Journal of Orthopaedic & Sports Physical Therapy
Official Publication of the Orthopaedic and Sports Physical Therapy Sections of the American Physical Therapy Association

RESIDENT'S CASE PROBLEM

Clinical Decision Making in the Identification of Patients Likely to Benefit From Spinal Manipulation: A Traditional Versus an Evidence-Based Approach

John D. Childs, PT, MS, MBA, OCS, CSCS, FAAOMPT[1]
Julie M. Fritz, PT, PhD, ATC[2]
Sara R. Piva, PT, MS, OCS, FAAOMPT[3]
Richard E. Erhard, PT, DC[4]

BACKGROUND

Attempts to identify effective interventions for patients with low back pain (LBP) have been largely unsuccessful.[84,85] However, spinal manipulation is an intervention used by physical therapists in the treatment of individuals with LBP for which there is at least some supporting evidence.[1] Several randomized trials have found spinal manipulation to be more effective than placebo[17,56,66,68,92] or other interventions[12] for patients with acute LBP.[18,45,79] However, other studies have not shown any benefits for spinal manipulation versus other interventions.[7,29–31]

The apparently conflicting results in these clinical trials may be partly attributable to researchers admitting all patients with LBP into a study, rather than attempting to a priori identify the subgroup of patients with LBP most likely to benefit from spinal manipulation. Therapists who frequently use spinal manipulation as part of their treatment plan will attest to the notion that some patients with LBP respond rather dramatically and rapidly to spinal manipulation, while others do not experience much improvement. The challenge for therapists is determining which response is more likely for an individual patient with LBP.

Many theoretical approaches to identifying patients likely to benefit from spinal manipulation have been proposed,[6,32,38,42,54,58,60,64,91] however, there is little to no evidence to support their use. These approaches frequently incorporate complex diagnostic schemes based on pathoanatomical and biomechanical theories that utilize various examination procedures to identify a pathological motion segment or a biomechanical dysfunction towards which a manipulative intervention is then directed. Research has shown, however, that relevant pathoanatomical mechanisms can be identified in only a small percentage of patients with LBP,[5,48] and that many of the tests proposed to identify biomechanical dysfunction are of questionable reliability and validity.[15,21,22,67] Despite these research findings, most clinicians continue to rely on traditional theories and schools of thought to identify which patients with LBP they believe will benefit from spinal manipulation.[2,10,32,38,51] For example, Battie et al[2] surveyed therapists regarding hypothetical patients, and depending on the case, 47% to 63% reported that assessment of the sacroiliac (SI) joint would be indicated.

Many authorities have proposed that patients whose pathology or biomechanical dysfunction can be localized to the SI region would benefit from spinal

[1] *Physical Therapist, US Air Force, Wilford Hall Medical Center, Lackland AFB, TX; Doctoral Candidate, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.*
[2] *Assistant Professor, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.*
[3] *Doctoral Candidate, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.*
[4] *Head Chiropractor, University of Pittsburgh Medical Center Spine Specialty Center; Assistant Professor, Department of Physical Therapy, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, PA.*
This study was supported in part by a grant from the Foundation for Physical Therapy. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the U.S. Air Force or Department of Defense.
Send correspondence to John D. Childs, 508 Thurber Dr., Schertz, TX 78154-1146. Email: childsjd@bigfoot.com

manipulation.[8,12,14,18,20,32,34] Traditionally, clinicians have primarily relied on diagnostic tests purported to identify pathology and biomechanical dysfunction in the SI region to determine which patients are likely to benefit from manipulative interventions directed towards this area. Unfortunately, numerous studies in the literature have consistently found poor reliability and validity for these tests, despite diligent efforts to standardize and refine the testing procedures.[15,35,36,46,49,50,53,59,62,67,75,81,82,86]

The unacceptable reliability and validity for the majority of tests used to diagnose SI region dysfunction requires clinicians and researchers to pursue an alternative approach to identify patients who are likely to benefit from spinal manipulation. A clinical prediction rule (CPR) that considers multiple factors from the history and physical examination and uses a reference standard based on treatment outcome instead of pathological and biomechanical theories may improve therapists' ability to identify these patients. CPRs are tools designed to assist in the classification process and improve decision making for clinicians caring for patients.[47] The purpose of CPRs is to improve a clinician's accuracy in predicting a diagnosis or an expected outcome.[57] For example, CPRs have been developed to improve the accuracy of diagnosing ankle fractures in individuals with acute injuries[73] and to predict the likelihood of death within 4 years for individuals with coronary disease.[55]

A CPR to predict a priori which patients will most likely benefit from spinal manipulation would be tremendously helpful for clinicians in the clinical decision-making process. Flynn et al[20] have recently developed such a rule for 1 manipulative intervention that has been used in the treatment of patients with suspected SI region dysfunction, the details of which are published elsewhere. A brief review is provided here. Seventy-one patients with a minimum score of 30% on the Oswestry Disability Questionnaire (ODQ) and no neurologic signs were included. All patients received a detailed standardized history and physical examination and completed several self-report measures of pain and function. After the history and physical examination were completed, all patients received a manipulative intervention that was previously demonstrated to be effective for patients with LBP.[12,18] Patients were then judged 2 to 4 days later as to whether they experienced a dramatic improvement in their ODQ score. Dramatic improvement was defined as a 50% improvement on the ODQ based on previous research using the same intervention. In 3 previous studies, patients believed to be matched to this intervention experienced mean improvements in ODQ scores from 57% to 83%, while patients receiving unmatched interventions experienced mean improvements ranging from 20% to 38% over a 1- to 4-week period.[12,18,25] The investigators argued that requiring a 50% improvement in the ODQ over a 2- to 4-day period would provide adequate distinction between patients who responded to the intervention and those who simply benefited from the favorable natural history of LBP.[20]

Patients who met this 50% threshold were classified as having been successfully treated and were eliminated from the study. Patients who did not achieve at least 50% improvement were manipulated again and re-examined 2 to 4 days later. After the second treatment, patients who met the 50% threshold were classified as having been successfully treated, while those patients who did not achieve at least a 50% improvement were classified as having been treated without success. A CPR was then developed using logistic regression and by calculating pertinent diagnostic properties for the criteria that remained in the regression model. All factors, including many of the traditional SI region special tests, were included in the analysis. Success with treatment was used as the reference criterion. The most parsimonious set of factors was then determined based on the set of factors that maximized the diagnostic accuracy of predicting patients likely to benefit from spinal manipulation (ie, those patients who achieved at least a 50% improvement in their ODQ score). The results of this study identified a set of 5 criteria that accurately identified patients who would benefit from the manipulative intervention. The 5 criteria and the threshold for satisfying each criterion are listed in Table 1. Forty-five percent of the patients in the Flynn et al study[20] were classified as having been successfully treated, regardless of the CPR. In other words, if clinicians were to randomly manipulate patients with LBP, they could expect to achieve a 50% improvement in the ODQ within 1 week approximately 45% of the time.

The accuracy of the CPR can be expressed using likelihood ratio (LR) statistics. Because this study sought to identify patients who would likely benefit from manipulation, the statistic of interest was the positive LR. The positive LR expresses the change in odds favoring the outcome when the patient meets the CPR's criteria.[70] According to Jaeschke et al,[40] accuracy can be considered moderate when the positive LR is greater than 5.0. Accuracy is substantial when the positive LR is greater than 10.0.[40] When considering a patient's status with respect to the

TABLE 1. Criteria in the clinical prediction rule.

