SPINE Volume 29, Number 20, pp 2199–2205

A Randomized Clinical Trial of Treatment for Lumbar Segmental Rigidity

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Study Design. A randomized single-blind clinical trial of facet injections plus exercise, *versus* exercise alone, in chronic disabling work-related lumbar spinal disorders (CDWRLSD), accompanied by pilot interrater reliability and facet syndrome prevalence studies.

Objectives. To systematically investigate the use of facet injections as an adjunct to supervised lumbar stretching exercises in regaining lumbar range of motion (ROM) following prolonged deconditioning after work-related lumbar injuries. To assess interrater reliability of visual assessment of segmental rigidity (SR), and to evaluate the prevalence of facet syndrome in cases of lumbar SR.

Summary of Background Data. Corticosteroid joint injections have often been used to reduce musculoskeletal inflammation to facilitate joint mobilization in the presence of degenerative arthritis. Lumbar segmental rigidity is a recently described entity usually associated with painful chronic spinal disorders and postoperative spine surgery. Previous work has shown that SR and lumbar ROM improves with a brief intervention consisting of facet injections followed by specific stretching exercises. No systematic study has investigated the potential benefits of a combination of facet injections and exercise over supervised exercises alone to treat lumbar SR. Similarly, no study has assessed the association between SR and the facet syndrome.

Methods. From a group of consecutive patients (n = 421) with CDWRLSD referred for tertiary rehabilitation between November 1999 and January 2001, 70 were noted to have SR on intake physical examination. The first part of this study assessed interrater reliability for detecting SR, and intrarater reliability for 3-segment true lumbar ROM measurements. Patients randomly assigned to participate in supervised stretching exercises with the addition of fluoroscopically guided bilateral facet injections at the involved levels (Group A, n = 36) also underwent facet syndrome prevalence assessment at the time of injection. They were compared to a randomly allocated comparison group (Group B, n = 34) undergoing exercises alone in a single-blind design. Physical therapists saw patients an average of twice per week, providing supervision of a progressive home stretching program. Inclinometric joint ROM was measured at the time of group allocation, and again 5 to 7 weeks later. Validated questionnaires of pain (intensity VAS) and disability (Million VAS) related to the CDWRLSD were provided before and after the interventions.

Results. Part 1 reliability and facet syndrome prevalence work revealed that interrater reliability for experienced examiners to detect rigid segments was excellent (Pearson's r = 0.97, $P < 0.01$). Intrarater 3-joint motion measurement reliability was also good for all sagittal/coronal ROM (Pearson's r = 0.95–0.99, $P < 0.01$). Only 5 of 29 subjects with SR met criteria for facet syndrome (17%), consistent with prior prevalence studies of unselected patients with low back pain. In Part 2, a large majority of patients in both groups improved from the initial to the post-treatment ROM measurements (the primary outcome criterion of the study). However, a higher proportion of Group A (injection) patients (87%–95%) showed ROM improvement, compared to Group B (exercise only) patients (64%–79%). Group A patients showed a significantly greater ROM improvement in all sagittal and coronal movements, both in absolute terms and percent of initial measurement. No significant differences in pain or disability self-report were found between groups, pre- or postintervention, but both groups showed significant improvement from pre- to postintervention in pain and disability assessments.

Conclusions. The detection of SR and measurement of 3-segment true lumbar ROM by experienced examiners is highly reliable. Only 17% of CDWRLSD patients with lumbar SR met criteria for the facet syndrome, a rate approximately equal to that of unselected low back pain cohorts. This indicates that lumbar SR may be found whether or not pain of facet joint origin is present. In the randomized trial, facet injections significantly increased the percentage of patients with SR showing ROM improvement, as well as the degree of improvement in lumbar mobility after treatment. There is no evidence that facet injections increase the improvements in pain/disability report noted in both groups.

Key words: disability, facet injections, segmental rigidity, range of motion, stretching exercises, facet syndrome, lumbar work-related spinal disorders, spinal pain, reliability, occupational injury. **Spine 2004;29:2199–2205**

Low back pain has raised concern over high healthcare utilization[1,2] and the perceived limitations of effectiveness of many current treatments.[3–5] The most expensive single group of patients with low back pain on a per capita basis are those who have developed chronic disability following work-related lumbar spinal disorders. Although surgical treatment may be appropriate for a minority of these patients, a large majority will be ex-

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Acknowledgment date: March 18, 2003. First revision date: August 6, 2003. Second revision date: October 30, 2003. Acceptance date: November 3, 2003.
Supported in part by grants 2K02 MH01107, 2R01 MH46402, and 2R01 DE10713 from the National Institutes of Health.
The device(s)/drug(s) is/are FDA-approved or approved by corresponding national agency for this indication.
No funds were received in support of this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.
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posed to rehabilitation efforts. Over the past 15 years, secondary and tertiary rehabilitation programs have shifted their emphasis from passive methods to a focus on active exercise.[3,6,7] In any supervised exercise program designed to overcome chronic regional spine dysfunction, a sequence of training procedures is customary. Strength and endurance training is usually preceded by range of motion (ROM) exercises so that muscles can move through their full length and improve the length/tension association, while spastic muscles can be stretched as needed.[6–8]

