Physiotherapy Theory and Practice, 21(3):181–196, 2005

ISSN: 0959-3985 print/1521-0510 online
DOI: 10.1080/09593980500212987

Taylor & Francis
Taylor & Francis Group

Classification, treatment and outcomes of a patient with lumbar extension syndrome

Marcie Harris-Hayes, PT, DPT, OCS,[1] Linda R. Van Dillen, PhD, PT,[2] and Shirley A. Sahrmann, PhD, PT, FAPTA[3]

[1]*Assistant Professor, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO, USA*

[2]*Assistant Professor, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO, USA*

[3]*Professor and Associate Director for Doctoral Studies, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO, USA*

The purpose of the current report is to describe the classification, treatment, and outcomes of a patient with lumbar extension syndrome. The patient was a 40-year-old female with an 18-month history of mechanical low back pain (LBP). The patient reported a history of daily, intermittent pain (mean intensity of 9/10) that limited her ability to sit, stand, walk, and sleep, as well as perform work-related activities. Symptom-provoking movement and alignment impairments associated with the direction of lumbar extension were identified and modification of these impairments consistently resulted in a decrease in pain. Treatment was provided in 3 sessions over a 2-month period. Priority of treatment was to train the patient to restrict lumbar extension-related alignments and movements during symptom-provoking functional activities. Exercises to address the extension-related impairments also were prescribed. The primary change in outcome was a decrease in the mean intensity (2 months: 2/10; 6 months: 1/10) and frequency of pain (2 months: decreased pain with standing and walking; 6 months: additional decrease with sitting, standing and walking). She also reported a decreased duration and number of LBP episodes. Classification directed treatment resulted in improvement in short and long term impairment and functional-level outcomes.

Background

Low back pain (LBP) is one of the most common musculoskeletal pain complaints reported by people seeking healthcare (Jette, 1994; Lawrence et al, 1998). Despite technological advances and increased knowledge in the area of LBP, treatment continues to be a challenge. Some have proposed that the lack of consistent evidence to support nonsurgical interventions may be due to the use of heterogeneous study populations for comparison (Leboeuf-Yde, Lauristen, and Lauristen, 1997; Spitzer, 1987). A number of classification systems for use by physical therapists have been described in the literature (Delitto, Erhard, and Bowling, 1995; DeRosa and Porterfield, 1992; McKenzie, 1998; Riddle, 1998; Sahrmann, 2002; Van Dillen

Accepted for publication 14 September 2004.

This study was approved by the Human Studies Committee of Washington University Medical School, and funded in part by the National Institutes of Health, National Institute of Child Health and Human Development, National Center for Medical Rehabilitation Research, Grant #5-K01HD-01226-01A1.

Address correspondence to Marcie Harris Hayes, 4444 Forest Park Blvd., Box 8502, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO 63108, USA. E-mail: harrisma@msnotes.wustl.edu

et al, 1998). At this time, however, there is no consensus regarding the most acceptable system (Riddle DL, 1998).

Recently, an expert-based classification system, the Movement System Impairment Classification System for Low Back Pain (MSI) has been described and is currently being studied (Sahrmann, 2002; Van Dillen et al, 1998; Van Dillen et al, 2003a; Van Dillen et al, 2003b). The MSI classification is proposed to guide the treatment of LBP problems. In the MSI scheme the classification labels describe the specific directions of spinal alignment and movement proposed to contribute to the person's LBP problem. The classification labels include lumbar extension, lumbar flexion, lumbar rotation, lumbar rotation with flexion, and lumbar rotation with extension. A summary of the signs and symptoms associated with each classification is provided in Table 1 (Sahrmann, 2002; Van Dillen et al, 1998; Van Dillen et al, 2003b).

The theory underlying the MSI approach to LBP proposes that mechanical LBP is the result of a predisposition of the lumbar spine to move in a specific direction with movements of the trunk or limbs. This predisposition is proposed to be a consequence of repeated use of alignment and movement strategies in specific directions with functional activities. The repetition of direction-specific strategies contributes to changes in passive elements, for example muscle tissue and active elements, for example timing and force production of muscle. These changes are evident on examination as physical impairments. The exposure of spinal tissue to repeated loading in the same direction is proposed to contribute to cumulative tissue stress, microtrauma, and eventually LBP. The theory also contends that until the factors contributing to the use of the direction-specific alignment and movement strategies are modified, the LBP problem will persist or recur.

A standardized examination, based on the assumptions of the MSI theory is used to examine the patient with LBP (Maluf, Sahrmann, and Van Dillen, 2000; Sahrmann, 2002; Van Dillen et al, 1998; Van Dillen et al, 2003a; Van Dillen et al, 2003b). The focus of the examination is to identify the direction-specific alignment and movement strategies and associated impairments that consistently increase and decrease the patient's symptoms. The examination includes 1) assessment of symptoms with tests of movements and positions proposed to impose direction-specific (flexion, extension, rotation) stresses on the lumbar region, 2) judgments of alignment and movement in various positions, and 3) measurements of physical impairments such as joint flexibility and muscle performance. Similar to other examinations for LBP, the examination includes tests of symptoms with various trunk movements. Different from other examinations for LBP, the examination includes tests to assess the effect of limb movements on symptoms and the effect of modifying the lumbar spine alignment or restricting lumbar spine movement during previously symptomatic tests. The classification is named according to the direction-specific movements and alignments that appear to contribute to the individual's symptoms. Information from examiner judgments of movement and alignment are also considered in confirming the direction-specific classification.