1. FABQW* score <19 points
2. Duration of current episode <16 d
3. No symptoms extending distal to the knee
4. At least 1 hypomobile lumbar spine segment (judged from lumbar spring testing)
5. At least 1 hip with >35° of internal rotation range of motion

* Work subscale of the Fear-Avoidance Beliefs Questionnaire.

manipulation CPR, the positive LR was 24.4 for patients who had at least 4 out of 5 criteria.[20] To put this result in perspective, the probability of a dramatic improvement among this subgroup of patients increased from 45% to 95%. With 3 criteria met, the positive LR was 2.6, which translates into a 68% probability of success. Given the ease with which the technique can be performed and the reasonable risk and likelihood of benefit associated with the manipulation, this is still likely a sufficient probability to justify an attempt at manipulation. With less than 3 criteria met, the probability of success is essentially no better than the probability of success if you were to randomly manipulate patients with LBP. Thus the clinician may want to consider other treatment interventions that have a higher probability of success.[20] Based on these results, it appears that the CPR may offer a more accurate method than traditional tests for identifying patients likely to benefit from spinal manipulation. The purpose of these case reports is to describe the use of the CPR in the management of 2 patients with nonradicular LBP and to compare the decision making for the use of spinal manipulation based on the CPR versus the decision making based on traditional tests for SI region pathology and biomechanical dysfunction.

DIAGNOSIS

Patient Examination

The examination of each patient included a history and physical examination using the same techniques as those described by Flynn et al[20] to facilitate the determination of each patient's status with respect to the CPR. The history included the nature, location, and duration of symptoms of LBP. The mode of onset and aggravating and relieving factors were also recorded. Any prior history of LBP episodes was recorded along with interventions received previously.

The following self-report measures were completed by each patient:

Pain Diagram Each patient completed a body diagram to indicate the location and nature of their symptoms.[90]

Numeric Pain Rating Patients rated their current level of LBP intensity using an 11-point pain rating scale ranging from 0 (no pain) to 10 (worst pain imaginable).[41]

Oswestry Disability Questionnaire (ODQ) Disability due to LBP was assessed with the ODQ, a 10-item scale originally described by Fairbank et al,[19] in which each item is scored from 0 to 5. The scores are then added and multiplied by 2. The score is interpreted as a percentage out of 100, with higher numbers indicating greater disability. We used a modified version of the ODQ that substituted a section regarding employment and home-making ability for a section related to sex life. This modified version has been shown to possess high levels of reliability and responsiveness, similar to the original version.[28]

Fear-Avoidance Beliefs Questionnaire (FABQ) The FABQ quantifies the level of fear of pain and beliefs about avoiding activity in patients with LBP.[88] The instrument consists of 16 items subdivided into 2 subscales, a 5-item physical activity subscale (FABQPA) and a 11-item work subscale (FABQW) (Appendix). The subscales are reflected in the division of the instrument into separate sections. Questions 1 through 5 make up the FABQPA subscale, and questions 6 through 16 make up the FABQW subscale. Decision making using the CPR requires only the FABQW subscale score. However, all items on the questionnaire should be completed because all items were included when the reliability and validity of the scale was initially established. Each item is scored from 0 to 6, however, not all items within each subscale contribute to the score. Four items (items 2, 3, 4, and 5) are scored for the FABQPA subscale, and 7 items (items 6, 7, 9, 10, 11, 12, and 15) are scored for the FABQW subscale. Each scored item within a particular subscale is summed, thus possible scores range from 0 to 42 and 0 to 28 for the FABQW and FABQPA subscales, respectively. Higher scores represent increased fear-avoidance beliefs. Each subscale exists as a separate entity, thus there is no overall FABQ score that consists of the sum of the 2 subscales. Therapists should ensure that all scored items are completed as there is no procedure to adjust for incomplete items. Previous[39] studies have found a high level of test-retest reliability for the FABQPA (ICC = 0.77) and FABQW (ICC = 0.90) subscales. The FABQW subscale has been associated with current and future disability and work loss in patients with chronic[11,44,88] and acute[26,27] LBP.

The physical examination began with a brief neurologic screening examination to rule out any evidence of neurologic signs, which are generally viewed to be a contraindication for spinal manipulation.[4] Patients with neurologic signs were also excluded in the study by Flynn et al[20] for a similar reason. Sensory testing was carried out for dermatomes representing L1 through S1 distribution with pin prick examination. Manual muscle testing was performed for the myotomes representing L1 through S1 distribution according to the procedures described by Kendall.[43] Muscle stretch reflexes for the quadriceps and the Achilles tendon, as well as for the straight-leg raise and femoral-nerve-stretch tension signs, were examined according to procedures described by Magee.[52] The determination for identifying the presence of a positive neurologic sign was based on comparison to the noninvolved side.

The physical examination also included assessment of single active range of motion (ROM) movements of the lumbar spine with the patient standing. Inclinometer measurements of total flexion, extension, left and right side-bending ROM were made using techniques with documented reliability.[89] The status change associated with each movement was also judged as either centralized (paresthesia that was present disappeared, or pain and/or paresthesia moved proximally with the movement), peripheralized (paresthesia that was not present appeared, or pain and/or paresthesia moved distally with the movement), or status quo (not centralized or peripheralized).[23] Passive ROM for internal and external rotation of the hip was assessed with the patient prone using an inclinometer technique with documented reliability.[16] Segmental mobility testing of the lumbar spine (ie, spring testing) was performed with the patient prone. Posterior-to-anterior pressure was applied by placing the hypothenar eminence of the examiner's hand over the spinous process of each lumbar vertebra.[54] Two judgments were made, 1 for mobility and 1 regarding pain provocation. Mobility was judged as hypermobile, hypomobile, or normal. Interpretation of segmental mobility was based on the examiner's anticipation of what normal mobility should be for the patient and compared to the mobility detected in the segment above and below. Pain provocation during testing was also judged for each segment as either present or absent. When considered in isolation, segmental mobility testing has not been shown to have adequate reliability.[37] Traditional thinking suggests that the presence of adequate reliability is a necessary precursor to a test having any validity.[65] Although this may be the case in many circumstances, the results of this test were still useful enough in the study by Flynn et al[20] to be included as 1 of the final 5 criteria in the CPR. This implies that, despite the lack of reliability, the test results still provide an important piece of information with respect to which patients are responding to manipulation. One reason that reliability tends to be low for this test is that there tends to be a high prevalence of positive findings (ie, a tendency to find hypomobility), which leads to low variability in the data.[37] A lack of variability in data can artificially deflate the Kappa value,[72] which seems to be the case with this test. Combining the results of somewhat unreliable tests with other findings, which the CPR has done, is one suggestion for addressing this concern.[57]

The physical examination included a variety of traditional special tests because these tests have been advocated as capable of detecting pathology and/or biomechanical dysfunction in the SI region. The diagnostic examination procedures to assess the SI region consisted of tests designed to assess the symmetry of bony landmarks in the static position (static symmetry tests) and to assess the symmetry of bony landmarks with movement (movement symmetry tests). Static symmetry tests included palpation of bony landmarks with the patient standing and seated. The posterior superior iliac spine (PSIS) and iliac crests (IC) were palpated with the examiner standing behind the patient, and the anterior superior iliac spine (ASIS) was palpated with the examiner facing the patient. For each landmark, palpation was performed bilaterally, and a judgment was made as to the relative symmetry of height in the landmarks.[62,67] Several tests of movement symmetry were also used. These included the standing and seated flexion tests, Gillet test, supine long-sitting test, and prone knee flexion test.[67] The SI region tests and brief operational definitions for how each test was performed are outlined in Table 2.

Intervention

After the initial examination, each patient was treated using a manipulative intervention that has been previously described in the literature and upon which the CPR was based.[12,18] To perform the manipulative technique, the patient was supine. The therapist stood opposite the side to be manipulated and passively moved the patient into side-bending towards the side to be manipulated. The patient interlocked the fingers behind the head. The therapist then rotated the patient and delivered a quick thrust to the anterior superior iliac spine in a posterior and inferior direction (Figure 1). Following the manipulation, each patient was instructed in a hand-heel-rock ROM exercise as described in Figure 2.[17] We routinely instruct patients in this exercise to help maintain immediate improvements in ROM observed following manipulation.