Lumbar facet joints may develop stiffness, or rigidity, through prolonged immobilization, even without degenerative or other pathologic findings on diagnostic imaging. As in other diarthrodial joints, facet joints are susceptible to prolonged immobilization when chronic disabling work-related lumbar spinal disorder (CDWRLSD) patients avoid moving their lumbar spines for 6 to 12 months and longer. Improvements in sagittal and coronal ROM measured with an inclinometer have been correlated with improvements in pain report in chronically disabled industrial patients.[9–11] A condition termed segmental rigidity (SR) has described mobility deficits affecting the 3-joint complex at one or more lumbar levels.[12] A simple physical examination observational technique in lateral bending can be used to identify rigid segments in the lumbar spine. Just as disc degeneration of surgical significance usually occurs in the lower three lumbar segments (L3–S1), so SR in the unoperated patient usually occurs there also.[12] Surgical treatment alters the local physiology, so that rigidity at discectomy levels or adjacent segments is common. Rigidity above or below a lumbar spine fusion is also common. Segmental rigidity may extend into the upper lumbar spine if multiple level lumbar fusion has been performed at the lower levels.

Inclinometric techniques for measuring lumbar spine motion have been used for some time.[13–16] In the usual technique, inclinometers isolate the true lumbar motion in lumbar sagittal and coronal planes by placing inclinometers over the T12 spinous process and over the sacrum. The technique can easily be modified by experienced clinicians who can identify individual spinous processes, in all but the most obese subjects, to measure fewer segments. Because almost all lumbar SR occurs in the most caudad segments, measurements in this study were restricted to the three most caudad remaining mobile segments. Intrarater reliability for measuring three-segment true lumbar ROM was evaluated in Part 1 of the present study because no 3-segment studies measures could be found in the lumbar spine literature.

Facet joints, along with other posterior elements, have been implicated in a variety of painful lumbar conditions.[17–19] The concepts of low back pain of zygapophysial joint origin and its treatment remain controversial.[20–26] Various block techniques have been used to make the diagnosis of the facet syndrome, or pain of zygapophysial joint origin, for various purposes including facet joint denervation.[21,22,27–30] The prevalence of pain thought to be of facet joint origin in subacute and chronic patients with low back pain is about 15%. To ascertain whether prevalence was different in patients displaying SR, Part 1 of the present study used the same protocol of local anesthetic mixture, injection technique and an immediate, postinjection pain questionnaire used in prior work.[21,29,31]

The primary goal of the present study was to investigate the utility of corticosteroid facet injections as an adjunct to stretching exercises, and was evaluated in Part 2 of the study. The treatments were provided to, and supervised for, a group of CDWRLSD patients in the preliminary phases of a tertiary rehabilitation program. Pre- to postintervention observation time was longer than that expected for depot corticosteroid pharmacologic effect (5–7 weeks).

■ Materials and Methods

Study Participants. From a group of patients referred for tertiary functional restoration between November 1999 and January 2001 (n = 421), 70 patients with CDWRLSD were found to demonstrate lumbar SR on a screening physical examination and met inclusion criteria.[12] If lumbar rigidity between 1- and 3-levels was noted, patients were randomly allocated to two groups in a single-blind design (examiners and treating/evaluating therapists blinded). Group A (combined exercise/injection treatment) patients were assigned based on date of the month of their initial visit, alternating with patients allocated to Group B (exercise-only controls). Exclusion criteria involved any patients who declined injection as a treatment option (determined before allocation), failure to achieve insurance preauthorization (n = 2), and more than 3 levels of SR. All patients provided consent for injections after discussion of risks and benefits of the exercise or combined procedures, and there were no dropouts following initiation of the study. The demographic comparison between Groups A (n = 36) and B (n = 34) is presented in Table 1. All patients noted to have SR affecting a maximum of 3 segments were included (either unilateral or bilateral rigidity; see Figure 1 for an example). Prior surgery was not a contraindication (discectomy and/or fusion). Note that Group A had a higher percentage of surgeries, leading to a bias against the hypothesis that this group would show greater ROM improvements (*i.e.*, bias toward lower pre- and post-treatment ROM). All patients met criteria for admission to the functional restoration program. No other exclusions applied. The only other significant difference between groups was the greater pretreatment rigidity in Group A, consistent with the surgical differences, again creating a potential bias against our working hypothesis. All patients had a diagnosis of lumbar degenerative disc disease at one or more levels. There was no significant difference in the number of surgeries and there were no cases of spondylolisthesis or significant central/foraminal stenosis. All patients had lumbar radiographs and MRI at a minimum. Both groups were similar in terms of workers' compensation status (venue, financial benefits, *etc.*).

