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Research Article

Hip Muscle Flexibility After Six Weeks of Lumbar Stabilization and Global Postural Reeducation Exercises in Men With Movement Control Dysfunction: A Randomized Clinical Trial

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Abstract

Background: Exercise therapy is one of the most effective methods for dealing with low back pain. The present study aimed to compare to examine the effects of two protocols, i.e., six weeks of lumbar stability exercises (LSE) and global postural reeducation exercises (GPR), followed by a subsequent period of non-training on hip muscle flexibility in men with chronic non-specific low back pain (NSLBP) with lumbar movement control impairment (MCI).

Methods: In this randomized clinical trial, 46 men suffering from NSLBP with lumbar MCI were selected and randomly divided into three groups (i.e., two exercise groups - one control group). Training intervention groups were allowed to perform exercises for 6 weeks, three sessions per week. Universal goniometer was used to measure the flexibility of hip muscles (i.e., hamstring, rectus femoris, external rotator, and tensor fasciae latae). Repeated measures ANOVA was utilized to compare the effect and durability of the two training protocols on the dependent variables at a significant level.

Results: The results showed that both training methods increased hamstring muscle flexibility ($P=0.001$). GPR method was found superior in increasing the flexibility of the right hip of the subjects in the post-test ($P=0.032$) and follow-up ($P=0.024$). However, no significant differences were observed in the other hip muscles flexibility.

Conclusion: It was concluded that the GPR method, compared to the lumbar stabilization method, had a greater potential to increase the flexibility of shortened muscles by enhancing the contraction of the antagonist muscles to avoid postural asymmetry. It seems both training protocols were effective in improving hamstring muscle flexibility in people with NSLBP suffering from MCI and this result was observed after both training and 4 weeks of inactivity.

Keywords: Low back pain, Abnormal movement, Global postural reeducation, Lumbar stabilization, Flexibility

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Background

Low back pain (LBP) is a common health-related problem. First symptoms often occur between the age of thirty and fifty (1). Approximately 80% of its variants include non-specific low back pain (NSLBP) (2). Chronic NSLBP is defined as LBP with no pathological evidence and with a history of more than three months (3). According to Luomajoki et al, the main mechanism of NSLBP is movement control impairment (MCI) caused by pain, abnormal tissue loading, lack of proprioceptive awareness, or absence of a withdrawal reflex motor response (4). Studies have shown that movement control in people with LBP undergoes changes in comparison to that in healthy people; and since these individuals show less ability in function and movement control in position shift, they face further adverse health consequences in addition to pain, such as the reduced movement control and its resulting motor function (5).

Inappropriate posture increases stress and strain on the body's supporting structures, changes muscle function and rest length, and decreases the efficiency of balance on the surface (6). In fact, the occurrence of significant deviations in posture can cause extensive negative adaptation in the joints and soft tissues in the long term, leading to muscle imbalance and movement deviation from the correct direction of movement (6). An exercise intervention on the back and hip is likely more effective in people with LBP (7). The results from several studies investigating short hamstring and its effect on spinal and pelvic movement disorders have shown that shortness of this muscle can be a major factor responsible for LBP (8-10). Burns et al (2018) carried out a randomized controlled trial examining 76 adults with LBP, who simultaneously had at least one hip defect. Exercise interventions in the "LBP only" or "LBP+Hip" groups included exercises focusing on the back as well as on the back and hip, which resulted in further improvement in pain and disability in the "LBP+Hip" group (7). The results of a similar study by Bade et al demonstrated that the effect of improvement in disability and pain was higher in the LBP+Hip group (11). On the other hand, the findings from a study by Stevenson et al examining factory workers revealed that the overall flexibility of the body muscles affected the incidence of LBP (12). A study by Gordon and Bloxham also found that regular exercise and physical activity not only relieved LBP, but also showed a real potential to improve flexibility and range of motion (13). Thus they recommended that a particular attention be given to correcting all the mechanical factors involved in disrupting the movement pattern, when designing the treatment plan for a person with MCI (14).

Global postural reeducation (GPR) is a method developed by the physiotherapist Philippe Souchard in 1980 to treat postural disorders (15). This treatment method relies on strong biomechanical and physiological concepts, and employs three primary principles when dealing with neuro-musculoskeletal disorders: the first one is individualism; that is, understanding the fact that people are essentially different from one another. The second is causality which aims to obtain a permanent and real solution to a problem. And finally, the whole body must be evaluated and treated (16).

Objectives

The current study aimed to compare the effect and durability of six weeks of lumbar stabilization exercise (LSE) and GPR exercises on hip muscle flexibility in men with NSLBP and suffering from MCI.