The emphasis of treatment is modifying symptom-provoking functional activities in which the person uses his direction-specific strategies. In addition, therapeutic exercise is prescribed to address physical impairments such as decreased abdominal strength that are considered to contribute to the movement system impairment.

The purpose of the current report is to describe 1) the use of an examination to identify the movement-system classification of a patient with chronic LBP (Sahrmann, 2002), 2) how the patient's LBP classification directed treatment, and 3) outcomes related to symptoms and function.

Patient examination

History

The patient was a 40-year-old woman referred to a University-based outpatient physical therapy facility with a medical diagnosis provided by her physiatrist, of lumbar spine segmental dysfunction and left sacroiliac joint pain. Informed consent was obtained and the rights of the human subject were protected. Her radiology report described findings of spina

Table 1. Mechanical low back pain classifications with associated signs and symptoms (Maluf, Sahrmann, and Van Dillen, 2000; Sahrmann, 2002).

Category	Associated signs and symptom behavior
Extension	Tendency for the lumbar spine to move in the direction of extension with movements of the spine and extremities Lumbar spine alignment tends to be extended relative to neutral[a] with the assumption of postures (ie standing, sitting, supine, side lying, prone, quadruped). Symptoms increase or are produced with the lumbar spine positioned or moved into extension. Symptoms decrease or are eliminated with restriction of lumbar extension.[b]
Flexion	Signs and symptoms are similar to those described for extension except that they occur with flexion.
Rotation	Tendency for the lumber spine to move in the direction of rotation with movement of the spine and extremities. Lumbar spine alignment tends to be rotated relative to neutral with the assumption of postures. Symptoms (often unilateral) increase or are produced with the lumbar spine positioned or moved into rotation. Symptoms decrease or are eliminated with restriction of lumbar rotation.
Rotation with flexion	Tendency for the lumbar spine to move in the direction of rotation and flexion with movement of the spine and extremities. Lumbar spine alignment tends to be flexed and rotated relative to neutral with the assumption of postures. Symptoms (often unilateral) increase or are produced with the lumbar spine positioned or moved into rotation and flexion. Symptoms decrease or are eliminated with restriction of lumbar rotation and flexion.
Rotation with extension	Signs and symptoms are similar to those described for rotation with flexion except that they occur with rotation and extension.

[a]"Neutral" is defined as the position of the lumbar spine at which an inclinometer centered over each lumbar spinous process would result in a measure of 0°, without rotation or side bending of any of the lumbar vertebrae (Van Dillen et al, 1998).
[b]Restriction of spinal motions and alignments is accomplished using verbal cues, active stabilization by the patient, and manual stabilization by the examiner.

bifida occulta at L5 with a large left transverse process of L5 articulating with the superior aspect of the sacrum.

The patient reported a 12-year history of LBP that began with her first pregnancy. Previous medical treatment for her LBP included 1) two corticosteroid injections to the lumbar region, 2) anti-inflammatory medications that included Daypro (600 mg twice daily), Celebrex (600 mg daily), Vicodin (5 mg in 500 mg of Tylenol, 1–2 tablets every 4 hours as needed), and 3) physical therapy that included exercise and iontophoresis. She reported no change in pain with these interventions. The patient also reported a history of multiple abdominal surgeries that included: 1) one cesarean section, 2) laparoscopies for a right and left ectopic pregnancy, and 3) a hysterectomy. Medications at the time of the initial physical therapy examination in our clinic included Tylenol with

codeine (1–2 tablets at bedtime) and ibuprofen (600 mg, 4 times daily). The patient was employed full-time as a physical therapist assistant in a hospital setting and part-time in home health. Her job required transferring patients who often needed moderate assistance. The patient worked three 12-hour shifts per week. The patient's height was 152.4 cm and her weight was 72.6 kg. She was married and had one child. The patient denied use of tobacco, alcohol, or illegal drugs, as well as involvement in litigation or a worker's-compensation claim.

The patient began seeking medical treatment for her current episode of LBP 18 months prior to her initial visit to our facility. At initiation in our clinic, the patient was in a flare-up of her chronic LBP problem (Von Korff, 1994). The patient reported daily, intermittent symptoms of aching and burning pain located in the left lumbar region (Spitzer, 1987). The patient was asked to rate the pain that she experienced during the previous week using an 11-point numerical scale (0–10; Bolton, 1999; Strong, Ashton, and Chant, 1991). Her average pain, as well as her worst pain intensity in the previous week was 9/10. She reported an increase in pain intensity with standing >10 minutes, walking >30 minutes, and sitting >1 hour (Delitto, Erhard, and Bowling, 1995). Work-related activities, particularly transferring patients, also increased her pain. Pain interrupted her sleep a minimum of 4 times per night. Other activities that increased her pain included 1) sitting on bleachers to watch basketball, and 2) prolonged standing when chaperoning dances at her son's school. The patient reported that her pain was decreased with positions of increased lumbar flexion, such as bending forward in standing and right side lying with her hips and knees maximally flexed.