Part 1 Procedures. Part 1 consisted of several preliminary studies designed to increase the validity of the findings of the randomized trial and to clarify the association between SR and

Table 1. Demographic Data for Group A (Injections + Stretching Exercises) and Group B (Stretching Exercises Only)

Variable	Group A (n = 36)	Group B (n = 34)	*P*
Age [mean (SD)]	43.4 (8.5)	46.2 (10.5)	0.23 (NS)
Gender (% male)	75.0	67.6	0.49 (NS)
Length of disability (mo) [mean (SD)]	12.4 (14.2)	15.6 (14.8)	0.36 (NS)
No. of surgeries [mean (SD)]	0.50 (.81)	0.27 (.67)	0.21 (NS)
No. of operated segments by surgery type [no. (%)]			0.39 (NS)
No surgery	23 (63.9)	29 (85.3)	
1-level discectomy	4 (11.1)	2 (5.3)	
2-level discectomy	2 (5.6)	1 (2.9)	
3-level discectomy	3 (8.3)	1 (2.4)	
1-level fusion	3 (8.3)	0	
2-level fusion	1 (2.8)	1 (2.9)	
No. (%) of rigid levels			0.021*
1 level	0	4 (11.8)	
2 levels	16 (44.4)	20 (58.8)	
3 levels	20 (55.6.7)	10 (29.4)	

NS = not significant.
*Categorical data analyzed by chi square analyses; continuous data analyzed by independent *t*-tests.

the facet syndrome. There were three components to this part of the study.

Segmental Rigidity Interrater Reliability. The first 13 patients entered into the study (both Groups A and B) were independently examined by the senior author and an experienced physical therapist on the same day of allocation. Each examiner was blinded to the other's finding. They separately assessed the levels of SR, either unilateral or bilateral. Each observer provided a determination of the number of levels of SR noted, and whether bilateral, or only left/right. An independent observer then calculated the correlation of the observations.

ROM Reliability (3 Segments). The accuracy of T12–S1 inclinometric true lumbar motion measurements have been previously well described.[9,13,14,16,32] In order to enhance precision for detecting small changes in ROM at the relevant levels, trained therapists practiced identifying the anatomic landmarks used to locate the three most caudad mobile segments (*i.e.*, L3–S1 in most cases, while incorporating, but not counting, any surgically fused levels). An intrarater reliability study was performed by an experienced physical therapist on 10 asymptomatic subjects to ascertain the accuracy of measuring 3-segment true lumbar ROM instead of the usual 6-segment (T12–S1) motion. These asymptomatic subjects were healthy staff members of the rehabilitation facility with no history of low back pain over the previous year, or any prior lumbar surgical history. Tests were performed 15 to 20 minutes apart, with a "rest period" to avoid exact duplication of movement by the normal subjects but also preventing other activities of daily living from creating variations in flexibility. The expectation was that the true ROM component would be reliable but that the pelvic ROM component would show greater variation.[9,13,14,16] The 3-segment true lumbar spine motion component, as well as the pelvic motion (as measured by the sacral inclinometer), were recorded, and the correlation coefficients were analyzed.

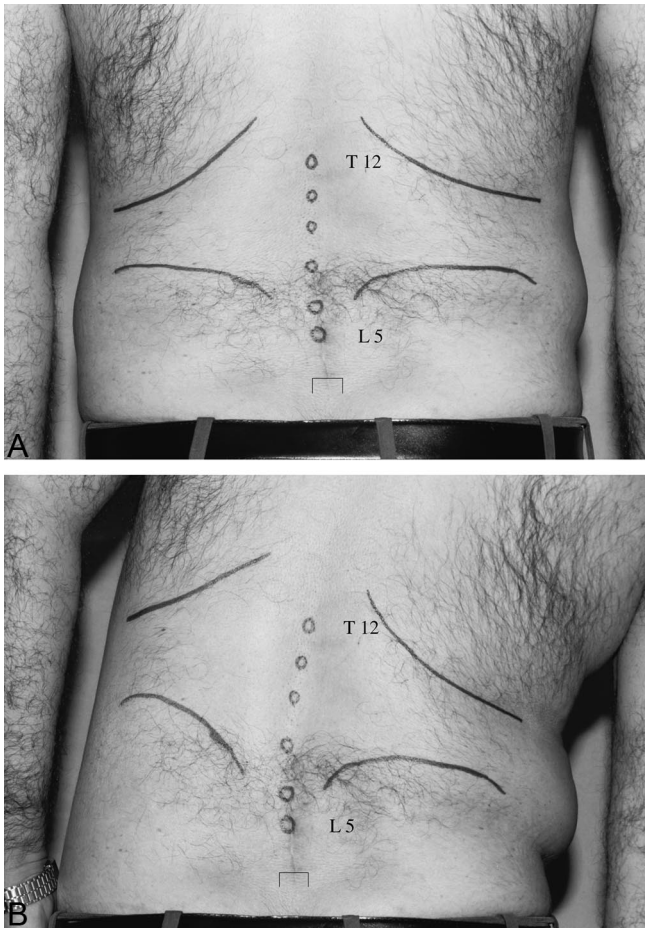

Figure 1. Unoperated CDWRLSD 47-year-old male patient with 21 months of continuous total disability since lumbar injury, 8 months status post L4 microdiscectomy with routine postoperative course presenting for tertiary rehabilitation. **A**, Erect posture viewed posteriorly with top of sacrum, T12–L5 lumbar spinous processes, lowest rib, and superior border of ilium outlined with skin marks. **B**, Right lateral bend movement demonstrating good motion in upper three lumbar motion segments, T12–L3, with no lateral curvature extending to the three lower motion segments, L3–S1. Note that left iliac crest skin mark no longer follows underlying bony landmark.