Materials and Methods

Study Population

This study was designed as a randomized clinical trial. The sample size for this study was estimated after performing a pilot study and using G*Power software with a power of 80% and a reliability coefficient of 95% (17). Then, 46 men aged 30-40 and with chronic NSLBP with MCI were selected and randomly divided into three groups, namely GPR (n = 17), LSE (n = 17), and control (n = 12) using randomization software. All study subjects participated in this study voluntarily, consciously, and by consent.

Measurement

The participants were tested for lumbar movement control using the scale developed by by Luomajoki et al and had to have at least two defects in the tests in order to be included in the present study (18, 19). Flexible ruler was used for measuring the arches of the spine to ensure that the participants had no functional or congenital kyphosis and lordosis (higher than 42 and 52 degrees) (20, 21). Scoliosis was measured using a scoliometer so that the vertebrae of the participants did not rotate more than 5 degrees (22). The pain measured by VAS had to range between 3 to 6 (Medium risk subgroups). It is worth mentioning that the internal reliability of this scale has been reported to range between 77% to 79% (23). Universal goniometer was used to evaluate flexibility of hip muscles (i.e., hamstring, rectus femoris, external rotator, and tensor fasciae latae) (Table 1). After identifying and placing the subjects in the groups, the intervention groups were allowed to perform LSEs and GPR exercises for six weeks, three sessions per week (Tables 2 and 3); while the control group was excluded from performing any specific exercise activities that were likely to affect the research results. By the end of the exercise and also four weeks after exercising, the degrees of hip muscle flexibility in all three groups were measured and the results were analyzed using SPSS software version 22 and descriptive-inferential statistics. After collecting data and confirming the normal distribution of data using Shapiro-Wilk test, the analysis of variance was performed with repeated measures at a significance level of 0.05 and Bonferroni post hoc test was used to compare the means in pre-test and post-test and in the non-exercising period.

Lumbar Stabilization Exercises

LSEs are used to create segmental stability as well

Table 1. Evaluating Muscle Flexibility

Evaluating Muscle Flexibility	
Rectus femoris	In the supine position, the patient's leg was hanging out of bed. The goniometer center (Axis) was placed on the lateral epicondyle. Its stationary arm was aligned with greater trochanter. Its moving arm was placed along the lateral malleolus. The patient's knee was flexed until he felt an extreme sense of stretching and pain in the anterior knee. The goniometer angle was read and recorded.
Tensor fasciae latae muscle	In the supine position, the patient's leg was hanging out of bed. The goniometer center was placed over the anterior superior iliac spine (ASIS) of the extremity being measured. The stationary arm was aligned with an imaginary line extending from one ASIS to the other. The moving arm was aligned with the anterior midline of the femur, using the midline of the patella for reference. The angle between the two goniometer arms showed muscle flexibility.
Hamstring muscle	In the supine position, the patient's leg was lifted with a straight knee passively until he felt a sense of the stretching and pain behind the knee. The goniometer center was placed on the lateral epicondyle. Its stationary arm and moving arm were parallel to the trunk and femur, respectively. Alteration of the goniometer angle represented muscle flexibility.
External rotator muscles	In the prone position, the patient's knee was flexed 90°. Its stationary arm and moving arm were parallel to the vertical line and tibia, respectively. Next, while the hip was fixed in place with one hand, the shin was moved inward with the other. In this case, the angle between the vertical line and the tibia was read and recorded.

Table 2. The Lumbar Stabilization Exercises

Phases	Exercises Program	Set/Repetition
Phase I	1. Normal breathing. 2. Support of a position must be done while exhaling.	-
Phase II	1. Pelvic tilt 2. Abdominal drawing-in manoeuver 3. Strengthen Multifidus	5-10s hold × 10 reps
Phase III	1. Curl-ups 2. Dead bug 3. Bird dog 4. Seated hip flexion 5. Heel slides 6. Bridge 7. Side bridge 8. Standing theraband exercises	2×5-10 reps

as improve movement control with qualifying and quantifying of the movements. Exercises were performed by the subjects under the direct supervision of the examiner. The approximate time of each exercise session ranged between 40 and 50 minutes. These exercises were performed for six weeks, three sessions in each week. A 48-hour interval was set between exercise sessions. According to Table 2, shows the exercises which were performed in this exercise group (24).

Global Postural Reeducation

This method included eight treatment postures of lying, sitting, and standing. In the present study, the given postures were adopted by taking: five items of supine lying with abducted hands and open thighs angel, supine lying with abducted hands and closed of thighs angle, sitting with adducted hands and closed thighs angle, standing and bending the trunk forward, and standing against the wall and opening the angle of thighs (Table 3). The duration of each item varied from 5 to 15 minutes. These exercises were performed for six weeks, three sessions per week (16, 25).

