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Original article

Slump stretching in the management of non-radicular low back pain: A pilot clinical trial ☆

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Abstract

The purpose of this study was to determine if slump stretching results in improvements in pain, centralization of symptoms, and disability in patients with non-radicular low back pain (LBP) with likely mild to moderate neural mechanosensitivity. Thirty consecutive patients referred to physical therapy by their primary care physician for LBP who met all eligibility criteria including a positive slump test but who had a negative straight-leg-raise test (SLR) agreed to participate in the study. All patients completed several self-report measures including a body diagram, numeric pain rating scale (NPRS), and the modified Oswestry Disability Index (ODI). Patients were randomized to receive lumbar spine mobilization and exercise ($n = 14$) or lumbar spine mobilization, exercise, and slump stretching ($n = 16$). All patients were treated in physical therapy twice weekly for 3 weeks for a total of 6 visits. Upon discharge, outcome measures were re-assessed. Independent t-tests were used to assess differences between groups at baseline and discharge. No baseline differences existed between the groups ($P > .05$). At discharge, patients who received slump stretching demonstrated significantly greater improvements in disability (9.7 points on the ODI, $P < .001$), pain (.93 points on the NPRS, $P = .001$), and centralization of symptoms ($P < .01$) than patients who did not. The results suggest that slump stretching is beneficial for improving short-term disability, pain, and centralization of symptoms. Future studies should examine whether these benefits are maintained at a longer-term follow-up.

Keywords: Low back pain; Neurodynamics; Slump test; Slump stretching

1. Introduction

Disability associated with low back pain (LBP) continues to rise, contributing to a substantial economic burden that exceeds nearly 50 billion annually in the United States alone (Frymoyer, 1992). Health care expenditures among individuals with LBP are also 60% greater than those without LBP (Luo et al., 2004) with 37% of the costs a direct result of physical therapy services (Maniadakis and Gray, 2000).

Physical therapists utilize a wide range of interventions in the management of LBP; however, evidence for the effectiveness of these interventions is limited (Philadelphia Panel, 2001). Given that LBP is a heterogeneous condition, it does not seem reasonable to expect that all patients will benefit from a single treatment approach. Rather, the key is to identify subgroups of patients with a high probability of achieving a successful outcome with a particular intervention. Evidence suggests that short- and longer-term outcomes are improved when a classification-based approach is used compared to decision-making based on

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clinical practice guidelines (Fritz et al., 2003). To date, evidence for several subgroups of LBP exist, such as patients likely to benefit from manipulation (Childs et al., 2004; Flynn et al., 2002), lumbar stabilization (O'Sullivan et al., 1997), and specific directional exercise (Long et al., 2004).

One subgroup that has not been readily examined is patients with more distal symptoms whose symptoms are not improved with specific directional exercises (i.e. flexion- or extension-oriented exercise). These patients are commonly thought to be experiencing altered neurodynamics, the interaction between nervous system mechanics and physiology (Shacklock, 1995a, b). A number of neurodynamic tests have been purported to assess the mechanosensitivity of neurogenic structures (Cyriax, 1942; Kenneally et al., 1988; Maitland, 1985). Cyriax (1942) originally used neurodynamic testing, specifically the straight-leg-raise (SLR), to identify the presence of perineuritis. Maitland (1985) further refined the technique and described the slump test, which incorporated cervical flexion and ankle dorsiflexion which was believed to assess the mechanosensitivity of the neuromeningeal structures within the vertebral canal.

Studies (Adams and Logue, 1971; Breig, 1978; Goddard and Reid, 1965) have supported the claims of Cyriax (1942) and Maitland (1985) by demonstrating that in the cadaver model, spinal flexion resulted in tension of the nerve roots and dural sleeve (Breig, 1978). Although it has often been stated that neurodynamic tests have limited diagnostic utility in the differentiation between neural and non-neural structures (Di Fabio, 2001), recent evidence demonstrated that pain of nonneural origin (experimentally induced) was not exacerbated by slump stretching (Coppieters et al., 2005). The authors suggested that the results of their study support the use of neurodynamic tests (including the slump) in the identification of altered neurodynamics.

Since Maitland (1985) described the slump test it has been used as an assessment tool for the identification of possible altered neurodynamics and more recently has been suggested as a possible treatment technique (Butler, 2000). However, limited evidence exists to support the effectiveness of using the slump test as a treatment approach and has only been presented in the form of case reports or case studies (Cleland et al., 2004; Cleland and McRae, 2002; George, 2000, 2002).