Facet Syndrome Evaluation. Diagnosis of the facet syndrome is determined by fluoroscopically guided facet blocks followed by the patient's response to a pain questionnaire over the ensuing several hours to monitor immediate response to the local anesthetic.[21,31,33,34] We were interested in the prevalence of facet syndrome in patients demonstrating SR on physical examination. In providing the fluoroscopically guided facet injections to Group A patients, we followed the previously described protocols for facet blockade used in determining the presence of the facet syndrome immediately after the injection procedure. The patients were provided with a standardized questionnaire asking for the percentage of pain relief hourly over the ensuing 6 hours.[21,33,34] A diagnosis of facet joint pain (facet syndrome) was made only if patients demonstrated at least 80% pain relief at both 1- and 2-hour intervals postinjection.

Part 2 Procedures. The randomized single-blind clinical trial followed these preliminary aspects of the study. There were two components to this part of the study.

Facet Levels and Injection Procedure. Within Group A, facet injections were performed bilaterally at the affected levels in all subjects. Bilateral injections were performed even when some motion was present to one side at a given level because it was impossible to determine whether the mobility limitation was correlated with ipsilateral, contralateral, or bilateral facet stiffness. During the injection procedure, all Group A patients underwent facet injections under fluoroscopic control. They received local anesthetic for the procedure. Based on the findings of SR on the initial physical examination, as confirmed on the day of injection, one to three levels were injected bilaterally. Each joint was injected with a mixture of 1 mL 2% lidocaine, 1 mL 0.5% bupivacaine, and 1 mL of a depot corticosteroid preparation.[31] Interarticular placement was verified fluoroscopically, and injection proceeded until resistance was encountered (1–1.5 mL), whereupon the needle was withdrawn slightly, allowing placement of the remainder of the 3-mL mixture around the posterior facet capsule. Radiologists provided needle placement under fluoroscopic control, and all injections were by the same clinician. All eligible candidates were assessed based specifically on the three most caudad remaining mobile lumbar segments, which in all cases contained the rigid segments. If a surgical fusion had occurred at one or more levels between L3 and S1, an additional cranial level was added to the ROM measurement for each level fused. For example, if a patient was fused L4–S1, measurements were taken from L1 to S1 (incorporating the 2-segment fusion). If the patient had undergone an isolated L4–L5 fusion, motion was recorded from L2 to S1 (incorporating the mobile segments at L2–L3, L3–L4, and L5–S1). Post-treatment measures were performed 5 to 7 weeks after the initial measurements at a time when the pharmacologic effect of the depot steroid would be markedly lessened or dispersed so that persistent changes could not be solely related to drug effect.

Exercise and Evaluation Procedure. Shortly after pretreatment measurements were taken, all patients were instructed in a home stretching exercise program to be supervised by physical therapists on each subsequent visit. During the interval between measures, patients were supervised on an average of twice a week in the facility and were advised in performing exercises as part of the home stretching program. They came to the facility for 4 to 6 hours, usually beginning 1 or 2 times per week and ending with a final week of daily part-day treatment. Intervals between measures varied according to factors unrelated to this trial, including pace of narcotic detoxification, stabilization on psychotropic medications, preauthorization delays, and degree of physical inhibition and deconditioning. There were no group differences in the distribution of these factors.

At the time of each physical measurement, pain and disability questionnaires were administered to the patients. Patients completed a pain drawing with a pain intensity visual analog scale (VAS), as well as a Million VAS disability score.[20,35–40] The pain intensity score is rated on a 10-cm line, running from "no pain" (0) to "most severe pain"(10). The Million VAS represents the answers to 15 items dealing mainly with how pain affects activities of daily living, with a range from "no disability" (0) to "most severe disability" (150).

■ Results

Reliability Studies

Thirteen of the initial patients were assessed independently by two examiners. There was unilateral agreement on all segmental levels noted to be rigid. The Pearson's product correlation coefficient was r = 0.97 ($P < 0.001$).