Results

Demographic characteristics of the subjects is shown in Table 4, and the repeated measures analysis of variance test for hip muscle flexibility is presented in Table 5.

Table 5 presents the descriptive results obtained from evaluating the variables in all three stages of the test in the form of the means and standard deviations, as well as the results obtained from repeated measures analysis of variance for the hip muscle flexibility. The results showed that only the hamstring flexibility in both groups in the post-test and durability test was significantly different from that in the pre-test ($P \geq 0.05$).

The findings from the analysis of covariance (ANCOVA) test are presented in Table 6. The results of Bonferroni post hoc test indicated that there was a significant difference between the mean scores of GPR group right hip hamstring muscle flexibility and the scores of the LSE group in post-test ($P = 0.032$), (CI: -5/62 - -0/19(and durability test

Table 3. The Global Postural Reeducation Exercises

Posture	Performance	
The lying posture with extension of the legs	The supine position (also called "frog on the ground") emphasizes the stretching of the anterior muscle chain and release the diaphragm muscle.	
The lying posture with flexion of the legs	The supine position emphasizes the stretching of the posterior muscle chain.	
the sitting posture	The sitting position emphasizes the stretching of the posterior muscle chain.	
The bending-forward posture with flexion of the trunk	The bending-forward position emphasizes the stretching of the posterior muscle chain.	
The Standing posture	The Standing posture emphasizes the stretching of the anterior muscle chain.	

Table 4. Individual Characteristics of the Subjects

Variable	Control	LSE	GPR	*P* Value
Age (y)	34.3±3.11	34.1±2.87	33.3±2.45	0.59
High (cm)	173.5±6.51	171±3.71	172.5±4.78	0.41
Weight (kg)	74.9±6.98	70.4±5.22	71.4±5.23	0.11
BMI	24.83±0.88	24.02±1.46	23.95±1.30	0.16

($P=0.024$), (CI: -4/62 - -0/26(, ($P\geq0.05$). This difference was, on average, in favor of GPR exercises. Furthermore, a significant difference was detected between the mean degree of the hamstrings muscle flexibility in the control group and those in two training groups in both post-test ($P=0.001$) and durability test ($P=0.001$), ($P\geq0.05$).

Discussion

This study compared the effect and durability of two different methods of LSE and GPR exercises on hip muscle flexibility in men with NSLBP suffering from lumbar MCI. Although LBP is known as a multifactorial problem, recent evidence has shown that people with LBP who participate in exercise interventions including "LBP+hip" exercises experience pain relief (7). According to our study results, the changes in hip movement caused compensatory movement of the lumbar spine. Coordinated movements were observed in the hip and lumbar spine due to their adjacent to the pelvis. Therefore, any restriction of hip movement was determined to cause excessive stress in the lumbo-pelvic region (26). Our study results also revealed that GPR method had a real potential to provide a further flexibility of the hamstring muscles. According to the anatomical and physiological characteristics of the hamstring muscle, shortness of this muscle causes posterior pelvic tilt and reduction in the lumbar arch, resulting in flattening of the back, which in turn leads to back pain (27). Therefore, it is likely that increasing the flexibility of this muscle reduces the pain. Our study results were in agreement with the findings from the study by Fasuyi et al suggesting that an increase in the length of the hamstring muscles significantly reduced the pain in people with LBP, while no significant relationship was discovered between the length of hamstring muscles and the amplitude of pelvic tilt (28).

On the other hand, it seems that poor understanding of muscle physiology, especially the ignorance of the fact that static and dynamic muscles have different physiologies and therefore must be treated differently is a common error in conventional physiotherapy. In addition, the effectiveness of the GPR method depends on the accurate understanding of the fact that each person has a unique

Table 5. The Within-subject Analysis for Comparing the Effect of Exercises in the Three Groups

