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Utilizing Directional Preference and Lumbopelvic Mechanics Training in the Treatment of an Adult with Chronic Low Back Pain and Sacral Radiculopathy: A Case Report

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Abstract

Background: Directional preference and lumbopelvic mechanics training are two exercise interventions that have demonstrated beneficial effects in patients with chronic low back pain (LBP) and radiculopathy. Research is inconclusive on which intervention is preferred. This case highlights using both interventions to treat a patient with chronic LBP and sacral radiculopathy. **Case Description:** The patient was a 56-year-old male referred to an outpatient physical therapy clinic. On examination, the patient demonstrated radicular pain, plantar flexion weakness, absent left Achilles reflex and limited, painful trunk flexion. **Interventions:** Five physical therapy sessions involving primarily directional preference and lumbopelvic exercises were provided. Additionally, single limb plantar flexion strengthening and traction were trialed. **Outcome Measures:** The primary outcomes assessed were the patient-specific functional scale, numeric pain scale, strength testing, reflex testing and the slump test. After five treatments of physical therapy, the patient had a negative slump test and demonstrated improvement in pain, function and plantar flexion strength. However, he did not regain his Achilles reflex. **Discussion:** The patient had a variable progression through care, but ultimately demonstrated improvements with the combination of directional preference exercises, lumbopelvic mechanics training and an anti-inflammatory medication. Studies of physical therapy interventions have not been able to clearly identify which exercises are best for patients with chronic LBP. This case presents a practical example of successfully applying two different treatment approaches to address chronic LBP in conjunction with pharmacologic interventions.

Keywords: Low back pain; LBP; radiculopathy; exercise; orthopedics; neurology; physical therapy; rehabilitation

Background

Low back pain (LBP) is one of the most common and expensive health conditions in the United States. The incidence of LBP is estimated to be as high as 30%, and nearly 84% of adults may experience LBP in their lifetime[2, 21]. The majority of LBP cases resolve within 12 weeks[2]. Cases that become chronic, lasting 12 weeks or longer, are strongly associated with long-term missed work, disability and reduced quality of life[6]. Additionally, billions of healthcare dollars are spent on the management of LBP annually[20]. Given the magnitude of this problem, it is imperative that clinicians provide evidence-based care to manage chronic LBP.

LBP includes a spectrum of etiologies. The majority of LBP cases are labeled nonspecific, meaning an underlying physical cause for the patient's back pain has not been identified. Specific etiologies can include both skeletal and non-skeletal causes that range in severity[21], including lumbosacral radiculopathy. It is estimated that between 3 to 5 percent of adults will experience lumbosacral radiculopathy in their lifetime[9]. The most common causes of radiculopathy are disc herniation and spondylosis, resulting in damage to lumbar and/or sacral nerve roots. Other causes of radiculopathy include spondylolisthesis, spinal trauma, congenital abnormalities, tumors, infection, inflammation, vascular diseases and cauda equina syndrome[2, 9].

The clinical presentation of lumbosacral radiculopathy varies based on the nerve root affected. In the majority of cases, the L5 or S1 nerve root is damaged. This can produce symptoms like pain, sensory disturbances, weakness, and/or reflex changes[9]. These symptoms, as well as red flags for non-musculoskeletal causes of radiculopathy, can be assessed by patient examination. In some cases, additional diagnostic testing may be needed.

Treatment for lumbosacral radiculopathy depends on the duration of symptoms and underlying etiology[9]. For acute cases in which serious causes have been ruled out, initial treatment typically includes symptom management utilizing anti-inflammatory medication and activity modification[10]. Studies on physical therapy interventions for acute cases are inconclusive, and physical therapy is generally not recommended in the first two weeks[10]. Acute cases often resolve within 4 weeks regardless of intervention[10].

For patients with subacute or chronic LBP, non-pharmacological interventions that require active patient participation are recommended[3]. Options include education, self-care information, exercise, yoga, tai chi, cognitive-behavioral therapy, relaxation techniques and multidisciplinary care. This approach is consistent with a biopsychosocial model of care[3]. This report will focus on exercise treatments, specifically.

Evidence suggests that exercise may provide benefits for patients with chronic LBP[19]. The exact manner in which exercise benefits patients is unclear. Based on animal and human studies, it is theorized that exercise may alter nervous system processes involved in the experience of pain and produce beneficial effects on the musculoskeletal system leading to reduced pain and improved function[19]. Additionally, exercise has also demonstrated positive effects on psychological factors associated with chronic LBP, such as depression. However, it is unknown what type of exercise is best for patients with chronic LBP[19].