Outcome Assessment

Previous research has shown an average ODQ score of approximately 40% for new patients referred to physical therapy, with a standard deviation of about 10%.[25,74] The purpose of the CPR is to identify patients who experience important clinical changes in disability in a relatively short period of time and changes beyond that likely attributable to the favorable natural history of LBP. These are the patients that clinicians surely do not want to miss when considering the use of spinal manipulation. Because Flynn et al[20] used change in disability as the reference standard, they required patients to have at least a baseline score of 30% on the ODQ. This minimum baseline level of disability insured the inclusion of a spectrum of patients, yet prevented a floor effect from occurring due to low baseline disability scores. Additionally, the minimum clinically important difference (MCID) for the ODQ has been shown to be a 6% improvement.[28] A threshold of 30% on the ODQ at baseline using 50% improvement as the reference standard to judge success helps clinicians to distin-

TABLE 2. Special tests.*

SI Static Symmetry Tests	Procedure	Criteria for Positive Test
• PSIS symmetry standing	• Palpation of right and left PSIS with the patient standing	• 1 PSIS judged to be higher than the other
• ASIS symmetry standing	• Palpation of right and left ASIS with the patient standing	• 1 ASIS judged to be higher than the other
• Iliac crest symmetry standing	• Palpation of right and left iliac crest with the patient standing	• 1 iliac crest judged to be higher than the other
• PSIS symmetry sitting	• Palpation of right and left PSIS with the patient sitting	• 1 PSIS judged to be higher than the other
• Iliac crest symmetry sitting	• Palpation of right and left iliac crest with the patient sitting	• 1 iliac crest judged to be higher than the other
SI Movement Symmetry Tests	**Procedure**	**Criteria for Positive**
• Standing flexion test	• The patient is standing and the relative heights of the PSIS are assessed. The patient is asked to flex forward as far as possible with the examiner continuing to palpate the PSIS.	• A change in the relative relationship of the PSIS is found in the fully flexed position
• Seated flexion test	• The patient is seated and the relative heights of the PSIS are judged. The patient is asked to bend forward as far as possible, with the examiner continuing to palpate the PSIS.	• A change in the relative relationship of the PSIS is found in the fully flexed position
• Supine long-sitting test	• The patient is supine with hips and knees extended. The examiner grasps around each ankle with the thumbs below the medial malleoli. A visual estimation of leg length is made. The patient is assisted to a long-sitting position, and the examiner re-examines the relative leg lengths.	• A change in the relative position of medial malleoli occurs
• Prone knee bend test	• The patient is prone. The relative leg lengths are assessed by looking at the heels. The examiner passively flexes the patient's knees to approximately 90°. The relative leg lengths are assessed again in this position.	• A change in relative lengths occurs between the 2 positions
• Gillet test	• The patient is standing. The examiner places 1 thumb under the PSIS on the side being tested with the other thumb over the S2 spinous process. The patient is instructed to stand on 1 leg and flex the other hip and knee, bringing the leg towards the chest.	• The PSIS fails to move posterior and inferior with respect to S2

* Abbreviations: SI, sacroiliac; PSIS, posterior superior iliac spine; ASIS, anterior superior iliac spine.

guish patients who are responding to the manipulative intervention versus improvements solely attributable to the favorable natural history of LBP.[3] At a minimum threshold of 30%, a 50% improvement corresponds to a 15-point improvement in disability. This magnitude of change represents 2.5 times the MCID for the ODQ, increasing the clinician's confidence that the improvement can be attributed to the manipulative intervention rather than a favorable natural history. Higher baseline levels of disability result in even greater magnitudes of improvement when using 50% improvement as the reference standard. To be consistent with this intent, the judgment of success for these patients was made at the next therapy appointment, 3 days after the manipulative intervention, using a 50% improvement in the ODQ to establish whether the patient experienced an important clinical change in disability.

Case Description: Patient 1

History and Self-Reports The first patient was a 54-year-old male with a history of more than 10 episodes of LBP over the previous 5 years. Previous treatment included a heel lift, spinal manipulation, and lumbar spine stabilization exercises, to which he had previously responded positively. Based on his frequent history of LBP and positive response to lumbar

FIGURE 1. Manipulative intervention (clinician is theoretically manipulating the right sacroiliac region).

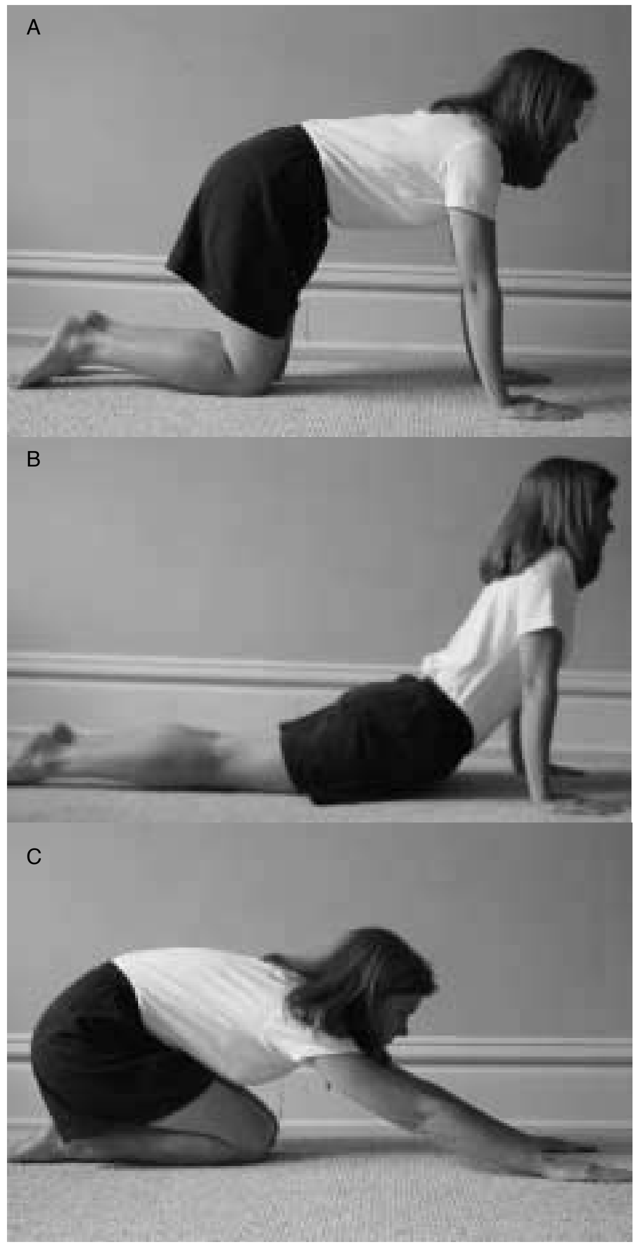


FIGURE 2. Description of hand-heel-rock range of motion exercise. (A) Starting position: get on all fours on the floor, resting some of the weight on hands and arms, moving hands to just slightly higher than shoulders. (B) Forward rock: transfer weight more to hands, not allowing arms to bend and allowing abdomen to sag toward the surface while head tends to look up, pause momentarily toward the end of range, then start back toward neutral. (C) Backward rock: rock backwards as though you were attempting to sit on your heels, allowing your back to round out (do not be concerned if you have to drag your hands along the surface in order to get back to the fully backward position).