Flexibility	Group	Hip	Mean ± SD pre-test	Mean ± SD Post-test	Mean ± SD Follow-up	*P* Value
Rectus femoris	Control	Right	40.92±3.06	40.42±2.61	40.42±2.47	0.451
		Left	40.33±2.23	39.42±2.54	39.83±1.85	0.112
	LSE	Right	41.29±2.58	41.88±1.80	41.12±2.29	0.190
		Left	39.94±2.30	40.65±2.50	40.82±2.30	0.196
	GPR	Right	42.59±2.87	42.06±1.67	42.23±1.75	0.394
		Left	41.35±3.33	40.70±2.23	41.12±2.69	0.309
Tensor fasciae latae	Control	Right	25.75±3.08	24.83±3.41	25.33±3.34	0.527
		Left	26.42±2.35	26.92±4.17	26.83±2.66	0.882
	LSE	Right	25.47±3.32	25.76±4.55	25.88±4.38	0.724
		Left	26.18±2.85	26.82±4.25	26.29±3.04	0.444
	GPR	Right	27.18±3.22	26.59±2.92	27.53±3.32	0.253
		Left	26.35±2.93	28.59±3.20	27.29±3.10	0.001*
Hamstring	Control	Right	80.42±5.21	80.33±6.06	81.08±5.73	0.737
		Left	83.08±5.74	83.00±5.27	83.42±4.38	0.880
	LSE	Right	84.18±4.60	89.12±5.02	88.70±5.07	0.001*
		Left	86.23±4.84	90.94±6.06	90.41±4.54	0.001*
	GPR	Right	83.35±4.82	91.29±5.06	90.35±5.22	0.001*
		Left	85.82±5.11	92.35±4.55	90.94±4.67	0.001*
External rotator	Control	Right	35.83±2.98	34.33±3.87	35.25±3.05	0.222
		Left	37.42±3.15	38.50±2.50	37.58±2.31	0.273
	LSE	Right	38.00±3.12	36.35±5.58	38.59±4.47	0.100
		Left	38.06±3.15	37.18±4.13	37.70±3.92	0.597
	GPR	Right	37.47±4.11	38.18±5.05	37.65±4.59	0.292
		Left	36.12±4.47	38.06±5.30	37.41±4.49	0.001*

**P* value ≥0.05

Table 6. The Between-subject Analysis for Comparing the Effect of Exercises in the Three Groups

Flexibility	Test Steps	Group	Mean*		F		P-value		Eta Squared	
			Right	Left	Right	Left	Right	Left	Right	Left
Rectus femoris	Post-test	Control	42.83	39.57	3.010	3.379	0.060	*0.044	0.125	0.139
		LSE	42.09	40.07						
		GPR	41.56	40.17						
	Follow-up	Control	40.89	40.00	0.992	0.216	0.379	0.051	0.045	0.133
		LSE	41.35	41.27						
		GPR	41.66	40.55						
Tensor fasciae latae	Post-test	Control	25.20	26.81	0.786	1.709	0.462	0.193	0.036	0.075
		LSE	26.37	26.94						
		GPR	25.73	28.54						
	Follow-up	Control	25.70	26.75	0.530	0.647	0.593	0.529	0.025	0.030
		LSE	26.48	26.38						
		GPR	26.68	27.26						
Hamstring	Post-test	Control	82.53	84.88	23.141	19.390	*0.001	*0.001	0.524	0.480
		LSE	87.97	90.10						
		GPR	90.88	91.87						
	Follow-up	Control	83.47	85.12	21.288	24.230	*0.001	*0.001	0.503	0.537
		LSE	87.47	89.65						
		GPR	89.91	90.50						
External rotator	Post-test	Control	35.78	38.30	2.280	2.817	0.115	0.071	0.098	0.118
		LSE	35.57	36.45						
		GPR	37.94	38.93						
	Follow-up	Control	36.41	37.41	0.834	0.614	0.441	0.546	0.038	0.028
		LSE	37.96	37.08						
		GPR	37.45	38.16						

[a] Adjusted based on pre-test values. * (*P*-value ≥ 0.05)

way of responding to an injury or potential injury, as well as on the clear understanding of the biomechanical processes that the body goes through before the injury or pain. After gaining a thorough understanding of the muscle physiology, the therapist may use these exercises to provide an effective and unique treatment for each structure and each person (16, 25). In the GPR method, stretch is done in the opposite direction and there are no possible compensations while performing a decompression action (16, 25). Our study findings about the improvement of hip muscle flexibility were consistent with the results reported by Sheikhi, who indicated that GPR exercises significantly increased hamstring muscle flexibility in patients with chronic NSLBP and MCI (29).

The insignificant effects of both training protocols on the improvement of other hip muscles flexibility observed in this study may have been attributed to the short duration of the exercise program. Seemingly, the changes observed in the posture were not the only changes which occur in muscle length and strength. Other significant changes may have occurred in neuromuscular factors, such as muscle recruitment (30). Therefore, performing both training protocols may have changed the strategy of muscle recruitment in people with MCI rather than their length.