Physical examination

In order to classify the patient's LBP problem, the first author performed a standardized examination (Sahrmann, 2002). Testing of the reliability of examiners performing physical tests and measures from the examination has been reported (Van Dillen et al, 1998). Reliability for symptom items was excellent (kappa = .89–1.00; percentage of agreement 97–100%; Van Dillen, 1998: 50). Reliability for judgments of alignment or movement was fair or good (kappa = .43–.78; percentage of agreement 65–95%; Sheehy, 1998: 118). The examiners were also able to classify a patient's LBP problem with a fair level of reliability (kappa = .59; percentage of agreement = 79%; Norton, Sahrmann, and Van Dillen, 2004). The examination included tests of symptoms, as well as judgments of alignments and movements across various positions. The patient was asked to assume a test position or perform a movement using her preferred strategy and report her pain relative to some reference position or movement. The tester also made a judgment of the alignment or movement of the lumbar spine with the test. Operational definitions for the possible symptom responses are provided in Appendix A. If the patient experienced an increase in pain with a test, the test was repeated modifying her preferred alignment or movement strategy. The modification was achieved by active stabilization by the patient and manual stabilization provided by the examiner. The patient then reported her pain with the modified test relative to pain with the previous test. The examination required between 30–45 minutes to administer. Examination findings of the patient are presented in Table 2. Of note is the consistent report of increased pain with tests associated with lumbar extension and decreased pain when those tests were modified to 1) restrict lumbar extension movement, or 2) align the lumbar spine in neutral.

The first author also examined the patient's extensibility and muscle performance during the examination to determine the factors that appeared to contribute to the patient's LBP problem (Sahrmann, 2002). The patient displayed decreased extensibility of the iliopsoas, tensor fascia lata, and rectus femoris muscles bilaterally. She also displayed difficulty stabilizing the lumbopelvic region with lower extremity strength and extensibility testing, potentially indicating decreased ability to recruit the abdominals or decreased stiffness of the lumbar spine region. The patient also demonstrated decreased function of the posterior gluteus medius bilaterally. During performance of the manual muscle test of the posterior gluteus medius, the examiner noted substitution using the hip flexors. Hip flexor substitution was thought

Table 2. Positive findings from standardized examination.

Test item	Test response	Associated direction of alignment or movement
Standing		
Alignment	[a]↑Lumbar extension, ↑anterior pelvic tilt with hip flexion, ↑symmetrical paraspinal hypertrophy LBP 7/10	Extension
Modified[b] alignment	Decreased lumbar extension [c]↓LBP	Extension
Return from forward bending	Initiated movement with lumbar extension ↑LBP	Extension
Modified return from forward bending	Prevent lumbar extension and increase extension at the hip joints ↓LBP	Extension
Standing lumbar extension	↑Extension across L4-L5 region ↑LBP	Extension
Sitting		
Alignment	Lumbar extension LBP 7/10	Extension
Sitting with lumbar spine flexed	↓LBP	Extension
Sitting		
Hip flexion	Lumbar rotation	Rotation
Supine		
Supine with hips and knees flexed	↓LBP	Extension
Active hip and knee flexion–unilateral	↓Lumbar extension at end range of hip flexion ↓LBP at the end range of hip flexion	Extension
Active hip and knee extension from hook lying position–unilateral	Lumbar extension at end range of hip extension ↑LBP	Extension
Modified active knee extension from hook lying position–unilateral	↓Lumbar extension resulted in ↓limited hip extension ↓LBP	Extension
Side Lying		
Alignment	Lumbar extension and side bending LBP 7/10	Extension, Rotation
Modified alignment	↓Lumbar extension ↓LBP	Extension

(*Continued*)

Table 2. Continued.

Test item	Test response	Associated direction of alignment or movement
Prone		
Alignment	Lumbar extension ↑LBP	Extension
Modified alignment	↓Lumbar extension ↓LBP	Extension
Prone active knee flexion	Lumbar extension with anterior pelvic tilt ↑LBP	Extension
Modified prone active knee flexion	↓Lumbar extension ↓LBP	
Quadruped		
Alignment	Flat lumbar spine ↓LBP	
Quadruped rocking backward	↓LBP	

[a] ↑ = increased.
[b] Modified test items = If the patient experienced an increase in pain with a test, the test was repeated modifying her preferred alignment or movement strategy. The modification was achieved by active stabilization by the patient and manual stabilization provided by the examiner.
[c] ↓ = decreased.

to be present when the lower extremity being tested moved from the desired test position into a position of increased hip flexion (Kendall, McCreary, and Provance, 1993).

Excessive use of the hip flexors and the paraspinal muscles also was observed throughout the examination as the patient moved or aligned herself using her preferred strategy. For example, the patient would sit at the edge of her chair, tilt her pelvis anteriorly and extend her lumbar spine. This method, which presumably required sustained contraction of the hip flexor and paraspinal muscles, was associated with an increase in LBP. The physical impairments noted during the examination appeared to be reinforcing the movement and alignment strategies of lumbar extension the patient demonstrated across the examination.

Symptom-provoking functional activities also were assessed. For example, the patient was observed performing a functional activity, such as moving from sit to stand, using her preferred movement strategy and symptoms were recorded. The examiner judged the movement strategy used. If the patient reported an increase in pain, the item was considered positive. The patient then was instructed to perform the same activity with modifications to prevent extension during the activity. The positive item was confirmed if the patient reported a decrease in pain with the modifications.