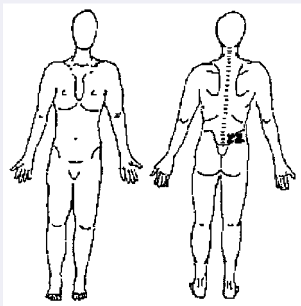
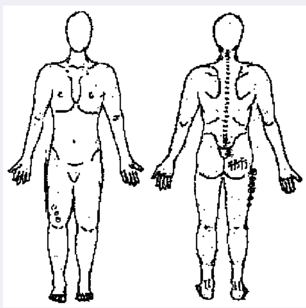
stabilization exercises, he was suspected to have segmental instability.[24] The most recent episode started gradually 1 week prior to the examination and had worsened over the 2 to 3 days before the examination. He did not recall a specific mechanism of injury. His predominant symptom was right-sided LBP in the area of the lumbosacral junction. The pain diagram and results of the self-report measures are given in Table 3. The ODQ score (42%) revealed moderate disability and the FABQW subscale score (8/42) showed a low level of fear-avoidance beliefs.

Physical Examination The results of the physical examination are summarized in Table 4. The results of the neurologic examination did not reveal any sensory, strength, or reflex deficits. There was no centralization or peripheralization noted during lumbar ROM testing. Rotation ROM of the left hip was somewhat limited compared to the right hip. During segmental mobility testing, the L4 and L5 segments were judged to be hypomobile and pain was also provoked. There were numerous positive findings for SI region dysfunction, including the standing and seated flexion, the Gillet, supine long-sitting, and prone knee flexion tests.

Case Description: Patient 2

History and Self-Reports The second patient was a 26-year-old male with complaints of right-sided buttock pain and intermittent pain and numbness into the right anterior/lateral thigh. These symptoms had begun approximately 3 years prior to the examination while the patient was a sprinter for his college track team. The onset was gradual and the symptoms prevented him from running at the time of the examination. The ODQ score (26%) revealed a lower level of disability for this patient. A baseline score of 26% does not strictly meet the minimum 30% level of disability on the ODQ used by Flynn et al.[20] However, a score of 26% is only 0.5 standard deviations below this minimum.[25,74] Additionally, based on our clinical experience, 26% on the ODQ is still a sufficient level of disability to prevent a floor effect from occurring, despite falling below the 30% threshold. Most importantly, a 50% reduction in the ODQ score for a

TABLE 3. History and self-report information for both patients.

Patient 1		
	• Chief complaint	• Right-sided low back pain
	• Duration of symptoms	• Symptoms began gradually 1 wk prior
	• Prior history of back pain	• Approximately 10 prior episodes of low back pain over the past 5 years
	• Pain rating	• Current level of pain 5/10
	• Oswestry score	• 42%
	• FABQ* work subscale score	• 8/42
Patient 2		
	• Chief complaint	• Right buttock pain, pain and numbness in right anterior/lateral thigh
	• Duration of symptoms	• Symptoms began 3 y prior while running track in college
	• Prior history of back pain	• No previous history of low back pain
	• Pain rating	• Current level of pain 4/10
	• Oswestry score	• 26%
	• FABQ work subscale score	• Not assessed

* Work subscale of the Fear-Avoidance Beliefs Questionnaire.

TABLE 4. Physical examination information for both patients.

Examination Component	Patient 1	Patient 2
1. Neurologic screening	No strength, sensory or reflex changes	No strength, sensory, or reflex changes
2. Lumbar active ROM and status change		
• Flexion	85°, status quo	78°, status quo
• Extension	30°, status quo	22°, status quo
• Right side-bending	25°, status quo	25°, status quo
• Left side-bending	15°, status quo	31°, status quo
3. Hip rotation passive ROM		
• Right-hip internal rotation	45°	18°
• Right-hip external rotation	45°	35°
• Left-hip internal rotation	35°	25°
• Left-hip external rotation	40°	32°
4. Lumbar segmental mobility and pain provocation	Hypomobility and pain provocation at L4 and L5	Mobility judged to be normal at all levels, pain provocation at L5
5. SI symmetry tests		
• PSIS symmetry standing	Right side judged to be higher	Left side judged to be higher
• ASIS symmetry standing	Left side judged to be higher	Right side judged to be higher
• Iliac crest symmetry standing	Right side judged to be higher	Judged to be symmetrical
• PSIS symmetry sitting	Judged to be symmetrical	Right side judged to be higher
• Iliac crest symmetry sitting	Judged to be symmetrical	Judged to be symmetrical
6. SI mobility tests		
• Standing flexion test	Positive on the right	Positive on the right
• Seated flexion test	Positive on the right	Positive on the right
• Gillet test	Positive on the right	Positive on the right
• Supine long-sitting test	Positive	Negative
• Prone knee flexion test	Positive	Not assessed

Abbreviations: ROM, range of motion; SI, sacroiliac; PSIS, posterior superior iliac spine; ASIS, anterior superior iliac spine.

patient with a baseline score of 26% still represents a clinically important improvement in disability.[28] The FABQ was not assessed on this patient.

Physical Examination The results of the physical examination are summarized in Table 4. Similar to the first patient, the results of the neurologic examination were negative and there was no peripheralization or centralization noted during lumbar ROM. Patient 2's hip ROM was generally less than that found in patient 1 and the right hip appeared to be limited in internal rotation as compared to the left hip. The right hip was also limited in flexion ROM as compared to the left hip. Segmental mobility testing provoked pain at the L5 segment and mobility was judged to be normal at all lumbar levels. There were also several positive findings for SI region dysfunction, including the standing and seated flexion tests, as well as the Gillet test.

Clinical Decision Making Based on Traditional SI Region Tests

Both patients had several positive findings on traditional tests designed to detect SI region dysfunction, including the standing and seated flexion tests and the Gillet test. Patient 1 also had positive findings on the supine long-sitting and prone knee flexion tests. Both patients were judged to have asymmetry of the pelvic landmarks, which is often believed to indicate SI region dysfunction.[10,12,18] Patient 2 had signs of hip joint dysfunction as well as possible SI region dysfunction. Based on these results, both patients appeared to be good candidates for spinal manipulation directed at the SI region and were treated in this manner at the first appointment.

Clinical Decision Making Based on Clinical Prediction Rule

Each patient's status with respect to the CPR[20] is outlined in Table 5. The first patient met all 5 criteria in the CPR, which suggests that he is highly likely to achieve a dramatic improvement with the manipulative intervention. The second patient met 1 of the criteria (no symptoms distal to the knee). This patient was not assessed on the FABQ at baseline, therefore his score of the work subscale could not be factored into the prediction rule. Patient 2 may therefore have met a maximum of 2 criteria. In either case, patient 2 met 2 or fewer criteria, making him unlikely to experience dramatic improvement with this manipulative intervention.

Interventions and Outcomes

Based on the results of the traditional SI region tests, both patients were treated with the manipulative intervention as previously described. Because of the lack of reliability in the judgments from tests often used to determine which side to manipulate,[69] the more symptomatic side was selected. An audible cavitation was achieved in both patients using the technique. Although the manipulative technique is theoretically directed towards 1 side of the pelvis, Cibulka et al[9] found changes in innominate tilt on both sides of the pelvis after the performance of this manipulation on 1 side. Thus the decision as to which side to manipulate is essentially random. In clinical practice, if the manipulative intervention is not successful on 1 side, we attempt to manipulate the opposite side. Following the manipulative intervention, both patients were instructed in a hand-heel-rock ROM exercise, as described in Figure 2,[17] and were instructed to perform 10 repetitions of the exercise 3 to 4 times daily. Finally, they were instructed to do all activities that did not increase their symptoms and to maintain their usual activity level within the limits of pain (advice to maintain usual activity has been found to assist in recovery from LBP[4,33]). They were also instructed to avoid activities that aggravate symptoms. Patient 1 was also instructed

TABLE 5. Status of the 2 patients with respect to the clinical prediction rule (CPR).