Two different exercise interventions that are often used to treat chronic LBP include directional preference exercises and lumbopelvic mechanics training[19]. Directional preference is a treatment that emphasizes exercise in a specific direction that causes symptoms to move toward the spine, or "centralize". Movements that cause pain to move away from the spine, or "peripheralize", are to be avoided[19]. For the purpose of this report, lumbopelvic mechanics training refers to core activation and spinal stabilization exercises with movement.

Numerous studies have examined the effectiveness of directional preference and lumbopelvic exercises, with some evidence supporting each in the treatment of chronic LBP[19]. Studies comparing the two interventions against each other have had mixed findings[8, 14]. Overall, no prevailing consensus exists to recommend one treatment over the other[19]. However, although not frequently discussed, the two treatments may not need to be mutually exclusive. Thus, the purpose of this case is to highlight the use of both directional preference and lumbopelvic mechanics training in the treatment of a patient with chronic LBP and sacral radiculopathy.

Case Description

A 56-year-old male presented to an outpatient physical therapy clinic with a referring diagnosis of chronic LBP with left-sided sciatica. His past medical history included essential hypertension. His past surgical history included right inguinal hernia repair, left shoulder arthroscopy and knee arthroscopy (unknown which side). Recently obtained radiographs demonstrated mild degenerative changes throughout the lumbar spine. He had also been prescribed Flexeril (a muscle relaxant) by his doctor.

The patient's chief complaint was left-sided LBP that radiated down his left lower extremity to his heel. These symptoms began five months earlier, after the patient bent forward and felt his lower back "pop". He rated his resting pain at 7 out of 10 on a numeric rating scale, and described it as sharp and shooting. Factors that increased the patient's pain included sitting and bending forward. Factors that decreased the patient's pain included ibuprofen and avoiding sitting. He was unsure if his Flexeril was helping, as he had just recently started taking it.

Previously, the patient had routinely received chiropractic treatment. He reported relief from chiropractic treatment for previous back problems, but not for his current low back and leg symptoms. This was the patient's first time receiving physical therapy for his back.

After gathering the patient's initial history information, a series of examinations were performed. First, we screened for serious red flags indicative of etiologies like cancer, infection or cauda equina syndrome. The patient denied having any fever, chills, bowel and bladder changes, unexplained weight loss or predominant night pain.

Physical Examination

First, we assessed sensation, muscle strength, reflexes and tissue bulk. Only left limb weakness and loss of reflexes were noted (see Table 1). We then assessed palpation tenderness, vertebral mobility, gait, posture, trunk motion, and special tests. The special tests included the straight-leg raise (SLR) and the slump test. The results of these assessments are provided in Table 2. Standardized survey assessments included the Oswestry Disability Index (ODI) and the Fear-Avoidance Beliefs Questionnaire (FABQ). Patient function was assessed using the Patient-Specific Functional Scale (PSFS). These results are provided in Table 3.

The main findings that guided care were a positive slump test, increased symptoms with lumbar flexion and relief with lumbar extension, weak and atrophied left gastrocnemius/soleus, absent left S1 reflex and a high FABQ-physical activity score. Interestingly, the SLR test was negative but the slump test was positive. In one study comparing the SLR to the slump test, the slump test was found to have greater sensitivity (0.84) than the SLR (0.52) in identifying patients with lumbar disc herniation. Conversely, the SLR was found to be marginally more specific (0.89) than the slump test (0.83)[15]. Despite a negative SLR, the rest of the examination was consistent with S1 radiculopathy possibly due to disc pathology. Additionally, the FABQ suggested the patient may have fear of physical activity[7]. Therefore, we wanted to design an intervention that would address the patient's symptoms using gradual exposure to exercise.

Table 1. Lower Extremity Examination

Assessment	Findings
Sensation	Light touch intact to bilateral lower extrmities.
Reflexes	-Patellar (L2-L4): present and symmetric -Achilles (S1): present on right; absent on left -Abnormal reflexes: Clonus and Babinski were negative bilaterally.
Muscle strength	-L2 Hip Flexion: 5/5 bilaterally -L3 Knee Extension: 5/5 on the right; 4/5 on the left -L4 Ankle Dorsiflexion: 5/5 bilaterally -L5 Great Toe Extension: 5/5 bilaterally -S1 Ankle Plantar Flexion: Performs 10 repetitions on right without difficulty. Performs 4 repetitions on the left leg. -Gluteus Medius Strength: 5/5 bilaterally
Tissue Bulk	Left gastrocnemius/soleus atrophy compared to right.