George (2002) recently described the outcomes in a subgroup of 6 patients hypothesized to respond favorably to slump stretching. Treatment was limited to those whose symptoms did not worsen or improve with lumbar flexion and extension movements and who exhibited a positive slump test in the absence of radicular signs. Although favorable outcomes were reported, the design of this study being a case series precludes establishing a cause and effect relationship. Therefore, the purpose of this study was to determine whether slump stretching is beneficial for the subgroup of patients hypothesized to benefit from this form of treatment. We hypothesized that patients who received slump stretching plus lumbar spine mobilization and exercise would experience greater improvements in disability, pain, and centralization of symptoms than patients who received lumbar spine mobilization and exercise only.

2. Methods

Participants were consecutive patients in primary care between 18 and 60 years of age with a chief complaint of LBP referred to physical therapy. Patients were required to have symptoms that referred distal to the buttocks, reproduction of the patient's symptoms with slump testing, no change in symptoms with lumbar flexion or extension, and a baseline Oswestry score greater than 10%. Patients with "red flags" for a serious spinal condition (e.g. infection, tumors, osteoporosis, spinal fracture, etc.) were excluded. Individuals who were pregnant, has a history of spinal surgery, positive neurologic signs or symptoms suggestive of nerve root involvement (diminished upper or lower extremity reflexes, sensation to sharp and dull, or strength), osteoporosis, or exhibited a straight leg raise (SLR) test of less than 45° were also excluded. Patients with signs of nerve root involvement were excluded to assure that patients selected for this study were similar to those identified by George (2002) as likely responders to slump stretching. In addition, we speculated that patients presenting with more severe neural mechanosensitivity might be more likely to experience an adverse response to the slump stretching. The study was approved by the Institutional Review Board at Franklin Pierce College (Rindge, NH). All patients provided consent prior to participation.

Patients completed a variety of self-report measures, followed by a standardized history and physical examination performed by a physical therapist. Self-report measures included a body diagram to assess the distribution of symptoms, numeric pain rating scale (NPRS), modified Oswestry Disability Index (ODI), and Fear-Avoidance Beliefs Questionnaire (FABQ). Patients recorded the location of their symptoms on the body diagram to determine the extent to which centralization occurred after treatment, which was determined according to the procedures described by Werneke et al. (1999). The most distal extent of symptoms were coded as occurring in the low back, buttock/thigh, or distal to the knee by placing a transparent overlay of the scoring grid over the patient's body diagram (Fig. 1). A score of (0) was given if there was no identification of symptoms,

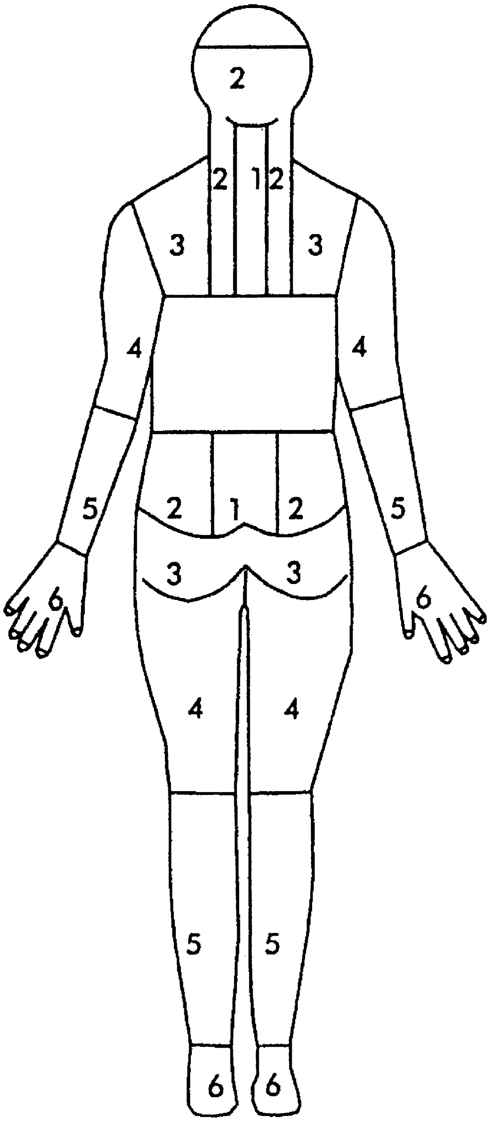

Fig. 1. Grid used to identify location of patient symptoms. Reprinted with kind permission from Werneke et al. (1999).

