow theraband (YTB) loop around ankles 2x10 and 1x10 no band ❖ Std. hip extension with 2# 2x10 with poor form, d/c from Tx **Visit 8** *as previously added plus progressed below:* ❖ STS from low mat 2x10 and 1x7	***Visit 5 added:*** o Std. B hip abd. with UE support 3x10 every other day ***Visit 8 added:*** o Std. hamstring curl with UE support 3x10 B every other day o Step ups on bottom step of staircase with railing assist 6" 3x10 B every

	❖ YTB lateral bandwalks with UE hand-held assist 25”x4 ❖ Std. hamstring curl 2x10 B 0# ❖ Std. chicken wings against foam roller 5” holds 10x each position ❖ Std. angels against foam roller 20x	other day o STS from kitchen chair 3x10 every other day o Chin tucks 5” hold 20x every day
Visit 9-16	**Visit 9 and 14** *Re-evaluations* **Visit 10, 11, 12** *as previously added* **Visit 13** a*s previously added plus progressed below:* ❖ STS from low back 3x10 ❖ Step ups 8” 3x6 B **Visit 15** *as previous added plus initiated/progressed below:* ❖ Step ups 8” 2x10 B ❖ Bridging 3x6 **Visit 16** *as previous added plus progressed below:* ❖ Step ups 8” 3x10 B ❖ Bridging 2x10 B	***Visit 9 added:*** o Std. rows and shoulder extensions using GTB 2x15 B o ***Visit 12 added:*** o Std. pec stretch in door way 30”x3 B o ***Visit 16 added:*** o Bridging 2x10

Appendix 1: Modified Oswestry Low Back Questionnaire

The Modified ODI was one of the outcome measures administered to the patient at initial evaluation. The patient was asked to circle that number that most accurately represents his symptoms. © Copyright 2015 http://www.the-rheumatologist.org/

Please read: This questionnaire is designed to enable us to understand how much your low back pain has affected your ability to manage your everyday activities. Please answer each section by circling the ONE CHOICE that most applies to you. We realize that you may feel that more than one statement may relate to you, but PLEASE, CIRCLE JUST THE ONE CHOICE THAT MOST CLOSELY DESCRIBES YOUR PROBLEM RIGHT NOW.

SECTION 1—Pain Intensity
1. The pain comes and goes and is very mild.
2. The pain is mild and does not vary much.
3. The pain comes and goes and is moderate.
4. The pain is moderate and does not vary much.
5. The pain comes and goes and is severe.
6. The pain is severe and does not vary much.

SECTION 2—Personal Care
1. I would not have to change my way of washing or dressing in order to avoid pain.
2. I do not normally change my way of washing or dressing even though it causes some pain.
3. Washing and dressing increase the pain, but I manage not to change my way of doing it.
4. Washing and dressing increase the pain, and I find it necessary to change my way of doing it.
5. Because of the pain, I am unable to do some washing and dressing without help.
6. Because of the pain I am unable to do any washing and dressing without help.

SECTION 3—Lifting
1. I can lift heavy weights without extra pain.
2. I can lift heavy weights, but it causes extra pain.
3. Pain prevents me from lifting heavy weights off the floor.
4. Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned (e.g., on a table).
5. Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned.
6. I can lift only very light weights, at the most.

SECTION 4—Walking
1. Pain does not prevent me from walking any distance.
2. Pain prevents me from walking more than one mile.
3. Pain prevents me from walking more than 1/2 mile.
4. Pain prevents me from walking more than 1/4 mile.
5. I can walk only while using a cane or on crutches.
6. I am in bed most of the time and have to crawl to the toilet.

SECTION 5—Sitting
1. I can sit in any chair as long as I like without pain.
2. I can sit only in my favorite chair as long as I like.
3. Pain prevents me from sitting more than one hour.
4. Pain prevents me from sitting more than 1/2 hour.
5. Pain prevents me from sitting more than 10 minutes.
6. Pain prevents me from sitting at all.

SECTION 6—Standing
1. I can stand as long as I want without pain.
2. I have some pain while standing but it does not increase with time.
3. I cannot stand for longer than one hour without increasing pain.
4. I cannot stand for longer than 1/2 hour without increasing pain.
5. I cannot stand for longer than 10 minutes without increasing pain.
6. I avoid standing, because it increases the pain straight away.

SECTION 7—Sleeping
1. I get no pain in bed.
2. I get pain in bed, but it does not prevent me from sleeping well.
3. Because of my pain, my normal night's sleep is reduced by less than 1/4.
4. Because of my pain, my normal night's sleep is reduced by less than 1/2.
5. Because of my pain, my normal night's sleep is reduced by less than 3/4.
6. Pain prevents me from sleeping at all.

SECTION 8—Social Life
1. My social life is normal and gives me no pain.
2. My social life is normal, but increases the degree of my pain.
3. Pain has no significant effect on my social life apart from limiting my more energetic interests (e.g., dancing, etc.).
4. Pain has restricted my social life, and I do not go out very often.
5. Pain has restricted my social life to my home.
6. I have hardly any social life because of the pain.

SECTION 9—Traveling
1. I get no pain while traveling.
2. I get some pain while traveling, but none of my usual forms of travel make it any worse.
3. I get extra pain while traveling, but it does not compel me to seek alternative forms of travel.
4. I get extra pain while traveling, which compels me to seek alternative forms of travel.
5. Pain restricts all forms of travel.
6. Pain prevents all forms of travel except that done lying down.

SECTION 10—Changing Degree of Pain
1. My pain is rapidly getting better.
2. My pain fluctuates, but overall is definitely getting better.
3. My pain seems to be getting better, but improvement is slow at present.
4. My pain is neither getting better nor worse.
5. My pain is gradually worsening.
6. My pain is rapidly worsening.

Comments _____

Patient's Signature _____ Date _____