Note: S1 strength was assessed from number of repetitions of single limb plantar flexion. All other muscle tests were graded on a 0-5 scale (4 = moderate strength; 5 = full strength).

Table 2. Additional Physical Examination Results

Assessment	Findings
Palpation	-No tenderness to palpation of lumbar paraspinal tissues or vertebral bodies. -Palpation for mobility of lumbar vertebrae and sacrum graded normal.
Posture	Forward head, rounded shoulders, reduced lumbar lordosis
Gait	No deviations noted.
Trunk Motion	-Flexion limited and increases pain intensity and radiation. Limited hip hinge. -Extension WNL and relieves symptoms -Sidebending WNL
Special Tests	-SLR: negative on both sides -Slump Test: positive on left, negative on right

Table 3. Standardized Assessments and Patient Function

ODI	FABQ	PSFS
28/100	Physical activity subscale: 19/24 Work subscale: 0/20	Average: 4.7

Note: The ODI classified the patient as moderately disabled [17]. The FABQ suggested the patient may have fear of physical activity [7]. The PSFS average score was determined by finding the mean of the scores of three patient-identified functional limitations (sitting, putting socks on, and bending forward to feed pets).

Interventions

The primary interventions used were directional preference and lumbopelvic mechanics training. We started with three directional preference exercises and one lumbopelvic exercise on the first day of treatment, and progressed exercises during subsequent visits (see Table 4 for details). Additional interventions included single limb plantar flexion strengthening and traction. All interventions prescribed were guided by the patient's symptoms. Any exercises that increased the patient's pain or caused symptoms to peripheralize were avoided.

The first intervention utilized was directional preference exercise. The patient's directional preference was determined based on the trunk motion screen. With lumbar flexion, the patient's pain increased and his symptoms radiated down his left lower extremity below his knee (peripheralization). With lumbar extension, the patient's pain decreased and his symptoms centralized. Based on these findings, we determined lumbar extension to be the patient's directional preference. Initial exercises were then prescribed focusing on extension.

The second intervention utilized was lumbopelvic mechanics exercise. We prescribed these exercises based on the following findings. First, in addition to increased pain and peripheralization of symptoms, the patient was also noted to have limited hip motion with flexion. Second, the patient reported activities that involved forward bending aggravated his symptoms. Because forward bending is required for multiple daily activities (sitting, getting into and out of vehicles, picking up items, etc.), we wanted to train the patient to perform forward bending with better mechanics and without increasing pain. When instructed on ideal forward bending with emphasis on abdominal bracing and maintaining a neutral spine with a hip hinge strategy, the patient's pain did not increase or peripheralize.

We then prescribed specific exercises targeting core activation and spinal stabilization as lumbopelvic mechanics training. These included quadruped and hook lying movements in combination with abdominal bracing. While these exercises were technically more flexion-based, we ensured the patient performed each exercise with a neutral spine. We emphasized minimizing motion through the lumbar spine and instructed the patient to keep his spine stable as he moved his extremities.

Table 4. Physical therapy interventions by session.

Session	Interventions
1	-Directional preference exercises: prone lying, prone lying on elbows, prone hip extension. -Lumbopelvic mechanics: Instruction in forward bending.
2	-Quadruped progression: hip hinges, shoulder flexion, leg extension, combined contralateral leg extension and shoulder flexion. -Hook lying progression: heel slides, bent knee fallouts (hip external rotation with the knee bent), single-leg marching and double-leg marching. -Trialed lumbar mechanical traction. -Added single-limb plantar flexion strengthening.
3	-Directional preference: added prone press-ups. -Hook lying: added bridges. -Added self-traction technique with arms hanging from overhead support.
4	Reviewed and performed exercises from previous sessions
5	Reviewed and performed exercises from previous sessions and instructed in progression to general exercise program.

Exercises for both directional preference and lumbopelvic mechanics training are listed in Table 4 in order of complexity, with more challenging exercises prescribed in later visits. We used a combination of time-based and repetition-based exercise prescription. The time-based interventions included prone lying and prone lying on elbows. The patient was instructed to perform each of these for one minute, three times per day. He was also advised to move into these positions periodically throughout each day for symptom relief. We also instructed the patient to practice forward bending with abdominal bracing and a hip hinge anytime he needed to bend forward during his daily activities.