(1) if pain was isolated to the central low back, (2) if pain was indicated in the lateral low back, (3) if pain was located in the buttocks, (4) if pain was located in the upper leg, (5) if pain was located in the lower leg, and (6) if pain was located in the foot. This procedure has been shown to exhibit excellent reliability ($\kappa = .92$) (Werneke et al., 1999).

The 11-point NPRS ranges from 0 ("no pain") to 10 ("worst pain imaginable") and was used to indicate the intensity of current pain and at its best and worst level over the last 24 h (Jensen et al., 1994). These 3 ratings were averaged to arrive at an overall pain score. The scale has been shown to have adequate reliability, validity, and responsiveness in patients with LBP when the 3 scores are averaged (Childs et al., 2004). The modified ODI was used to measure disability and consists of 10 questions. Each question is scored from 0 to 5, with higher scores indicating greater disability. The scores were then converted to a percentage out of 100. The test–retest reliability of the modified ODI has been shown to be high (ICC = .90) (Fritz and Irrgang 2001). The FABQ was used to quantify the patient's fear of pain and beliefs about avoiding activity (Waddell et al., 1993). Previous studies have found high level of test–retest reliability for both the Physical Activity (FABQPA) and Work (FABQW) subscales (Jacob et al., 2001). Fear avoidance beliefs have been associated with current and future disability and work loss in patients with acute (Fritz and George, 2002) and chronic (Crombez et al., 1999) LBP. This measure was collected to assess the potential confounding effects of fear-avoidance beliefs on outcome.

The standardized history consisted of demographic information including age, gender, past medical history, location and nature of symptoms, relieving/aggravating activities, prior episodes, occupation and leisure activities. The standardized physical examination included measurements of active lumbar range of motion, passive posteroanterior mobility of the lumbar spine (Maitland et al., 2000), myotomal testing, sensory examination to sharp and dull, muscle stretch reflex testing, the SLR test (Butler, 2000), and the slump test (Maitland, 1985).

The slump test was performed as described by Maitland (1985) and is outlined in Table 1. For the purpose of this study, the slump test was considered positive if the patient's clinical symptoms were reproduced during the performance of the slump test and these symptoms improved with structural differentiation, in this case, release of neck flexion. The inter-examiner reliability of detecting a positive slump test has been shown to be high ($\kappa = .83$) (Philip et al., 1989).

Following the baseline examination, patients were randomly assigned to receive lumbar spine mobilization and exercise or lumbar spine mobilization, exercise, and slump stretching. A computer-generated randomized table of numbers created prior to the beginning of the study was utilized to determine the randomization scheme. Group assignment was sealed in an opaque envelope and opened after the treating therapist completed the examination. All treatment was administered by 3 physical therapists with a mean of 2.3 years of clinical experience in outpatient orthopaedics. All patients were scheduled for treatment twice weekly for 3 weeks, for a total of 6 visits.

2.1. Mobilization and exercise group

The lumbar spine mobilization and exercise intervention group performed a 5-min exercycle warm-up at the beginning of each treatment. Following the warm-up patients received lumbar spine mobilization and completed a standardized exercise regimen since a combination

Table 1
The slump testing sequence as described by Maitland (1985)

Summary of slump test procedure
1. Patient was instructed to sit erect with knees in 90° of flexion. The presence or absence of symptoms was recorded.
2. Patients were instructed to "slump" shoulders and lower back while maintaining the cervical spine in neutral. The presence or absence of symptoms was recorded.
3. While maintaining the position described in step 2 the patients was instructed to tuck their chin to the chest and the clinician applied overpressure into cervical flexion. The presence or absence of symptoms was recorded.
4. While maintaining overpressure into cervical flexion the patient was instructed to extend the knee. The presence or absence of symptoms was recorded.
5. Position 4 was maintained while the patient was instructed to actively dorsiflex the ankle. The presence or absence of symptoms was recorded.
6. Overpressure of the cervical spine was released and the patients were instructed to return the neck to a neutral position. The presence or absence of symptoms was recorded.