Table 2. Pearson Product Correlation Coefficients and *P* Values for True Lumbar Sagittal (Flexion-Extension) and Coronal (Right/Left) Lateral Bend Range of Motion for Normal Subjects (n = 10) Compared With Pelvic Range of Motion Component on a Test-Retest Protocol

Variable	Pearson Product Correlation	*P*
Flexion		
True	0.996	<0.01
Pelvic	0.997	<0.01
Extension		
True	0.979	<0.01
Pelvic	0.901	<0.01
Lateral bend right		
True	0.948	<0.01
Pelvic	0.652	<0.05
Lateral bend left		
True	0.971	<0.01
Pelvic	0.803	<0.01

The 3-segment ROM reliability study is summarized in Table 2. As all asymptomatic subjects (n = 10) lacked any prior back surgery or history of back pain within the past year, it was expected that true lumbar ROM would be highly reproducible as measured by experienced examiners. Pelvic motion, because it is based on multiple factors, including effort, hamstrings fatigue, slight differences in ankle/knee flexion, *etc.*, would be anticipated to show more variation with repeated measures. This is the pattern that is noted for the inclinometric ROM measurements, as shown by the Pearson product coefficients in Table 2. All 4 sagittal/coronal measurements proved highly reliable for identifying true lumbar motion across 3 mobile segments.

Facet Syndrome Prevalence

Of the 36 Group A patients, 29 completed pain relief questionnaires immediately following the injections (unrelated to pre- or post-treatment VAS scores). Only 5 of 29 patients (17.2%) met criteria for pain of facet joint origin, or the facet syndrome (80% pain relief 1- and 2-hours postinjection).[30,31] There was no significant difference in their motion measurements or symptom report compared to the 24 patients who did not meet criteria for facet syndrome.

Part 2: Randomized Trial Outcomes

Motion Measurements

Table 3 documents the percentage of each group demonstrating improvement (positive change) from the pre- to the post-trial ROM measurements. The percentage showing improvement in Group A was significantly higher than Group B for all movements, although a large majority of patients in both groups showed improvement. Between 87% and 95% of Group A patients showed improvement in sagittal/coronal motion, while 64% to 79% of Group B patients improved.

Table 3. χ^2 Analysis of the Proportion of Those Who Showed Range of Motion Improvement Among Groups A and B

Variable	Group A (n = 36)	Group B (n = 34)	*P*
True flexion (% of patients improved)	94	79	0.030
True extension (% of patients improved)	89	74	0.049
True lateral bend right (% of patients improved)	92	77	0.041
True lateral bend left (% of patients improved)	89	64	0.007

Monitoring changes in ROM was the primary outcome for this study. Table 4 presents the 3-segment ROM measurements pre- and postintervention, along with the mean percentage improvement for Groups A and B. Considering that the true lumbar measurements reflect movement of only the 3 most caudad lumbar mobile segments, the postintervention movements were quite high, with the means reflecting 75% to 90% of anticipated motion for these segments in an asymptomatic subject population. Group B exercise-only comparison patients also showed excellent improvements in mobility over the training period. However, the improvements for Group A showed statistically greater improvements, ranging from 60% to 93% over pretrial ROM measures, compared to Group B gains of 25% to 48%.

Pain and Disability Assessment

The pain intensity analog and Million disability VAS means and standard deviations were calculated for each group pre- and post-training (Table 5). Both groups showed a significant decrease in the mean VAS pain intensity from pre- to post-trial. They also showed a decrease in VAS disability scores from pre- to post-trial. The two groups were comparable in their pain and disability ratings pre- and post-trial. The percentage of patients in both Group A and B who improved was not statistically different for both the pain and disability ratings.

Table 4. True Lumbar Range of Motion [mean (SD)] (Flexion, Extension, and Lateral Bend) at Pre- and Postintervention Measurements

Variable	Group A (n = 36)	Group B (n = 34)	*P**
True flexion			
Pre [mean (SD)]	15.9 (9.8)	19.1 (10.5)	
Post [mean (SD)]	33.0 (10.5)	27.8 (12.5)	
% improvement	93	48	<0.001
True extension			
Pre [mean (SD)]	7.6 (4.4)	7.1 (3.7)	
Post [mean (SD)]	13.5 (6.7)	9.0 (3.9)	
% improvement	77	25	0.004
True right lateral bend			
Pre [mean (SD)]	8.8 (3.9)	10.2 (4.0)	
Post [mean (SD)]	14.4 (4.9)	12.9 (5.4)	
% improvement	60	29	0.011
True left lateral bend			
Pre [mean (SD)]	6.8 (3.8)	6.7 (3.9)	
Post [mean (SD)]	11.1 (4.0)	8.9 (4.0)	
% improvement	65	32	0.027

The % improvement represents the mean of individual patients' percent of improvement: [(Post-Rx ROM − Pre-Rx ROM)/Pre-Rx ROM] x 100.
*Independent *t* test comparison of the means of individual patients' percent improvement.

Table 5. Pain Intensity VAS and Million Disability VAS Scores for Group A and B Patients, and the Percentage of Each Group Demonstrating Improvement

Variable	Group A (n = 36)	Group B (n = 34)	*P*
Pain intensity			
Pre [mean (SD)]	6.3 (1.5)	6.7 (1.8)	0.39 (NS)
Post [mean (SD)]	5.4 (1.6)	5.9 (2.1)	0.27 (NS)
*P** % patient improvement	<0.003	<0.004	
	53%	50%	0.82 (NS)
Million VAS			
Pre [mean (SD)]	99.7 (16.7)	100.0 (29.2)	0.95 (NS)
Post [mean (SD)]	85.6 (21.5)	92.2 (25.1)	0.24 (NS)
*P** % patient improvement	<0.001	<0.003	
	72%	68%	0.68 (NS)

NS = not significant.
*Paired *t* tests for change from pre- to post-training.