Factors in the CPR	Patient 1	Patient 2
1. FABQW score <19 points	8	Not assessed
2. Duration of current episode <16 d	5 d	3 y
3. No symptoms extending distal to the knee	LBP only	Right buttock and thigh pain, not distal to the knee
4. At least 1 hypomobile lumbar spine segment (judged from lumbar spring testing)	Hypomobility at L4 and L5	Mobility judged WNL at all lumbar levels
5. At least 1 hip with >35° of internal rotation ROM	Left-hip IR, 35° Right-hip IR, 45°	Left-hip IR, 25° Right-hip IR, 18°
Total:	5/5	1/5

Abbreviations: FABQW, work subscale of the Fear-Avoidance Beliefs Questionnaire; LBP, low back pain; WNL, within normal limits; ROM, range of motion; IR, internal rotation.

to initiate a previously prescribed regime of lumbar spine stabilization exercises to address suspected lumbar spinal instability that may have contributed to his LBP.[56] Patient 2 was also treated with manual distraction mobilization of the right hip and contract-relax stretching of the right hip flexors.

Both patients returned for a follow-up appointment 3 days after the baseline examination and manipulative intervention. The pain rating and ODQ were reassessed at that time. The changes in pain and ODQ score for both patients are pictured in Figures 3 and 4, respectively. For patient 1, the pain rating decreased from 5/10 to 0/10 and the ODQ decreased from 42% to 18% (57% decrease). For patient 2, the pain rating remained unchanged at 4/10 and the ODQ was essentially unchanged at 28% versus 26% at baseline (8% increase).

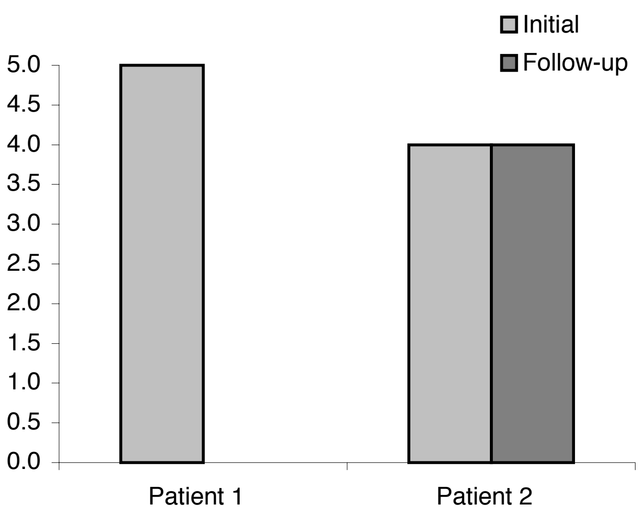


FIGURE 3. Numeric pain rating at initial evaluation and 3 days later for both patients. An 11-point scale was used with 0 meaning no pain and 10 meaning worst pain imaginable. (Pain was 0.0 for patient 1 at follow-up.)

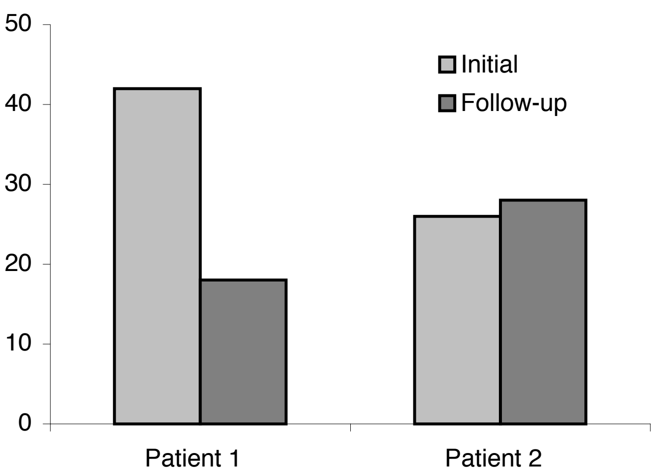


FIGURE 4. Oswestry Disability Questionnaire score at initial evaluation and 3 days later for both patients. Scores range from 0% to 100% with 0% being no disability and 100% being maximum disability.

Patient 1 appeared to have made dramatic improvement following the manipulative intervention and ROM exercise. After 3 days, he reported no pain and the 24-point improvement in the ODQ is equivalent to 4 times the minimum clinically important difference (MCID) of 6% that has been established for this instrument.[28] Patient 2 did not appear to benefit from the manipulative intervention and ROM exercise. His pain rating and ODQ scores were unaffected by the intervention. The first patient did not return for subsequently scheduled visits based on his self-report that he was progressing well with the exercise program and could not coordinate regular physical therapy sessions into his work schedule. He was contacted approximately 1 month after the initial appointment in which he self-reported that his LBP had continued to improve and that he was only having symptoms with prolonged standing at work. Ergonomic and appropriate shoewear recommendations were made and the patient was discharged from therapy. The second patient was seen for 5 additional appointments over the ensuing 3 weeks. Treatment consisted of hip joint mobilizations, flexibility and strengthening exercises for the right hip, and deweighted ambulation on a treadmill. The manipulation was repeated 1 additional time during the course of care. His status remained unchanged. He was referred for further examination of the right hip. A subsequent MR arthrogram revealed an anterior labrum and capsular tear of the right hip that eventually required surgical correction.

DISCUSSION

Because of the difficulty subgrouping patients with LBP based on pathoanatomical mechanisms,[87] attempts have been made to subgroup or to classify patients based on findings from the history and physical examination.[13,58,61,71,83] Unfortunately, many of the tests used to make classification decisions are based on unsubstantiated theoretical rationales and are of questionable reliability and predictive validity. CPRs, such as the one developed by Flynn et al[20] have the potential to provide clinicians with a practical tool grounded on evidence with which to assist in the identification of relevant subgroups of patients. Without the ability to match patients to specific interventions, clinicians are left without evidence for their decision making in selecting interventions. Developing effective clinical methods for classifying patients with LBP should improve clinical decision making and intervention outcomes by matching interventions to the patients most likely to benefit from them.

These 2 cases highlight the potential value of a CPR for physical therapists. The CPR used in this study was developed to identify patients with LBP most likely to receive dramatic benefit from a manipulative intervention traditionally believed to affect the SI region. Five clinical findings go into determining a patient's likelihood of success (Table 1). Patient 1 had all 5 criteria present, indicating a high likelihood of success with the treatment. Patient 2 had only 1 (possibly 2) positive findings, indicating a low likelihood of responding to the treatment. Both patients were judged to have numerous positive findings that have traditionally suggested the need for treatment of the SI region. In these 2 cases, the CPR more accurately predicted the eventual outcome of the intervention than the traditional SI region tests.

The utility of the traditional SI region tests in the clinical decision-making process may be limited for several reasons. First, judgments derived from these tests have not demonstrated sufficient reliability and validity, which makes using the results of these tests for clinical decisions questionable. Second, the theories that underlie these traditional tests may be faulty. There is growing evidence that movement of the SI joint is so small that detecting subtle differences may be extremely difficult if not impossible.[76–78] Furthermore, using roentgen stereophotogrammetric analysis, Tullberg et al[80] found that spinal manipulation did not alter the position of the SI joint. These results suggest that the theoretical foundation for bony movement—upon which many of the traditional tests are based—even if reliably measured, may be seriously flawed.

Despite these concerns, many clinicians have continued to rely on traditional tests for SI region dysfunction.[2,10,32,38,51] This is understandable given that the treatment techniques appear to work for a large number of patients and that a more reasonable alternative to clinical decision making has not been available. The development of CPRs that are based on an examination of data instead of anatomical and biomechanical theories may offer an alternative in helping clinicians become more efficient and effective practitioners. The CPR developed by Flynn et al[20] is simple to use. Only 2 out of 5 of the criteria in the rule are based on the results of the clinician's physical examination (hypomobility in the lumbar spine and hip internal rotation ROM). The other 3 criteria are based on the patient's self-report (duration of symptoms, score on the FABQW subscale, and the location of symptoms). In essence, clinicians can get a good initial impression of whether a patient may benefit from spinal manipulation and a ROM exercise before the physical examination even begins. Determining a patient's status with respect to the CPR should take no longer than 5 minutes and offers clinicians an efficient and practical evidence-based guide in the clinical decision-making process to identify patients with LBP who are likely to benefit from this intervention.