The slump test is considered positive if the patient's symptoms were reproduced in position 5 but alleviated when overpressure of the cervical spine was released.

of manual therapy and exercise have been shown to be effective in reducing disability in patients with chronic LBP (Aure et al., 2003). The physical therapist performed posteroanterior mobilizations to hypomobile lumbar spine vertebrae segments as determined on the initial evaluation. Grades III–IV mobilizations (Maitland et al., 2000) were selected based upon the patient response and the physical therapist's clinical reasoning.

Patients also completed a standardized exercise program consisting of pelvic tilts, bridging, wall squats, quadruped alternate arms/legs activities as described by Childs et al. (2004), which has been shown to result in clinically meaningful improvements in disability. Patients were asked to perform 2 sets of 10 repetitions of each exercise. The physical therapist progressed the patient's exercise routine according to the patient's symptoms. Patients were instructed to perform the exercises at home once daily, and to maintain their usual activity level and refrain from initiating any new forms of exercise during the study.

2.2. Slump stretching group

Patients in the slump-stretching group completed the identical warm-up followed by lumbar spine mobilization and the identical standardized stabilization exercise program, but also received slump-stretching exercises that were provided by the physical therapist. Slump stretching was performed with the patient in the long sitting position with the patient's feet against the wall to assure the ankle remained in 0° of dorsiflexion. The therapist applied over pressure into cervical spine flexion to the point where the patient's symptoms were reproduced (Fig. 2). The position was held for 30 s. A total of 5 repetitions were completed. The time spent performing the slump stretching added only 3–4 min to the total treatment time, thus the potential for an attention effect to exist is extremely low.

Fig. 2. Slump stretching technique utilized in the clinic.

Patients in the slump stretching group completed a similar self-slump stretching home exercise program, except patients actively flexed their neck and applied overpressure using their upper extremities until symptoms were reproduced (Fig. 3). Patients completed 2 repetitions, maintaining this position for 30 s. The decision to use a treatment procedure that reproduced the patient's symptoms was based on a case series reported by George (2002). In this study patients exhibiting a positive slump test in the absence of radicular symptoms were subjected to slump stretching following a brief warm-up, as a treatment protocol. A decrease in symptom intensity was observed following 5–12 treatment sessions.

2.3. Follow-up

At the completion of 6 physical therapy sessions (3 weeks), an office assistant who was unaware of group assignment or the nature of the study re-administered the self-report questionnaires. The potential for rater bias is further minimized based on the use of patient-completed outcome measures.

2.4. Data analysis

Sample size calculations were performed using SPSS statistical software (SPSS Inc., Chicago, IL). Calculations were based on detecting a 6-point difference between the groups in the 3-week Oswestry score, assuming a standard deviation of 5.5 points, a 2-tailed test, and an α-level equal to 05. A 6-point difference corresponds to the smallest magnitude of difference that would be considered clinically meaningful (Fritz and Irrgang, 2001). A sample size of 15 subjects per group provides greater than 80% power to detect both statistically significant and clinically meaningful differences between the groups.

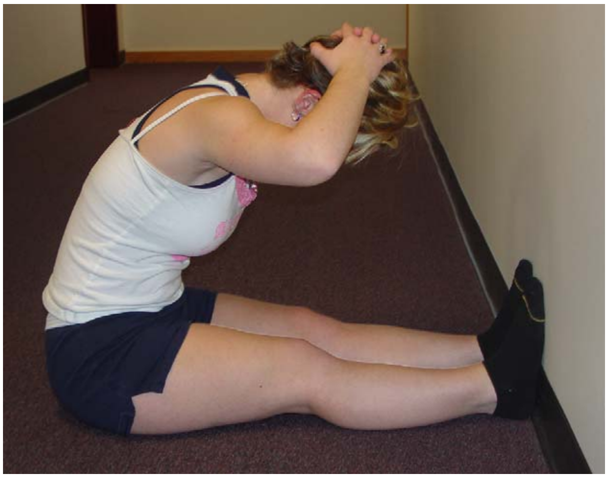

Fig. 3. Slump stretching technique performed as the patient's home exercise program.

Key baseline demographic variables and scores on the self-report measures were compared between groups using independent t-tests for continuous data, and χ^2 tests of independence for categorical data (Table 2). The level of fear-avoidance beliefs between groups was considered as a potential covariate based on its having been shown to confound outcome and indicate a less favorable prognosis for recovery (Crombez et al., 1999; Fritz and George, 2002). The independent variable was group (mobilization and exercise vs. slump stretching), and the primary dependent variable was perceived disability as recorded by the ODI. Secondary dependent variables included centralization of symptoms and pain. Separate independent t-tests were used to assess differences between groups at discharge. The α-level was divided equally between dependent variables to maintain the family-wise α-level equal to .05, such that the per comparison α-level was .017. Data analysis was performed using the SPSS Version 10.1 statistical software package (SPSS Inc., Chicago, IL).