Discussion

This randomized clinical trial in a CDWRLSD population suggests that facet injections may be a useful adjunct to monitored stretching exercises for regaining lumbar mobility in cases of localized SR but do not add to improvements in pain/disability reports provided by exercise alone. Data suggest that postintervention motion is higher in the sagittal and coronal planes, the percentage improvement of all four movements over initial ROM is enhanced, and the percentage of chronic pain patients demonstrating 3-segment motion improvement is greater when facet injections are added to the supervised stretching program. Several study weaknesses are worth noting. First, this study did not include a placebo group who failed to either receive any active interventions at all, or who underwent some type of sham procedure (*e.g.*, injection with saline). There were a number of practical and bioethical considerations that prevented a placebo control being used. This was a workers' compensation chronic pain population for whom no inducements could be devised to elicit cooperation with a placebo trial. There was the ethical issue that subjects given a placebo will probably not improve, and some may actually deteriorate, resulting in harm to the subject created an additional barrier. This would seriously violate the ethical concern of the "right to treatment." Indeed, Freedman (in 1987) and Levine (in 1999) have comprehensively reviewed significant bioethical concerns associated with placebo-control groups that violate the Declaration of Helsinki.[41,42] Therefore, with these issues in mind, as well as the fact that a workers' compensation sample was being treated, a placebo-control condition

could not be included in this design. A second "active treatment" group involving oral or injectable corticosteroids might have been used, but the authors chose not to use this approach for similar reasons. Thus, while the data suggest that facet injections provide a useful adjunct for treating SR within this population, the possibility that oral or intramuscular corticosteroid alone could have a similar effect was not investigated in this study. We further note that significant variability is introduced into the percent improvement measure because the pretrial measure is often relatively small in amplitude, which may disproportionately magnify the percentage gain (or loss) of motion for certain individuals. Nonetheless, this is the most useful measurement identified for expressing the change that has taken place from pre- to postintervention.

Injections were performed only once, with the expectation that the pharmacologic effect of the depot steroid would have a sufficient duration to achieve appropriate gains if patients complied with the stretching program. Both groups showed improvement from pre- to post-trial for pain (intensity VAS) and disability (Million VAS) self-report. However, there was no evidence that facet injections helped pain or disability report, because both groups improved similarly, with comparable pre- and post-trial measures. Because the cortisone should not have been producing a significant pharmacologic effect at either the pre- or post-trial assessments in both groups, improvement in pain and disability self-report corresponded to increases in motion, regardless of the degree of improvement or the method used.

As another concern in this study, the distribution of preintervention SR showed differences between the groups despite randomization. Group A had more 3-level rigidity observed on physical examination, and might therefore be presumed to have more limitation of preintervention movement. However, actual measured preintervention motion means (Table 4) demonstrated marginally less flexion and right lateral bend movement for Group A, and slightly greater extension and left lateral bend motion. Of course, if it were present, a difference in observed rigidity could bias the study in two ways. First, greater pretrial SR for Group A suggests they have "further to go" and may have a smaller denominator, magnifying the "percent improvement" variable. However, observation of postintervention movements (Table 4) showed that the Group A movements were all larger than Group B. Second, there is no evidence to suggest that a completely rigid segment (or one that appears to be so on physical examination) is either more difficult or easier to mobilize than one that shows lesser restriction of movement. Therefore, it is unlikely that significant bias is created by this finding. While it is possible that unintended bias was present despite randomization, we demonstrated no significant pretrial group differences in age, gender, duration of disability, number and type of surgery, pain or disability self-report scores that would suggest any systematic likelihood that one group would be able to disinhibit movements or overcome fear-avoidance with greater alacrity than the other.

Another interesting finding was appended to the randomized trial. The question of whether the facet syndrome (pain of facet joint origin) exists in a greater proportion of patients ultimately demonstrating SR associated with their chronic disability has been an open question. We used the methodology of Dreyfuss *et al*[21,31,33,34] with the injection patients (all of whom had confirmed lumbar SR), and found that only 17% of the group met the criteria for facet syndrome. Only those receiving facet injections could be part of this substudy. The result is very similar to the prevalence among other back pain populations that have been studied, suggesting that lumbar SR is an independent entity, no more likely to occur in the presence of the facet syndrome than without it.