The results of the study by Flynn et al[20] do not advocate the use of spinal manipulation as a panacea for patients with LBP, nor do they indicate that spinal manipulation is the only treatment intervention that should be considered for patients who satisfy at least 4 of the criteria. Even patients who meet all 5 of the criteria in the CPR will likely need other treatments to complement the use of spinal manipulation in order to minimize the functional limitations and disability associated with their LBP. The rule is intended to predict which patients will receive a large initial benefit from the manipulative intervention and does not predict the patient's long-term prognosis. This point can be highlighted based on the history and physical examination findings from patient 1, who was thought to have segmental instability of the lumbar spine based on his history of chronic LBP and positive response to a previous rehabilitation program consisting of spinal stabilization exercises. Some therapists would have chosen not to manipulate this patient based solely on the impression that spinal manipulation would not be helpful, and perhaps even harmful, to a patient with suspected segmental instability. However, consideration of the patient's status with respect to the CPR helped guide the selection of an intervention when, without this information, the therapist might have incorrectly assumed that spinal manipulation should not be considered as a potential treatment option.

Perhaps the manipulative intervention and ROM exercise in this case served as a catalyst to facilitate his recovery from the acute episode and permited him to initiate the stabilization exercises earlier than he might have otherwise have been able to. It is highly unlikely that this patient's dramatic improvement over such a short period of time could be attributed to the stabilization exercises, because these exercises require completion over a longer period of time to demonstrate positive effects.[63]

Patient 2 illustrates a different advantage of the CPR. Based on traditional clinical reasoning, this patient's pain diagram and physical examination strongly suggested that spinal manipulation might be an effective intervention. This turned out not to be the case, and in fact, the patient's symptoms were originating from pathology at the hip. Had the CPR been used as the foundation for clinical decision making for this patient, instead of traditional theories, the lack of benefit from spinal manipulation could have been predicted. The value of CPRs is not just their potential ability to identify patients likely to benefit from a particular intervention, but also their ability to identify patients for whom an alternative course of treatment is more appropriate.

Given the intent to identify patients who experience clinically important changes in disability, application of the CPR becomes less useful at lower levels of disability. For example, although an improvement from 10% on the ODQ at baseline to 5% after treatment represents a 50% improvement, this magnitude of change falls below the MCID of 6% that was established for this instrument.[28] We do not have data to establish a minimum level of disability below which application of the CPR is no longer useful in the clinical decision-making process. However, to be conservative, few would argue that an improvement of 3 times the MCID for the ODQ (ie, an 18-point improvement) over such a short period of time can be attributed to the favorable natural history of LBP. Based on this consideration, the chance to observe this magnitude of improvement diminishes once patients fall below a baseline ODQ of 20%. Additionally, patients with levels of disability below 20% may more likely represent chronic LBP and may respond to another intervention, such as a spinal stabilization treatment approach.[25]

McGinn et al[57] outlined a 3-step process for developing and testing a clinical prediction rule. The first step is developing the rule, which was the purpose of the study by Flynn et al.[20] The second step is validation and the third step is an assessment of the impact of the rule on clinical behavior and costs of care. Validation of the proposed clinical prediction rule is the purpose of an ongoing randomized clinical trial in which subjects are stratified as to whether they meet 4 out of the 5 criteria in the CPR and randomized to receive either the manipulative intervention or a standard exercise program. Ultimately, any clinical prediction rule must be shown to improve outcomes and clinical decision making before it can be advocated for widespread use.[47] Furthermore, only 1 manipulative technique was used and it is unknown if other techniques would provide similar results. Due to these factors, the CPR used in these cases should be viewed as preliminary and subject to refinement with further research.[57]

Growing evidence suggests that spinal manipulation is effective in the management of LBP. However, in the absence of evidence of an alternative approach, clinicians have primarily relied on diagnostic tests with questionable reliability and validity in the clinical decision-making process to identify potential candidates for spinal manipulation. These 2 cases highlight the use of a CPR developed by Flynn et al,[20] which demonstrates that there are a few simple criteria from the history and physical examination that can be used to help clinicians decide if spinal manipulation and a ROM exercise may be helpful in the management of a patient with LBP. Importantly, these results provide clinicians with an easy-to-use procedure to accurately identify patients with LBP who are likely to achieve a dramatic improvement prior to treatment. We believe this CPR offers clinicians an efficient and practical evidence-based tool that can be applied by even the novice physical therapist who is familiar with the CPR and the technique that was used in its development. This CPR should encourage clinicians who were previously reluctant to incorporate spinal manipulation into their clinical practice to use it more frequently based on a patient's status with respect to the CPR.

REFERENCES

1. American Physical Therapy Association (APTA). *Guide to Physical Therapy Practice.* 2nd ed. Alexandria, VA: APTA; 2001.
2. Battie MC, Cherkin DC, Dunn R, Ciol MA, Wheeler KJ. Managing low back pain: attitudes and treatment preferences of physical therapists. *Phys Ther.* 1994;74(3):219–226.
3. Beurskens AJ, de Vet HC, Koke AJ. Responsiveness of functional status in low back pain: a comparison of different instruments. *Pain.* 1996;65(1):71–76.
4. Bigos SG, Bowyer OR, Braen GR, Brown K, Deyo RA. *Acute Low Back Problems in Adults. AHCPR Publication 95-0642.* Rockville, MD: Agency for Health Care Policy and Research, US Department of Health and Human Services; 1994.
5. Bouter LM, van Tulder MW, Koes BW. Methodologic issues in low back pain research in primary care. *Spine.* 1998;23(18):2014–2020.
6. Boyling JD, Palastanga N, Grieve GP. *Grieve's Modern Manual Therapy: The Vertebral Column.* Louis, MO: Churchill Livingstone; 1994.
7. Cherkin DC, Deyo RA, Battie M, Street J, Barlow W. A comparison of physical therapy, chiropractic manipulation, and provision of an educational booklet for the treatment of patients with low back pain. *N Engl J Med.* 1998;339(15):1021–1029.
8. Cibulka MT. Low back pain and its relation to the hip and foot. *J Orthop Sports Phys Ther.* 1999;29(10):595–601.
9. Cibulka MT, Delitto A, Koldehoff RM. Changes in innominate tilt after manipulation of the sacroiliac joint in patients with low back pain. An experimental study. *Phys Ther.* 1988;68(9):1359–1363.
10. Cibulka MT, Koldehoff R. Clinical usefulness of a cluster of sacroiliac joint tests in patients with and without low back pain. *J Orthop Sports Phys Ther.* 1999;29(2):83–89; discussion 90–82.
11. Crombez G, Vlaeyen JW, Heuts PH, Lysens R. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. *Pain.* 1999;80(1–2):329–339.
12. Delitto A, Cibulka MT, Erhard RE, Bowling RW, Tenhula JA. Evidence for use of an extension-mobilization category in acute low back syndrome: a prescriptive validation pilot study. *Phys Ther.* 1993;73(4):216–222; discussion 223–218.
13. Delitto A, Erhard RE, Bowling RW. A treatment-based classification approach to low back syndrome: identifying and staging patients for conservative treatment. *Phys Ther.* 1995;75(6):470–485; discussion 485–479.
14. DonTigny R. Dysfunction of the sacroiliac joint and its treatment. *J Orthop Sports Phys Ther.* 1979;1:23–29.