During assessment of functional activities, the patient demonstrated a consistent strategy of increased lumbar extension. While sitting, the patient's short stature prevented her feet from resting on the floor. Her preferred method was to sit at the edge of the chair positioning her pelvis in an anterior tilt in an attempt to achieve "good posture." She reported that she tried to maintain this posture throughout all of her activities. The examiner observed, however, that her perceived 'good posture' was actually a position of exaggerated lumbar extension.

The patient also demonstrated an increase in lumbar extension with activities such as sit to stand, standing, raising arms overhead, and simulated patient transfers. The patient reported an increase in pain with performance of each of these activities. With modification of each activity to restrict extension of the lumbar spine, the patient reported that her pain was decreased.

Classification based on results of physical examination

The patient's signs and symptoms were consistent with the classification of lumbar extension syndrome. Data providing some evidence for the validity of the lumbar extension category has been reported previously (Van Dillen et al, 2003b). Sustained alignments and repeated movements of lumbar extension resulted in increased pain in the left lumbar region during the examination as well as with functional activities. Restriction of lumbar extension during the examination and with functional activities resulted in decreased symptoms. The patient also reported decreased pain with flexion related positions. Together these findings support her classification. Physical impairments considered to contribute to her preferred strategies indicated 1) short hip flexor muscles, 2) decreased performance of abdominal and gluteal muscles bilaterally, and 3) excessive use of hip flexor and paraspinal muscles with functional activities.

Treatment

Treatment was provided in 3 sessions over a 2-month period. Because the patient's physical therapy classification was lumbar extension, the emphasis of her program was on training the patient to restrict lumbar extension alignments and movements during symptom-provoking functional activities. In addition, exercises were prescribed that emphasized correcting the specific alignment and movement strategies identified in the examination, and addressing physical impairments of muscle length and strength of the trunk and pelvic girdle muscles proposed to be contributing to the patient's preferred strategies.

Functional training

The patient was educated regarding her LBP classification, and specific instruction then was given to the patient regarding her functional activities. A summary of the instructions is listed in Table 3. Emphasis was placed on discouraging lumbar extension movements and alignments during functional activities. The activities addressed included those that the patient had reported as symptomatic, such as sitting and walking. The patient was first instructed in the proper abdominal contraction to decrease extension of the lumbar spine. She was instructed to 'easily pull in your abdominals and reduce the curve in your low back.' In addition, to discourage her preferred lumbar extension alignment with sitting, the patient was given the suggestion to decrease the height of her chair at work so that her feet could reach the floor or to use a footstool to support her feet.

The patient also was instructed in methods to provide pain relief throughout the day. For example, to decrease compression loading on the lumbar spine and relax the paraspinal muscles while sitting, she was instructed to push on the armrests of the chair with her hands. We have found this method of decompression to be helpful for patients when traction appears to reduce pain. Patients are able to perform the decompression maneuver frequently throughout the day, with the goal of reducing compressive loading on the tissues in the lumbar spine region. The patient also decreased her home health workload to 1 patient visit, every 2 weeks.

Home exercise program

The patient was instructed in specific exercises to address physical impairments that appeared to contribute to her LBP problem. The exercise components consisted of practice in the performance of modified versions of movement and alignment tests from the physical examination that resulted in a decrease in pain. Exercises were modified in follow-up visits based on accuracy of performance or complaints of a worsening of pain during or after exercise. The patient also

Table 3. Classification-specific instructions for functional activity modification.

Activity	Do	Do Not
Alignment in all positions	Contract abdominals to support the low back	Tilt pelvis posteriorly Increase flexion of the thoracic spine
Sitting	Support the low back by using back of chair Put stool under feet Knees should be positioned above the hips Keep shoulders aligned over hips Relax back when sitting without back support	Sit at the edge of chair and arch (extend) your low back Use a lumbar roll when sitting
Standing	Stand with the feet apart to increase base of support With prolonged standing, place 1 foot on a stool; alternate feet	Arch (extend) low back
Painting overhead	Limit distance that arms are lifted overhead Use tools with long handles Use a step stool	Arch (extend) the low back when reaching overhead
Forward bending/return from forward bending	Flex the hips and maintain a neutral spine while bending forward Extend the hips and maintain neutral spine with return from forward bending	Arch (extend) the low back with return from forward bending
Sit to Stand	Slide to the front of the chair Use legs to push up from the chair Extend the hips to come to the upright position	Stand from the back of the chair Allow the shoulders to be aligned behind the hips Arch (extend) the low back when coming to the upright position
Patient Transfers	Limit the number of transfers performed throughout the day Keep patient close to body Prior to and during the lift, contract abdominals	Arch (extend) the low back during transfer
Sleeping position	Side lying Flex hips and knees towards chest Supine Place pillows under the knees to decrease potential stress induced by stiff hip flexors on the low back	Assume a prolonged position of lumbar extension
Ambulation	Contract the abdominals Take smaller steps to decrease extension of low back	