3. Results

One hundred and seventeen patients were screened for eligibility during an 18-month period from January 2002 to June 2003. Eighty-one patients (69%) did not satisfy the inclusion and exclusion criteria for the study. The high rate of ineligibility was due to the stringent inclusion criteria requiring symptoms distal to the buttock, a positive slump test, and the exclusion of patients with a positive straight leg raise. Six patients (5%) refused participation because they did not desire to be randomized. The remaining 30 patients, mean age equal to 38.7 (SD = 11.6) (21 male), were randomized to receive the mobilization and exercise intervention ($n = 14$) or the mobilization and exercise intervention combined with slump stretching ($n = 16$).

Table 2
Baseline demographic and self-report variables for both treatment groups

Variable	Mobilization and exercise group ($n = 14$)	Slump stretching group ($n = 16$)	P value
Age (years)	40.0 (12.2)	39.4 (11.3)	.56
Gender (# of female)	10	11	.88
Duration of current symptoms (median number of weeks)	18.5 (12.5)	14.5 (8.0)	.30
Oswestry Disability Index	24.4 (6.3)	26.2 (6.7)	.47
Numeric pain rating score	3.8 (1.0)	4.0 (.92)	.90
Location of symptoms	4.3 (.83)	3.9 (.77)	.83
Number of previous episodes of back pain	2.5 (1.2)	2.1 (1.3)	.36
Fear-avoidance beliefs score—physical activity subscale	8.8 (4.2)	8.2 (4.0)	.69
Fear-avoidance beliefs score—work subscale	13.2 (4.9)	12.4 (4.4)	.66
Fear-avoidance beliefs score—total	22.1 (6.6)	20.5 (6.4)	.51

Values represent the mean (SD), except where noted otherwise.

Table 3
Discharge self-report variables, change scores for both groups and associated 95% confidence intervals, differences between groups with associated 95% confidence intervals and statistical significance

	Discharge mobilization and exercise group ($n = 14$)	Change scores for mobilization and exercise group (95% CI)	Discharge slump stretching group ($n = 16$)	Change scores for slump stretching group (95% CI)	Mobilization and exercise versus slump stretching (95% CI)	P value
Oswestry Disability Index	17.6 (6.1)	6.9 (3.2, 10.6)	7.9 (5.3)	18.2 (17.8, 18.6)	9.7 (5.4, 14.0)	< .01
Numeric pain rating score	2.7 (1.0)	1.2 (.47, 1.93)	1.7 (.42)	2.33 (1.4, 2.4)	.93 (.35, 1.6)	.001
Location of symptoms	3.0 (.92)	1.2 (.63, 1.8)	2.0 (.68)	1.88 (1.4, 2.4)	1.0 (.41, 1.6)	.002

No differences in key demographic variables or baseline levels of pain, disability, and fear-avoidance behaviors were detected between groups (Table 2). Patients who received slump stretching exhibited significantly improved disability ($P < .001$), overall perceived pain ($P = .001$), and centralization of symptoms ($P < .01$) (Table 3).

4. Discussion

The results of our study confirm our hypotheses that slump stretching may be beneficial in the management of patients with non-radicular LBP. Slump stretching in addition to lumbar spine mobilization and exercise was beneficial in reducing short-term disability and improving pain and promoting centralization of symptoms in this subgroup of patients. Our results are similar to those of George (2002) who reported that a subgroup of patients with LBP might exist who have distal symptoms but whose symptoms do not improve with flexion- or extension-oriented exercises.

The mean ODI scores for both groups were statistically equivalent at baseline ($P > .05$). It has been reported that reductions in the Oswestry of 6 points or greater are considered clinically meaningful (Fritz and Irrgang, 2001). The change scores for both groups in our study surpassed this clinically meaningful level (6.9, 95% CI 3.2, 10.6 in the mobilization and exercise group and 18.2 95% CI 17.8, 18.6 in the slump stretching group). It should be recognized that the change score for the mobilization and exercise group only marginally surpassed the clinically meaningful level while the change score in the slump stretching group greatly surpassed this level as did the lower bound estimate of the 95% CI. Perhaps the characteristics used as inclusion criteria suggest which patients are likely to benefit from this form of treatment. Further research is necessary to examine this hypothesis.