The durability of the effect of exercises may have been due to the plasticity of body tissues. Plasticity refers to several neurophysiological processes associated with learning and sensory-motor adaptation, which tends to occur within the whole sensory-motor system (31). By adapting a part of the neuromuscular chain, muscle can exhibit dramatic adaptation in line with central plasticity. Changes in the muscle may occur in the form of length adaptation, hypertrophy, as well as changes in the fibre type of the muscle (31). GPR method relies on the muscles viscoelasticity property, which enables them to obtain a creep after certain time and fulfill the force-rate parameters (16). In this study, GPR exercise was found to improve the hip muscle flexibility after four weeks of inactivity. One of the limitations of this study was the lack of control over the daily activities of the subjects, as well as their sleep and rest habits.

Conclusion

In sum, GPR method was found to play a positive role in improving the flexibility of hamstring muscles in patients with NSLBP and suffering from lumbar movement control dysfunction. Moreover, no significant

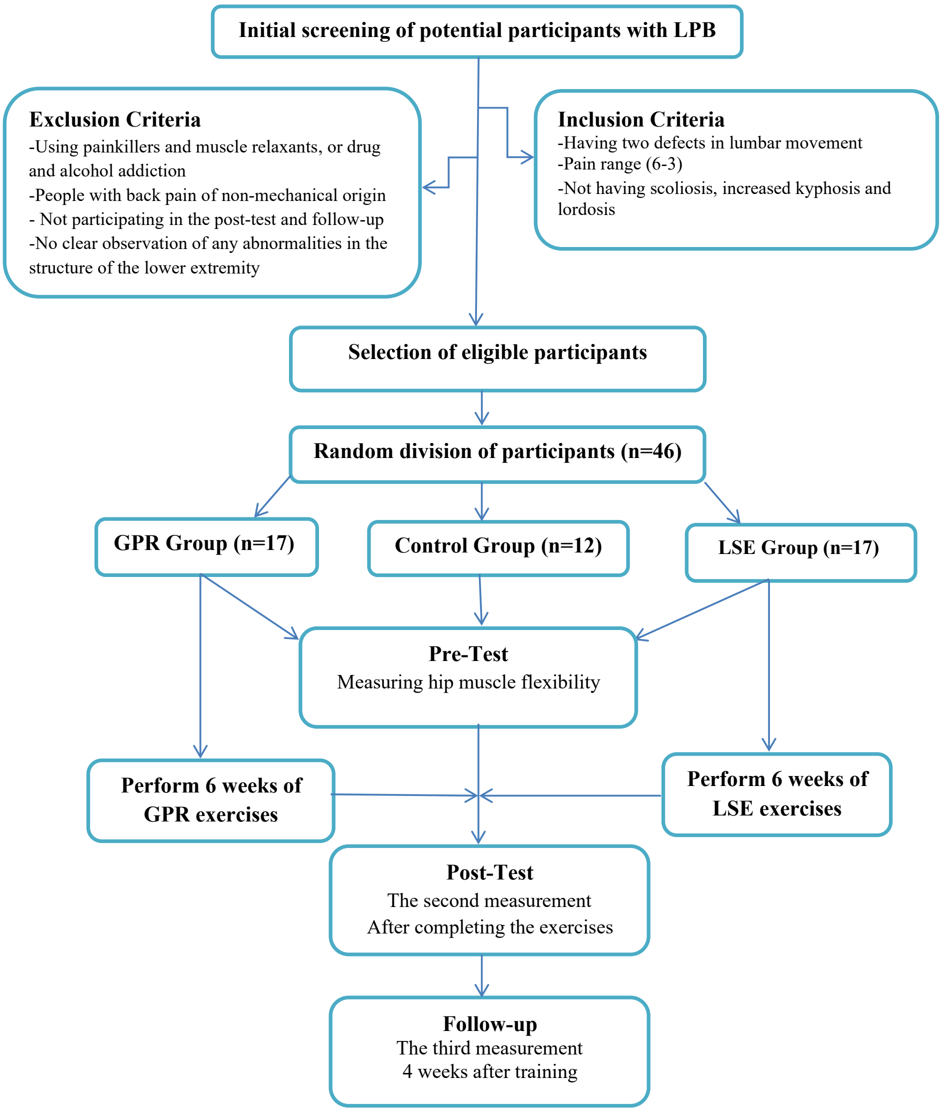

Figure 1. Study Flow Chart.

difference was detected in all three stages of the test on hip muscle flexibility in the control group . Therefore, it was recommended that GPR exercises be performed in order for improving the flexibility of hamstring muscles in these people.

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Conflict of Interests
The authors declare that they have no competing interests.

Ethical Approval
This clinical trial study was registered in the Iranian Registry of Clinical Trials website (identifier: IRCT20200817048433N1), after obtaining the approval of the Ethics Committee of the University of Tehran under the code number IR.UT.SPORT.REC.1398.053.

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