Data are unavailable to exactly identify the prevalence of SR in the CDWRLSD population. However, approximately 70% of the study population referred for treatment during the study interval (n = 421) claimed a lumbar injury as at least one of their compensable body parts. Of this group, approximately 25% were noted to have SR at a minimum of one level on their screening history and physical examination. This study does not suggest that facet injections are medically indicated for such CDWRLSD patients. As demonstrated herein, several patients showed decrease in motion over the study period, even after facet injections (Table 3), thus demonstrating that inhibition of function may override any benefit derived from injections and exercise in some cases. Other cases may be so mild, or of such short duration, that exercise alone may be equally effective in resolving the immobility. As indicated earlier, corticosteroid by any route of administration may account for the ROM differences between groups in this study. Clearly, clinical judgment is required in making a determination of whether facet injections are appropriate in individual cases of lumbar SR in CDWRLSD patients until further evidence suggests otherwise.

Interarticular corticosteroid injections have been shown to have a deleterious effect on load-bearing joints if performed frequently. When injections are performed for pain alone, their value has been seriously questioned.[2,25] A satisfactory pain relief response to facet injections and/or medial branch blockade may result in rhizotomy, a surgical procedure designed to ablate the neural input to the joints, thereby creating an iatrogenic, aseptic Charcot joint. For patients with SR, in whom the goal is to regain mobility in the affected segments, the temporary pain relief from facet injection should not be a precursor to rhizotomy. However, if the decrease in pain consistent with steroid use helps to reduce the inhibition of movement brought about by pain, a dual benefit of facet injection on pain and motion may be realized. It is also important to emphasize the cost of fluoroscopically guided facet injections. While they may be an appropriate adjunct to exercise, they may be unnecessary in many

cases. Selection criteria for the procedure may therefore include those patients with a greater length of disability (creating more entrenched rigidity), as well as those with greater fear-avoidance, and in whom more pain control may stimulate higher motivation to enhance mobility. Further research is needed to clarify the role of facet injections in ameliorating SR arising in CDWRLSD.

■ Key Points

- The detection of segmental rigidity and measurement of 3-segment true lumbar range of motion by experienced examiners is highly reliable.
- A total of 17% of chronic disabling work-related lumbar spinal disorder patients with lumbar segmental rigidity meet the criteria for the facet syndrome. The prevalence is similar to other back pain cohorts, suggesting that segmental rigidity is an independent entity, no more likely to occur in the presence of the facet syndrome than without it.
- A higher percentage of patients randomized to supervised stretching exercises and facet injections at the involved levels demonstrated improvement in range of motion, with greater individual improvements, relative to the "exercise only" patients.
- Patients with facet injection note identical improvements in pain/disability report seen with exercise-induced mobility gains in both groups.