Centralization of symptoms in patients with LBP indicates a favorable prognosis (Aina et al., 2004; Werneke and Hart, 2001) and is typically used to guide treatment in patients with low back and lower extremity symptoms. However, the slump stretching technique used in this study was designed to reproduce the patient's symptoms, which sometimes resulted in a peripheralization of their symptoms. The decision to proceed with treatment despite the peripheralization of symptoms in this group is consistent with the treatment approach used by George (2002) . In our study, slump stretching resulted in significant improvements in disability and pain and centralization of symptoms compared to a lumbar spine mobilization and exercise program without slump stretching. Therefore, perhaps centralization is not prognostic for a favorable outcome among all subgroups of patients with LBP.

A few studies (Cleland et al., 2004; Cleland and McRae, 2002; George, 2000, 2002; Kornberg and Lew, 1989; Scrimshaw and Maher, 2001) have investigated the effects of neural mobilization techniques on patients with LBP and lower extremity symptoms. However, with the exception of 2 studies (Kornberg and Lew, 1989; Scrimshaw and Maher, 2001) the others have been single case reports or a case series. Scrimshaw and Maher (2001) investigated the effects of neural mobilization following lumbar dissection, fusion, or laminectomy. The results of a 12-month follow-up demonstrated that neural mobilization did not provide additional benefits to traditional postoperative care. However, the patients in this study exhibited a straight leg raise range of motion that was within normal limits suggesting that perhaps performing neural mobilizations on patients with a normal straight leg raise may not be beneficial in decreasing pain and disability. Kornberg and Lew

(1989) determined that slump stretching combined with hamstring stretching in a group of Australian Rules football players expedited return to sport following a hamstring strain compared to patients who only received hamstring stretching exercises. However, this study was performed in individuals without LBP.

Although the slump test is used clinically to investigate the presence of altered neurodynamics there is currently a lack of evidence suggesting that any particular neurodynamic treatment technique results in changes of the mechanical or physiological function of nerve tissues. Determining the mechanism for why patients receiving slump stretching improved to a greater extent is beyond the scope of this study. However, it is useful to consider plausible physiological explanations for our findings. Perhaps the slump stretching was effective in reducing the patients pain by dispersing intraneural edema, thus restoring pressure gradients, relieving hypoxia and reducing associated symptoms (Cowell and Phillips, 2002). Slump stretching may also have resulted in improved outcomes by reducing antidromic impulses generated in C-fibers at the dysfunctional site which result in the release of neuropeptides and subsequent inflammation in the tissues supplied by the nerve (Shacklock, 1995a). Hence if normal neurodynamics are restored by alleviating any sites of neural compression, excessive friction or tension, antidromically evoked impulses may perhaps be eliminated. It is also possible that slump stretching may have resulted in a reduction of scar tissue, which had adhered to neural tissue and its associated connective tissue structures (Turl and George, 1998). Although preliminary evidence exists in support of the validity of the slump test in identifying neural tissue involvement (Coppieters et al., 2005), the possibility that the source of pain was derived from structures other than the neural tissues cannot be eliminated. Further research is necessary to examine the sensitivity and specificity of neurodynamic tests as well as the effectiveness of using such techniques in the management of altered neurodynamics.

A few limitations should be considered. First, we excluded patients with a SLR less than 45°, thus potentially excluding patients with more severe neural mechanosensitivity, thus the results may not be generalizable to this patient population. We incorporated this exclusion criteria to enroll patients similar to those described by George (2002). This was also done based on the concern that patients with more severe neural mechanosensitivity might be more likely to experience an adverse response to slump stretching. In addition, our sample size was small, and data were collected at a single outpatient orthopaedic physical therapy clinic, limiting the generalizability of the findings. Future studies should investigate the prognostic value of the characteristics used in this study to guide decision-making regarding the use of slump stretching in a larger patient population with LBP.

5. Conclusion

Slump stretching is beneficial for improving short-term disability, decreasing pain, and centralization of symptoms compared to treatment without slump stretching in a subgroup of patients hypothesized to benefit from this form of treatment. These data provide preliminary evidence supporting the notion that patients with distal symptoms who are unable to centralize their symptoms may be a distinct subgroup of patients with LBP that benefit from slump stretching exercise. Future studies should examine whether these benefits are maintained at a longer-term follow-up.

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