15. Dreyfuss P, Michaelsen M, Pauza K, McLarty J, Bogduk N. The value of medical history and physical examination in diagnosing sacroiliac joint pain. *Spine.* 1996;21(22):2594–2602.
16. Ellison JB, Rose SJ, Sahrmann SA. Patterns of hip rotation range of motion: a comparison between healthy subjects and patients with low back pain. *Phys Ther.* 1990;70(9):537–541.
17. Erhard RE, Delitto A, Cibulka MT. Relative effectiveness of an extension program and a combined program of manipulation and flexion and extension exercises in patients with acute low back syndrome. *Phys Ther.* 1994;74(12):1093–1100.
18. Erhard RE. *The Spinal Exercise Handbook: A Home Exercise Manual for a Managed Care Environment.* Pittsburgh, PA: Laurel Concepts; 1998.
19. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. *Physiotherapy.* 1980;66(8):271–273.
20. Flynn T, Fritz J, Whitman J, et al. A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with spinal manipulation. *Spine.* 2002;27(24):2835–2843.
21. Freburger JK, Riddle DL. Measurement of sacroiliac joint dysfunction: a multicenter intertester reliability study. *Phys Ther.* 1999;79(12):1134–1141.
22. Freburger JK, Riddle DL. Using published evidence to guide the examination of the sacroiliac joint region. *Phys Ther.* 2001;81(5):1135–1143.
23. Fritz JM, Erhard RE, Hagen BF. Segmental instability of the lumbar spine. *Phys Ther.* 1998;78(8):889–896.
24. Fritz JM, Delitto A, Vignovic M, Busse RG. Interrater reliability of judgments of the centralization phenomenon and status change during movement testing in patients with low back pain. *Arch Phys Med Rehabil.* 2000;81(1):57–61.
25. Fritz JM, George S. The use of a classification approach to identify subgroups of patients with acute low back pain. Interrater reliability and short-term treatment outcomes. *Spine.* 2000;25(1):106–114.
26. Fritz JM, George SZ. Identifying psychosocial variables in patients with acute work-related low back pain: the importance of fear-avoidance beliefs. *Phys Ther.* 2002;82(10):973–983.
27. Fritz JM, George SZ, Delitto A. The role of fear-avoidance beliefs in acute low back pain: relationships with current and future disability and work status. *Pain.* 2001;94(1):7–15.
28. Fritz JM, Irrgang JJ. A comparison of a modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. *Phys Ther.* 2001;81(2):776–788.
29. Gibson T, Grahame R, Harkness J, Woo P, Blagrave P, Hills R. Controlled comparison of short-wave diathermy treatment with osteopathic treatment in non-specific low back pain. *Lancet.* 1985;1(8440):1258–1261.
30. Glover JR, Morris JG, Khosla T. Back pain: a randomized clinical trial of rotational manipulation of the trunk. *Br J Ind Med.* 1974;31(1):59–64.
31. Godfrey CM, Morgan PP, Schatzker J. A randomized trial of manipulation for low-back pain in a medical setting. *Spine.* 1984;9(3):301–304.
32. Greenman PE. *Principles of Manual Medicine.* Philadelphia, PA: Lippincott Williams and Wilkins; 1996.
33. Haas M, Peterson D, Rothman EH, et al. Responsiveness of leg alignment changes associated with articular pressure testing to spinal manipulation: the use of a randomized clinical trial design to evaluate a diagnostic test with a dichotomous outcome. *J Manipulative Physiol Ther.* 1993;16(5):306–311.
34. Hawk C, Azad A, Phongphua C, Long CR. Preliminary study of the effects of a placebo chiropractic treatment with sham adjustments. *J Manipulative Physiol Ther.* 1999;22(7):436–443.
35. Hawk C, Phongphua C, Bleecker J, Swank L, Lopez D, Rubley T. Preliminary study of the reliability of assessment procedures for indications for chiropractic adjustments of the lumbar spine. *J Manipulative Physiol Ther.* 1999;22(6):382–389.
36. Herzog W, Read LJ, Conway PJ, Shaw LD, McEwen MC. Reliability of motion palpation procedures to detect sacroiliac joint fixations. *J Manipulative Physiol Ther.* 1989;12(2):86–92.
37. Hicks GE, Fritz JM, Delitto A. Inter-rater reliability of clinical examination measures for identification of lumbar segmental instability. *Arch Phys Med Rehabil.* In press.
38. Isaacs ER, Bookhout MR, Woburn MA. *Bourdillon's Spinal Manipulation.* 6th ed. Oxford, UK: Butterworth-Heinemann, Inc.; 2002.
39. Jacob T, Baras M, Zeev A, Epstein L. Low back pain: reliability of a set of pain measurement tools. *Arch Phys Med Rehabil.* 2001;82(6):735–742.
40. Jaeschke R, Guyatt GH, Sackett DL. Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? The Evidence-Based Medicine Working Group. *JAMA.* 1994;271(9):703–707.
41. Jensen MP, Turner JA, Romano JM. What is the maximum number of levels needed in pain intensity measurement? *Pain.* 1994;58(3):387–392.
42. Kaltenborn F. *The Spine: Basic Evaluation and Mobilization Techniques.* Minneapolis, MN: Orthopaedic Physical Therapy Products; 1993.
43. Kendall FP, McCreary EK, Provance PG. *Muscles: Testing and Function.* 4th ed. Baltimore, MD: Williams and Wilkins; 1993.
44. Klenerman L, Slade PD, Stanley IM, et al. The prediction of chronicity in patients with an acute attack of low back pain in a general practice setting. *Spine.* 1995;20(4):478–484.
45. Koes BW, Bouter LM, van Mameren H, et al. The effectiveness of manual therapy, physiotherapy, and treatment by the general practitioner for nonspecific back and neck complaints. A randomized clinical trial. *Spine.* 1992;17(1):28–35.
46. Laslett M, Williams M. The reliability of selected pain provocation tests for sacroiliac joint pathology. *Spine.* 1994;19(11):1243–1249.
47. Laupacis A, Sekar N, Stiell IG. Clinical prediction rules. A review and suggested modifications of methodological standards. *JAMA.* 1997;277(6):488–494.
48. Leboeuf-Yde C, Lauritsen JM, Lauritzen T. Why has the search for causes of low back pain largely been nonconclusive? *Spine.* 1997;22(8):877–881.
49. Levangie PK. Four clinical tests of sacroiliac joint dysfunction: the association of test results with innominate torsion among patients with and without low back pain. *Phys Ther.* 1999;79(11):1043–1057.
50. Levangie PK. The association between static pelvic asymmetry and low back pain. *Spine.* 1999;24(12):1234–1242.
51. Li LC, Bombardier C. Physical therapy management of low back pain: an exploratory survey of therapist approaches. *Phys Ther.* 2001;81(4):1018–1028.
52. Magee DJ. *Orthopaedic Physical Assessment.* 2nd ed. Philadelphia, PA: WB Saunders Co.; 1992.