While lumbar mechanical traction was trialed for twenty minutes at session 2, the patient did not feel this intervention helped. However, the patient reported relief with self-traction, a technique we tried at session 3. He was advised to hold the position for ten to thirty seconds at a time and instructed that he could perform this self-traction technique throughout each day as he desired. This provided the patient with another method to potentially relieve his symptoms as needed.

All other exercises listed in Table 4 were repetition-based. The patient was instructed to try to complete ten repetitions of each exercise, two times per day. The only exception was single limb plantar flexion, which the patient was instructed to perform what he could tolerate, twice each day. Progression of these exercises was based on the patient's pain, technique and ability to complete the exercises. Exercises were only progressed when the patient could complete ten repetitions without increased pain, signs of peripheralization or loss of spinal stability during motion. As the patient progressed, some of the simpler exercises performed were removed and replaced with more challenging exercises.

Outcome Measures

The primary outcome measures used in this case were pain, the slump test, lower extremity reflex and muscle strength testing and the PSFS. We assessed pain using a numeric rating scale and the patient's subjective reports on the quality of his pain. Specifically, we examined the patient's pain intensity and assessed for signs of centralization. A numeric rating of resting pain was assessed on treatment day one, day three, day four and day five (see Table 5). As can be observed, the patient's pain rating fluctuated over time. His pain rating decreased between treatment day one and day three. His pain rating increased between day three and day four. However, from the fourth to the fifth visit, his pain decreased by 5 points (6 points overall since visit one). The minimal clinically important difference (MCID) for numeric pain rating in chronic LBP patients is 1.7 points[(16)]. This suggests the patient noticed a meaningful difference in his pain overall and only a marginally MCID increase in pain between visits 3 and 4. Although the patient's reports on pain intensity and its impact on function varied, he consistently reported signs of his pain centralizing (Table 5). For example, on treatment day one, his pain radiated down his left lower extremity to his heel. On treatment day two, he reported his pain radiated to his mid-calf. By treatment day five, he reported his pain was primarily localized to his back.

The slump test was used to further assess neural irritation and signs of centralization. The SLR was not used because it was negative on treatment day one. However, it would have been beneficial to compare the SLR to the slump test throughout treatment. The slump test was assessed at every treatment. The test was considered positive when the patient's pain radiated below his knee. The test was considered negative when the patient's pain did not radiate below his knee. During treatments one through four, the slump test was positive. On the fifth treatment, the slump test was negative, indicating the patient had less neural irritation.

The patient's subjective reports on his perceived change in pain also fluctuated throughout treatment. Some days, he reported his pain was improved; other days, he reported his pain was debilitating. Because of his variable response to therapy, an MRI was obtained and epidural injection was considered. The MRI confirmed a left paracentral disc bulge and mild S1 nerve root damage. Ultimately, he decided to forego epidural injection due to his symptoms improving.

Table 5. Self-reported pain metrics by visit.

	Visit 1	**Visit 2**	**Visit 3**	**Visit 4**	**Visit 5**
Pain Intensity (0 – 10 NPR scale)	7	-	4	6	1
Most distal pain location	L heel	L mid-calf	-	-	Mid-back
Pain past knee with slump test	+	+	+	+	-

NPR =Numeric pain rating; Note: not all pain variables were recorded at every visit.

In addition to the slump test, muscle strength and reflex testing were also re-assessed. Of primary interest were left plantar flexion strength and the left S1 reflex. On treatment day one, the patient was only able to perform four repetitions of single limb plantar flexion. By treatment day five, he was able to perform ten repetitions with minimal difficulty. While plantar flexion strength appeared to improve, the left S1 reflex was absent throughout treatment.

The degree of the patient's improvement in daily function was assessed by the PSFS. On treatment day one, the patient's average PSFS score was 4.7. On treatment day five, the patient's average PSFS score was 8. For low back pain, the minimal detectable change (MDC) is 1.4 points. The patient's score improved 3.3 points, indicating he had meaningful improvements in function(18).

The ODI, FABQ and trunk motion were assessed on initial examination but not at discharge. On initial examination, the ODI categorized the patient as moderately disabled(17); the FABQ suggested that the patient may have fear-avoidance of physical activity(7); and trunk flexion was limited and caused radiating pain. Collecting this information at discharge would have helped further assess the patient's progress with treatment.