was given guidance for exercise progression. Exercises given during the first visit included 1) standing forward bending, 2) standing hip and knee flexion and extension while sliding along a wall, 3) heel sliding in supine, 4) hip lateral rotation and abduction in side lying, and 5) rocking backward in quadruped. During the second visit, the exercise program was reviewed and the heel sliding exercise while passively holding one knee to chest, was added to her program. On her third and final visit, the patient was instructed in progression of her exercise program. Additional exercises provided at the final visit included 1) sitting against the wall and performing shoulder flexion, progressing to standing shoulder flexion, 2) supine with shoulders supported in flexion overhead and sliding the lower extremities into extension one at a time, and 3) knee flexion in prone over 2 pillows (Sahrmann, 2002). The overall goal of the exercises prescribed was to decrease her preferred strategy of extending the lumbar spine during extremity and trunk movements. Table 4 contains the specific details of the initial home exercise program and Figures 1–9 illustrate the exercises prescribed. The patient was warned that she should not experience an increase in her pain during or after performance of any exercise. If she was unable to perform an exercise without an increase in her pain, she was to discontinue the exercise until she consulted her therapist. The patient was supplied with handouts that included illustrations with written instructions for proper performance of the exercises.

Medical treatment

Prior to her final visit, the patient's physiatrist prescribed nortriptyline, a tricyclic antidepressant. When taken in low doses, nortriptyline has been proven to be effective for relieving pain experienced by patients with chronic pain (Atkinson, Slater, and Williams, 1998). The patient began taking 25 mg once daily for 2 weeks, and then increased the dosage to 25 mg twice daily for 3 months. She then took a tapering dose of nortriptyline. Approximately 3 1/2 months after discharge from physical therapy, she required no pain medication. Five months after discharge from physical therapy, she experienced an unrelated episode of foot pain and was prescribed 25 mg of Vioxx 1 × /day. Vioxx is an anti-inflammatory agent used in the treatment of the symptoms of osteoarthritis and rheumatoid arthritis (Day, Morrison, and Armando, 2000). The timeline of medication prescription is provided in Table 5.

Outcomes

The patient was seen 3 times over the course of 2 months. The patient also was contacted by phone throughout the initial 2 months and again at 6 months after her final visit. Patient outcomes are presented in Table 5. Overall, the patient's primary change in outcome was a decrease in the intensity and frequency of her LBP. The average intensity ratings were as follows: 1) 9/10 at initial visit, 2) 2/10 at 2 months, and 3) 1/10 at 6 months. The patient reported decreased pain with standing and walking at 2 months and additional decreases in pain with sitting, standing, and walking at 6 months. Furthermore, the patient reported uninterrupted sleep and decreased duration and number of LBP episodes at 6 months.

Discussion

The patient reported a number of improvements in functional activities and a decrease in pain after 3 physical therapy visits. Because this is a case report we cannot conclude that another treatment approach would not have achieved similar outcomes. The patient, however, had received a previous course of physical therapy, including nonspecific exercise and iontophoresis that did not provide significant relief. She also reported no significant relief with corticosteroid injections and various medications administered prior to being treated in our facility.

A causal relationship cannot be inferred based on a case report alone. Other factors were present that may have been associated with improvement in the patient's pain. In particular, our patient initiated a new medication, nortriptyline, 8 days following her second physical therapy visit, which might have been responsible for the pain relief that she experienced. We propose, however, that the medication provided

Table 4. Classification-specific intervention: exercise descriptions and patient-specific instructions.

Visit	Exercise description	Patient-specific instructions
1 (initial)	Standing forward bending. (Figure 1) Stand facing a table with feet positioned comfortably apart. Place your hands on the table putting the weight of your trunk into your hands. Bend forward in the hip joints keeping your back straight. Bend only as far as you can without reproducing pain or arching your back. Return to standing.	Pull in your abdominals. With forward bending and with return from forward bending, be sure to move at your hips. Do not arch your back. Perform 4–5 repetitions, 3–4 times per day.
	Standing hip and knee flexion and extension sliding along the wall. (Figure 2) Stand with your back against a wall, feet positioned comfortably apart, and heels about 4" from the wall. Slide down the wall by bending at your knees until your back is flat against the wall. Pull in your abdominals and hold them in as you slide up the wall by straightening the knees.	Do not arch your back when you slide up the wall. Perform 4–5 repetitions, 3–4 times per day.
	Heel sliding in supine. (Figure 3) Lie on your back with your hips and knees bent and your feet on the floor. Pull in your abdominals and slide one leg down. Do not let your back arch. Slide the leg back to the starting position. Repeat with the opposite leg.	Pull in your abdominals. Keep the heel in contact with the surface. Do not let your back arch as you slide the legs. Perform 10 repetitions, 1–2 times per day.
	Hip lateral rotation and abduction in side lying. (Figure 4) Lie on your side with the hips and knees bent. Rotate your top leg so that your knee turns upward. Move in the hip only. Do not let your pelvis move or your back arch.	In the initial position, place a small pillow under your side and be sure that your back is not arched. Pull in your abdominals. Do not let your back arch. Perform 10 repetitions, 1–2 times per day.