53. Maigne JY, Aivaliklis A, Pfefer F. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. *Spine.* 1996;21(16):1889–1892.
54. Maitland GD. *Vertebral Manipulation.* 5th ed. Sydney, New South Wales, Australia: Butterworths; 1986.
55. Mark DB, Shaw L, Harrell FE, Jr., et al. Prognostic value of a treadmill exercise score in outpatients with suspected coronary artery disease. *N Engl J Med.* 1991;325(12):849–853.
56. McGill SM. Low back exercises: evidence for improving exercise regimens. *Phys Ther.* 1998;78(7):754–765.
57. McGinn TG, Guyatt GH, Wyer PC, Naylor CD, Stiell IG, Richardson WS. Users' guides to the medical literature: XXII: How to use articles about clinical decision rules. Evidence-Based Medicine Working Group. *JAMA.* 2000;284(1):79–84.
58. McKenzie RA. *The Lumbar Spine: Mechanical Diagnosis and Therapy.* Waikanae, New Zealand: Spinal Publications Ltd.; 1989.
59. Meijne W, van Neerbos K, Aufdemkampe G, van der Wurff P. Intraexaminer and interexaminer reliability of the Gillet test. *J Manipulative Physiol Ther.* 1999;22(1):4–9.
60. Mennell JM. *Back Pain.* Boston, MA: Little Brown and Company, Inc.; 1960.
61. Moffroid MT, Haugh LD, Henry SM, Short B. Distinguishable groups of musculoskeletal low back pain patients and asymptomatic control subjects based on physical measures of the NIOSH Low Back Atlas. *Spine.* 1994;19(12):1350–1358.
62. O'Haire C, Gibbons P. Inter-examiner and intra-examiner agreement for assessing sacroiliac anatomical landmarks using palpation and observation: pilot study. *Man Ther.* 2000;5(1):13–20.
63. O'Sullivan PB, Phyty GD, Twomey LT, Allison GT. Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiologic diagnosis of spondylolysis or spondylolisthesis. *Spine.* 1997;22(24):2959–2967.
64. Paris SV. *Introduction to Spinal Evaluation and Manipulation: S1 Seminar Manual.* 3rd ed. St. Augustine, FL: Patris Press; 1997.
65. Portney LG, Watkins MP. *Foundations of Clinical Research: Applications to Practice.* Norwalk, CT: Appleton and Lange; 1993.
66. Postacchini F, Facchini M, Palieri P. Efficacy of various forms of conservative treatments in low back pain: a comparative study. *Neuro Orthop.* 1988;6(1):28–35.
67. Potter NA, Rothstein JM. Intertester reliability for selected clinical tests of the sacroiliac joint. *Phys Ther.* 1985;65(11):1671–1675.
68. Rasmussen GG. Manipulation in treatment of low back pain: a randomized clinical trial. *Manual Med.* 1979;1:8–10.
69. Riddle DL, Freburger JK. Evaluation of the presence of sacroiliac joint region dysfunction using a combination of tests: a multicenter intertester reliability study. *Phys Ther.* 2002;82(8):772–781.
70. Sackett DL, Straus SE. *Evidence-Based Medicine: How to Practice and Teach EBM.* 2nd ed. New York, NY: Churchill Livingstone, Inc.; 2000.
71. Sikorski JM. A rationalized approach to physiotherapy for low-back pain. *Spine.* 1985;10(6):571–579.
72. Spitznagel EL, Helzer JE. A proposed solution to the base rate problem in the kappa statistic. *Arch Gen Psychiatry.* 1985;42(7):725–728.
73. Stiell IG, McKnight RD, Greenberg GH, et al. Implementation of the Ottawa ankle rules. *JAMA.* 1994;271(11):827–832.
74. Stratford PW, Binkley J, Solomon P, Gill C, Finch E. Assessing change over time in patients with low back pain. *Phys Ther.* 1994;74(6):528–533.
75. Strender LE, Sjoblom A, Sundell K, Ludwig R, Taube A. Interexaminer reliability in physical examination of patients with low back pain. *Spine.* 1997;22(7):814–820.
76. Sturesson B, Selvik G, Uden A. Movements of the sacroiliac joints. A roentgen stereophotogrammetric analysis. *Spine.* 1989;14(2):162–165.
77. Sturesson B, Uden A, Vleeming A. A radiostereometric analysis of movements of the sacroiliac joints during the standing hip flexion test. *Spine.* 2000;25(3):364–368.
78. Sturesson B, Uden A, Vleeming A. A radiostereometric analysis of the movements of the sacroiliac joints in the reciprocal straddle position. *Spine.* 2000;25(2):214–217.
79. Triano JJ, McGregor M, Hondras MA, Brennan PC. Manipulative therapy versus education programs in chronic low back pain. *Spine.* 1995;20(8):948–955.
80. Tullberg T, Blomberg S, Branth B, Johnsson R. Manipulation does not alter the position of the sacroiliac joint. A roentgen stereophotogrammetric analysis. *Spine.* 1998;23(10):1124–1128; discussion 1129.
81. van der Wurff P, Hagmeijer RH, Meyne W. Clinical tests of the sacroiliac joint. A systemic methodological review. Part 1: reliability. *Man Ther.* 2000;5(1):30–36.
82. van der Wurff P, Meyne W, Hagmeijer RH. Clinical tests of the sacroiliac joint. *Man Ther.* 2000;5(2):89–96.
83. Van Dillen LR, Sahrmann SA, Norton BJ, et al. Reliability of physical examination items used for classification of patients with low back pain. *Phys Ther.* 1998;78(9):979–988.
84. van Tulder MW, Koes BW, Bouter LM. Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. *Spine.* 1997;22(18):2128–2156.
85. van Tulder M, Malmivaara A, Esmail R, Koes B. Exercise therapy for low back pain: a systematic review within the framework of the cochrane collaboration back review group. *Spine.* 2000;25(21):2784–2796.
86. Vincent-Smith B, Gibbons P. Inter-examiner and intra-examiner reliability of the standing flexion test. *Man Ther.* 1999;4(2):87–93.
87. Waddell G, Somerville D, Henderson I, Newton M. Objective clinical evaluation of physical impairment in chronic low back pain. *Spine.* 1992;17(6):617–628.
88. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain.* 1993;52(2):157–168.
89. Waddell G. Low back pain: a twentieth century health care enigma. *Spine.* 1996;21(24):2820–2825.
90. Werneke M, Hart DL, Cook D. A descriptive study of the centralization phenomenon. A prospective analysis. *Spine.* 1999;24(7):676–683.
91. Winkel D, Aufdemkampe G, Matthijs O, Meijer OG, Phelps V. *Diagnosis and Treatment of the Spine.* Gaithersburg, MD: Aspen Publishers, Inc.; 1996.
92. Wreje U, Nordgren B, Aberg H. Treatment of pelvic joint dysfunction in primary care—a controlled study. *Scand J Prim Health Care.* 1992;10(4):310–315.

APPENDIX

Name: ______________________________ Date: _____/_____/_____
mm dd yy

Here are some of the things other patients have told us about their pain. For each statement please circle the number from 0 to 6 to indicate how much physical activities such as bending, lifting, walking or driving affect or would affect your back pain.

	Completely Disagree			Unsure			Completely Agree
1. My pain was caused by physical activity.	0	1	2	3	4	5	6
2. Physical activity makes my pain worse.	0	1	2	3	4	5	6
3. Physical activity might harm my back.	0	1	2	3	4	5	6
4. I should not do physical activities which (might) make my pain worse.	0	1	2	3	4	5	6
5. I cannot do physical activities which (might) make my pain worse.	0	1	2	3	4	5	6

The following statements are about how your normal work affects or would affect your back pain.

	Completely Disagree			Unsure			Completely Agree
6. My pain was caused by my work or by an accident at work.	0	1	2	3	4	5	6
7. My work aggravated my pain.	0	1	2	3	4	5	6
8. I have a claim for compensation for my pain.	0	1	2	3	4	5	6
9. My work is too heavy for me.	0	1	2	3	4	5	6
10. My work makes or would make my pain worse.	0	1	2	3	4	5	6
11. My work might harm my back.	0	1	2	3	4	5	6
12. I should not do my regular work with my present pain.	0	1	2	3	4	5	6
13. I cannot do my normal work with my present pain.	0	1	2	3	4	5	6
14. I cannot do my normal work until my pain is treated.	0	1	2	3	4	5	6
15. I do not think that I will be back to my normal work within 3 months.	0	1	2	3	4	5	6
16. I do not think that I will ever be able to go back to that work.	0	1	2	3	4	5	6