Overall, the patient did not have a smooth progression. His symptoms and function fluctuated treatment to treatment. Because of this, alternate medical interventions were considered. Ultimately, the patient reported improvement by the fifth visit, with the combination of naproxen sodium and his rehabilitation exercises. He determined he was ready for discharge and we provided him guidance on progressing to a general exercise program consisting of physioball and cardiovascular exercises.

Discussion

This case describes the combination of directional preference and lumbopelvic mechanics training to treat a patient with chronic LBP and S1 radiculopathy. Directional preference exercises focused on lumbar extension. Lumbopelvic mechanics training focused on core activation and spinal stabilization exercises with movement, including some involving trunk flexion. These two interventions may appear to conflict with each other, as the directional preference exercises were extension-based and the lumbopelvic exercises were more flexion-based. However, during lumbopelvic exercises, we emphasized maintaining a neutral, stable spine. Additionally, all treatment was guided by the patient's symptoms. None of the interventions utilized caused the patient's pain to increase or peripheralize during treatment sessions. Although the patient had variable progression throughout care, he reported and demonstrated overall findings of improved pain, strength and function after five treatments.

Previous studies have provided support for using directional preference or lumbopelvic exercises to treat patients with LBP(19). In one study examining patients that exhibited directional preference, directional preference exercises resulted in greater improvements in pain and function than exercises performed in the opposite direction(13). In another study looking at patients with sciatica, directional exercise resulted in improved pain and reduced neural irritation(4).

In addition to directional preference exercise, lumbopelvic exercises have also demonstrated positive effects on LBP and sciatica. In one study, core stabilization exercises resulted in improved pain and strength and decreased neural irritation in patients with sciatica(5). In another study, stabilization exercises were demonstrated to improve pain and function in patients with chronic LBP(12).

While evidence supports the use of both methods, studies comparing the two techniques have been inconsistent(8, 14). In one study involving patients with chronic LBP, stabilization exercises resulted in improved pain and function compared to directional exercises(8). However, in a systematic review of three different studies, the opposite was found(14). One favored directional preference for short-term function yet found no differences in pain. A second study favored directional preference for pain but found no differences in function. A third study found no significant differences in function between treatment groups, but did not assess pain(14).

These observed inconsistencies in research findings have been attributed to heterogeneous studies. Studies examining exercise and LBP have included patients with varying durations of symptoms and different etiologies. Additionally, definitions of each intervention and intervention parameters have also varied[2]. Overall, there is no consensus on which treatment is preferred. Additionally, when compared to other forms of exercise, neither directional preference nor lumbopelvic exercises have been found to be more effective[19].

Because of these inconsistencies, there have been classification systems developed to subgroup patients who may respond better to a particular therapy. One classification system is the mechanical diagnosis and therapy classification model, which capitalizes on directional preference. Other classification systems include the movement system impairment syndromes model (MSI), the mechanism-based classification system (MBC) and the treatment-based classification system (TBC)[2]. The TBC incorporates directional preference and core stabilization under different subgroups depending on the patient's presentation. Additionally, the TBC incorporates clinical prediction rules for patients likely to respond to stabilization exercises[2]. There has been some evidence that these approaches may improve clinical outcomes[2]. However, research in this area is conflicting as well[19]. Further research may elucidate approaches that show more consistency with subgroup-specific interventions.

Patients with chronic LBP, regardless of etiology, can be challenging to treat, and their progression with physical therapy may vary. As of now, research has not demonstrated one form of exercise therapy to be clearly better for patients with chronic LBP than other forms of exercise therapy[19]. Additionally, evidence is inconclusive on whether exercise is better than certain non-exercise therapies, including mindfulness-based stress reduction and acupuncture[20]. However, research has demonstrated that certain interventions, including education and manual therapy, may provide added benefit when combined with exercise[20].

Physical therapists may use multiple interventions to treat patients with chronic LBP, as opposed to choosing only one technique. This case demonstrates an example in which a patient demonstrated improved pain and outcomes with two different exercise interventions, that could be considered to be based on opposing strategies. However, the rationale for using both directional preference and lumbopelvic mechanics training was centered on reducing patient symptoms while training the patient to apply improved core stabilization when trunk flexion is necessary. During functional tasks it is not likely a patient can universally avoid one direction of trunk motion. Thus, the combined use of core stabilization with directional preference was applied. This case example demonstrates that one form of exercise therapy does not have to be used in isolation. Ultimately, clinicians should use their clinical judgment, as well as the patient's input and needs, to determine the best course of care.

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