	Rocking backward in quadruped. (Figure 5) While quadruped with feet pointing away from the body, center hips over the knees. Position the hips at a 90° angle, spine straight, shoulders centered over the hands, and the head in line with the body. Rock back toward your heels by moving in the hip. Do not let you back arch upwards.	Keep your back straight and do not allow the upper back to arch upwards. Push back with your hands as you rock back on your heels. Perform 10 repetitions, 1–2 times per day.
2	Heel sliding in supine while passively holding one knee to chest. (Figure 6) Lie on your back with both hips and knees bent and feet resting on the floor. Pull in your abdominals and lift one knee toward your chest. Use your hand to hold your knee to your chest. Slide your other leg down straightening the hip and knee. Slide your leg back to the starting position while contracting your abdominal muscles. Repeat with the opposite leg.	Slide the leg only as far as you can without arching the back. Perform 10 repetitions, 1–2 times per day.
3	Shoulder flexion in sitting. (Figure 7) Sit with your back against the wall. Pull in your abdominals. Bring your arms overhead and try to bring your hands and arms back against the wall. Do not let your back pull away from the wall. Hold the position for 5 to 10 seconds.	Use the wall for feedback to position your back. Avoid arching the back during the arm movement. Perform 10 repetitions, 1–2 times per day.
3	Heel slide with arms overhead. (Figure 8) Lie on your back with both hips and knee bent, feet resting on the floor, and arms at your sides. Pull in your abdominals. Raise both arms overhead as far as possible. Slide one leg down while keeping the arms overhead and your back flat. Slide the opposite leg down. Maintain your arms overhead and your back flat.	Do not arch the back during movement of the arms or the legs. Perform 10 repetitions, 1–2 times per day.
	Knee flexion in prone. (Figure 9) In face lying with your legs straight and relatively close together. Pull in your abdominals and bend your knee. Do not let your pelvis move or your back arch. Return your leg to the starting position. Repeat with the opposite leg.	Place a pillow under the abdomen. Do not let the back arch during movement of the leg. Perform 10 repetitions, 1–2 times per day.

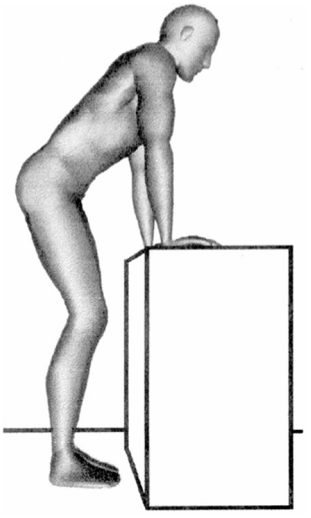

Figure 1. Standing forward bending.

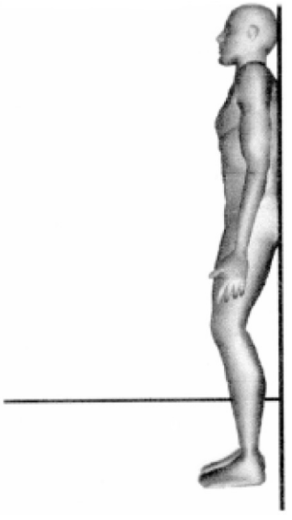

Figure 2. Standing hip and knee flexion and extension sliding along wall.

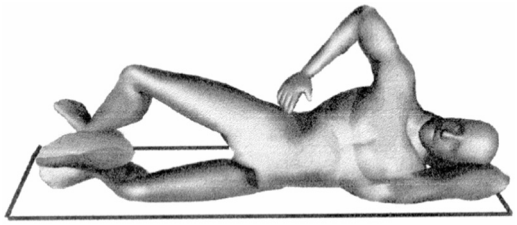

Figure 4. Hip lateral rotation and abduction in side lying.

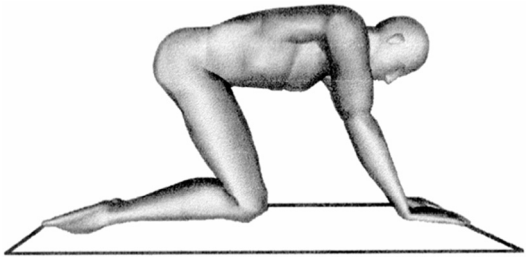

Figure 5. Rocking backward in quadruped.

only partial relief of her pain, because on her third visit, the patient reported that she experienced significant relief of her pain 6 days prior to the change in the medication. In addition, while on the nortriptyline, she reported increased pain with performance of activities that involved excessive lumbar extension, such as painting overhead and standing for prolonged periods of time. When these increases in pain occurred she reported use of her exercises to help alleviate her pain. We propose that the medication, nortryptiline was an important adjunct treatment that, combined with classification-directed treatment contributed to relief of her chronic pain, and the ability to independently manage her LBP problem.

The patient did not experience complete relief of symptoms during the treatment period or subsequent follow-up. The lack of complete and

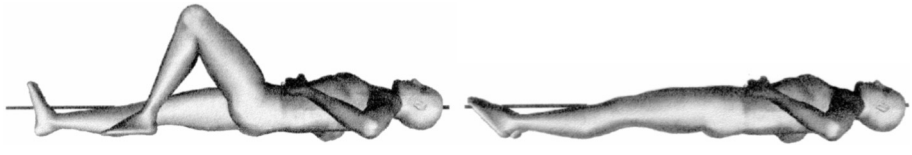

Figure 3. Heel sliding in supine.

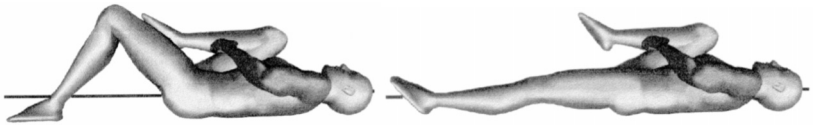

Figure 6. Heel sliding in supine while passively holding one knee to chest.