References

1. Andersson G. Epidemiological features of chronic low back pain. *Lancet* 1999;354:581–5.
2. Atlas S, Keller R, Chang Y, et al. Surgical and non-surgical management of sciatica secondary to a lumbar disc herniation: five-year outcomes from the Maine lumbar spine study. *Spine* 2001;26:1179–87.
3. Gatchel R, Mayer T. Occupational musculoskeletal disorders: introduction and overview of the problem. In: Mayer T, Gatchel R, Polatin P, eds. *Occupational Musculoskeletal Disorders*. Philadelphia: Lippincott, Williams & Wilkins, 1999:3–8.
4. Javid M, Hadar E. Long-term follow-up review of patients who underwent laminectomy for lumbar stenosis: a prospective study. *J Neurosurg* 1998;89: 1–7.
5. Woertgen C, Rothorel R, Borne K, et al. Variability of outcome after lumbar disc surgery. *Spine* 1999;24:807–13.
6. Mayer T. Functional restoration of patients with chronic spinal pain. In: Fardon D, Garfin S, eds. *AAOS Spine Orthopaedic Knowledge Update*, ed. 2. Chicago: AAOS Press, 2002;229–38.
7. Mayer T, Polatin P. Tertiary nonoperative interdisciplinary programs: the functional restoration variant of the outpatient chronic pain management program. In: Mayer T, Gatchel R, Polatin P, eds. *Occupational Musculoskeletal Disorders: Function, Outcomes and Evidence*. Philadelphia: Lippincott Williams & Wilkins; 1999:639–50.
8. Mayer T, Gatchel R, Polatin P, et al. Outcomes comparison of treatment for chronic disabling work-related upper extremity disorders and spinal disorders. *J Occup Environ Med* 1999;41:761–70.
9. Keeley J, Mayer T, Cox R, et al. Quantification of lumbar function: Part 5. Reliability of range of motion measures in the sagittal plane and an in vivo torso rotation measurement technique. *Spine* 1986;11:31–5.
10. Kohles S, Barnes D, Gatchel R, et al. Improved physical performance outcomes following functional restoration treatment in patients with chronic low back pain: early versus recent training results. *Spine* 1990;15:1321–4.
11. Mayer T, Pope P, Tabor J, et al. Physical progress and residual impairment quantification after functional restoration: I. Lumbar mobility. *Spine* 1994; 19:389–94.
12. Mayer T, Robinson R, Pegues P, et al. Lumbar segmental rigidity: can its identification with facet injections and stretching exercises be useful? *Arch Phys Med Rehabil* 2000;81:1143–50.
13. American Medical Association. Chapter 3. In: Engleberg A, ed. *American Medical Association Guides to the Evaluation of Permanent Impairment*, 3rd ed. Chicago: AMA Press, 1988:71–94.
14. American Medical Association. Chapter 15. In: Cochiarella L, Andersson G, eds. *American Medical Association Guides to the Evaluation of Permanent Impairment*, 5th ed. Chicago: AMA Press, 2000:373–431.
15. Loebl W. Measurements of spinal posture and range in spinal movements. *Ann Phys Med* 1967;9:103.
16. Mayer T, Tencer A, Kristoferson S, et al. Use of noninvasive techniques for quantification of spinal range-of-motion in normal subjects and chronic low-back dysfunction patients. *Spine* 1984;9:588–95.
17. Hirsh C, Ingelmark B-O, Miller M. The anatomical basis for low back pain: studies on the presence of sensory nerve endings in ligamentous, capsular and intravertebral disc structures in the human lumbar spine. *Acta Orthop Scand* 1963;33:1–17.
18. McCall I, Park W, O'Brien J. Induced pain referral from posterior lumbar elements in normal subjects. *Spine* 1979;4:441–6.
19. Mooney V, Robertson J. The facet syndrome. *Clin Orthop* 1976;115:149–56.
20. Capra P, Mayer T, Gatchel R. Adding psychological scales to your back pain assessment. *J Musculoskel Med* 1985;2:41–52.
21. Dreyfuss P, Schwarzer A, Lau P, et al. Specificity of lumbar medial branch and L5 dorsal ramus blocks: a computerized tomography study. *Spine* 1997; 22:895–902.
22. Eisenstein S, Parry C. The lumbar facet arthrosis syndrome. *J Bone Joint Surg Br* 1987;69:3–7.
23. Helbig T, Lee C. The lumbar facet syndrome. *Spine* 1988;13:61–4.
24. Jackson R. The facet syndrome: myth or reality? *Clin Orthop* 1992;279: 110–21.
25. Jackson R, Jacobs R, Montesano P. Facet joint injection in low back pain: a prospective statistical study. *Spine* 1988;13:966–71.
26. Mooney V. Percutaneous procedures for diagnosis and treatment of spinal pain. In: Garfin S, Vacarro A, eds. *AAOS Orthopaedic Knowledge Update: Spine*. Chicago: AAOS Press, 1997;121–6.
27. Ashton I, Ashton B, Gibson S, et al. Morphological basis for back pain: the demonstration of nerve fibers and neuropeptides in the lumbar facet joint capsule but not in the ligamentum flavum. *J Orthop Res* 1992;10:72–8.
28. Lau L, Littlejohn G, Miller M. Clinical evaluation of intra-articular injections for lumbar facet joint pain. *Med J Aust* 1985;143:563–5.
29. Schwarzer A, Aprill C, Derby R, et al. The false-positive rate of uncontrolled diagnostic blocks of the lumbar zygapophyseal joints. *Pain* 1994;58:195–200.
30. Schwarzer A, Aprill C, Derby R, et al. Clinical features of patients with pain stemming from the lumbar zygapophyseal joints: is the lumbar facet syndrome a clinical entity? *Spine* 1994;19:1132–7.
31. Dreyfuss P. Personal communication, 2000.
32. Mayer T, Kondraske G, Beals S, et al. Spinal range of motion: accuracy and sources of error with inclinometric measurement. *Spine* 1997;22:1976–84.
33. Dreyfuss P, Halbrook B, Pauza K, et al. Efficacy and validity of radiofrequency neurotomy for chronic lumbar zygapophysial joint pain. *Spine* 2000; 25:1270–7.
34. Kaplan M, Dreyfuss P, Halbrook B, et al. The ability of lumbar medial branch blocks to anesthetize the zygoapophyseal joint: a physiologic challenge. *Spine* 1998;23:1847–52.
35. Anagnostis C, Mayer T, Gatchel R, et al. The million visual analog scale: its utility for predicting tertiary rehabilitation outcomes. *Spine J* 2003;28:1–10.
36. Dersh J, Gatchel R, Polatin P. Chronic spinal disorders and psychopathology: research findings and theoretical considerations. *Spine J* 2001;1:88–94.
37. Dersh J, Gatchel R, Polatin P, et al. Prevalence of psychiatric disorders in patients with chronic work-related musculoskeletal pain disability. *J Occup Environ Med* 2002;44:459–68.
38. Million R, Hall R, Nilsen KH, et al. Assessment of the progress of the back-pain patient. *Spine* 1982;7:204–12.
39. Mooney V, Cairns D, Robertson J. A system for evaluating and treating chronic back disability. *West J Med* 1976;124:370–6.
40. Polatin P, Kinney R, Gatchel R, et al. Psychiatric illness and chronic low back pain: the mind and the spine: which goes first? *Spine* 1993;18:66–71.
41. Freedman B. Equipoise and the ethics of clinical research. *N Engl J Med* 1987;317:141–5.
42. Levine R. The need to revise the declaration of Helsinki. *N Engl J Med* 1999;341:531–4.