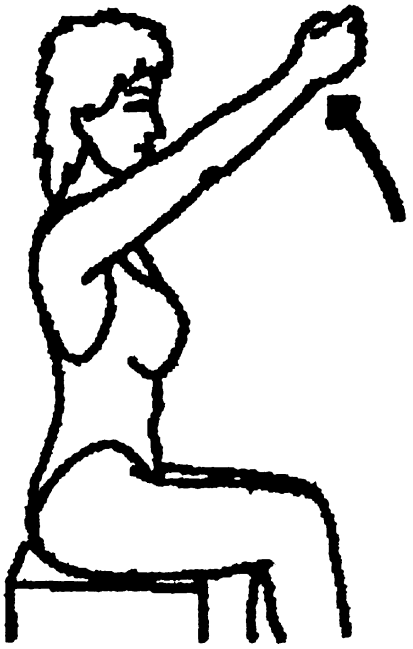

Figure 7. Shoulder flexion in sitting.

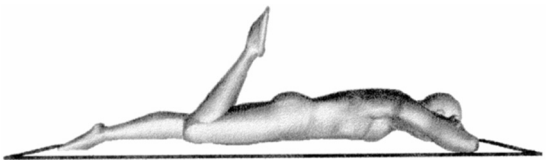

Figure 9. Knee flexion in prone.

lasting relief of her symptoms may have been the result of a number of factors. First, the patient was very active. She reported that she would often continue with an activity despite the fact that it would exacerbate her pain. It is our opinion that the presence of increased pain in such instances indicated possible tissue irritation. We propose that the ease with which her symptoms were exacerbated indicates that the patient could not remove the stresses from the already injured tissues in the lumbar region. Tissues that have been injured have a lower tolerance to tissue stress, and must be protected (Mueller and Maluf, 2002). The patient's reports of participating in activities that increased her pain make it likely that too much stress was being placed on the involved tissues too frequently and resulting in a delay of full recovery.

A second factor that potentially contributed to her lack of full relief of symptoms was the fact that the patient did not use her modification strategies during functional activities until her pain had increased. Further emphasis was placed on identifying the need for using the modification strategies before pain was increased however, she continued to have difficulty complying with these recommendations. We propose that the use of the activity modification before pain becomes apparent would help minimize tissue stress and promote healing. The patient also displayed some difficulty generalizing the information provided to her to other activities across her day. At the time of discharge, the patient appeared to be independent with the home program, however, she often

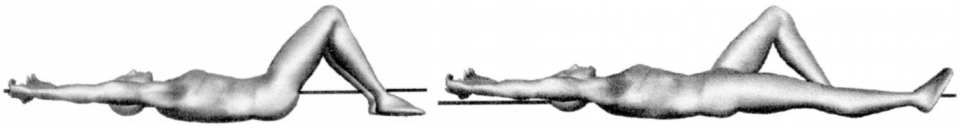

Figure 8. Heel slide with arms overhead.

Table 5. Patient outcomes and medications.

Data collection format	Time after initial visit (days)	Medications (dosage)	Pain behavior		Sleep interruption
			Average intensity*	frequency	
Examination Initial visit		• Tylenol with codeine (1–2 tablets/night)	9	Daily	4X/night
Phone call	8	• Ibuprofen daily (600 mg, 4X/day)	2	No Response Available	3X/week
Visit 2	18		7	No Response Available	4X/night
Medical Records	26	• Nortriptyline (25 mg 1X/day)			
Medical Records	40	• Nortriptyline	2	Daily	No Response
Visit 3	49	(25 mg 2X/day)			Available
Medical Records	74	• Nortriptyline (25 mg 1X/day)			
Medical Records	105	• No Medications being taken			
Medical Records	127	• Vioxx for foot pain	1	1/week	No
Phone call	198	(25 mg 1X/day)			interruptions

*Pain intensity based on an 11-point numerical rating scale (Bolton, 1999; Strong, Ashton, and Chant, 1991); 0 represents the absence of pain and 10 represents worst pain imaginable (Bolton, 1999).

required instruction to address correction of her daily activities. It is likely that her strategies were adopted over a long period of time and, thus, more instruction and practice may have been needed to improve the patient's ability to recognize the use of symptom-provoking strategies performed during all of her functional activities. We believe that further education might have assisted in achieving independence in pain management. Earlier, more frequent physical therapy visits, however, were not possible.

Finally, we propose that complete resolution of the patient's pain was additionally delayed by her structural alignment. The patient had a spina bifida occulta that may also have contributed to her LBP problem. Studies have shown a relationship between the presence of spina bifida occulta and LBP (Dai, 1999; Magora and Schwartz, 1978). We propose that the spina bifida not only had the potential to contribute to the classification of lumbar extension, but also complicated her ability to resolve her pain completely and consistently.

In the current report, we have presented a patient with a history of LBP. We described the assessment procedures used to identify the patient's primary movement-system impairments displayed during the examination and with functional activities. Treatment was described that emphasized modification of the identified impairments during performance of functional activities. The patient was also instructed in exercises to address physical impairments that were proposed to contribute to the patient's LBP problem. The patient reported a reduction in her pain after only 2 visits, and reported an ability to manage her pain up to 6 months.

Appendix A

Operational Definitions for Responses for Symptom Behavior Items of Physical Examination.*

*In circumstances in which the responses for proximal and distal symptoms are different, prioritization is given to the behavior of the most distal symptoms. There were no instances in which this occurred during the testing of this subject (Van Dillen et al, 2001).

Symptoms increased

The subject's symptoms (pain) are produced, the symptoms present at initiation of a particular test are increased in intensity, or the symptoms have moved distally from the lumbar spine, with assumptions of a test position or performance of a test movement, as compared with the referent symptoms status.

Symptoms decreased

The subject's symptoms are diminished or absent, or the symptoms have moved more proximally toward the lumbar spine with assumption of a test position or performance of a test movement, as compared with the referent symptom status.

Symptoms remained the same

Assumption of a test position or performance of a test movement has no effect on the intensity or location of the subject's symptoms, as compared with the referent symptom status.

Exercises in this collection are available in Diagnosis and Treatment of Movement Impairment Syndromes (Sahrmann SA, 2002). Computer program by Physio Tools, Ltd.

References

Atkinson JH, Slater MA, Williams RA 1998 A placebo-controlled randomized clinical trial of nortriptyline for chronic low back pain. Pain 16: 287–296

Bolton JE 1999 Accuracy of recall of usual pain intensity in back pain patients. Pain 83: 533–539

Dai L 1999 Lumbosacral transitional vertebrae and low back pain. Bulletin – Hospital for Joint Diseases 58: 191–193

Day R, Morrison B, Armando L 2000 A randomized trial of the efficiency and tolerability of the COX-2 inhibitor rofecoxib versus ibuprofen in patients with osteoarthritis. Archives of Internal Medicine 160: 1781–1787

Delitto A, Erhard RE, Bowling RW 1995 A treatment-based classification approach to low back syndrome: Identifying and staging patients for conservative treatment. Physical Therapy 75: 470–489

DeRosa CP, Porterfield JA 1992 A physical therapy model for the treatment of low back pain. Physical Therapy 72: 261–269

Jette AM 1994 Physical therapy episodes of care for patients with low back pain. Physical Therapy 74: 101–110

Kendall FP, McCreary FP, Provance PG 1993 Muscles: testing and function, 4th ed, Baltimore, Williams & Wilkins

Lawrence RC, Helmick CG, Arnett FC, Deyo RA, Felson DT, Giannini EH, Heyse SP, Hirsch R, Hochberg MC, Hunder GG, Liang MH, Pillemer SR, Steen VD, Wolfe F 1998 Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. Arthritis and Rheumatism 41: 778–799

Leboeuf-Yde C, Lauristen JM, Lauristen T 1997 Why has the search for causes of low back pain largely been non-conclusive? Spine 22: 877–881

Magora A, Schwartz A 1978 Relation between the low back pain syndrome and x-ray findings. 2. Transitional vertebra (mainly sacralization). Scandinavian Journal of Rehabilitation Medicine 10: 135–145

Maluf KS, Sahrmann SA, Van Dillen LR 2000 Use of a classification system to guide nonsurgical management of a patient with chronic low back pain. Physical Therapy 80: 1097–1111

McKenzie RA 1998 The Lumbar Spine: Mechanical diagnosis and Therapy, Waikanae, New Zealand, Spinal Publications Ltd

Mueller MJ, Maluf KS 2002 Tissue adaptations to physical stress: a proposed "Physical Stress Theory" to guide physical therapist practice, education and research. Physical Therapy 82: 383–403.

Norton BJ, Sahrmann SA, Van Dillen LR 2004 Differences in measurements of lumbar curvature related to gender and low back pain category. Journal of Orthopaedic & Sports Physical Therapy 34: 524–534

Riddle DL 1998 Classification and low back pain: a review of the literature and critical analysis of selected systems. Physical Therapy 78: 708–737

Sahrmann SA 2002 Diagnosis and treatment on movement impairment syndromes, St. Louis, Mosby, Inc

Spitzer WO 1987 Diagnosis of the problem (the problem of diagnosis). In: Scientific approach to the assessment and measurement of activity-related spinal disorders: A monograph for clinicians' report of the Quebec task force on spinal disorders, Spine 12(suppl): S16-S21

Strong J, Ashton R, Chant D 1991 Pain intensity measurement in chronic low back pain. Clinical Journal of Pain 7: 209–218

Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, Fleming DA, McDonnell MK, Woolsey NB 1998 Reliability of physical examination items used for classification of patients with low back pain. Physical Therapy 78: 979–988

Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, McDonnell MK, Bloom N 2003a The effect of modifying patient-preferred spinal movement and alignment during

symptom testing in patients with low back pain: a preliminary report. Archives of Physical Medicine & Rehabilitation 84: 313–322

Van Dillen LR, Sahrmann SA, Norton BJ, McDonnell MK, Fleming DA, Caldwell CA, Bloom NJ 2001 Response to invited commentary. Journal of Orthopaedic & Sports Physical Therapy 31: 416–418

Van Dillen LR, Sahrmann SA, Norton BJ, McDonnell MK, Fleming DA, Caldwell CA, Woolsey NB 2003b Movement system impairment-based categories for low back pain: Stage I validation. Journal of Orthopaedic & Sports Physical Therapy 33: 126–142

Von Korff M 1994 Studying the natural history of back pain. Spine 19: Suppl-2046S