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Effect of Global Postural Reeducation Exercise on Pain and Hip Muscle Flexibility in Patients with Chronic Low Back Pain and Movement Control Dysfunction

Bahram Sheikhi[1*]

[1]Department of Biomechanics and Sports Injuries, Faculty of Physical Education and Sports Sciences, Kharazmi University, Tehran, Iran

***Correspondence to**
Bahram Sheikhi,
Department of Biomechanics and Sports Injuries, Faculty of Physical Education and Sports Sciences, Kharazmi University, Tehran, Iran
Tel: +989376569397, +982122228001,
Email: sheikhibahram@gmail.com

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Abstract

Introduction: Patients with non-specific low back pain (NSLBP) and movement control dysfunction demonstrate alternation in hip muscles flexibility and spinal movement patterns. Therapeutic modalities that augment hip muscles flexibility could help these patients. The aim of this study was to investigate the effect of global postural reeducation (GPR) on pain and hip muscle flexibility in patients with NSLBP and movement control dysfunction.

Materials and Methods: A total of 27 men with a mean age of 31.21 ± 2.5147 years, height of 166.44 ± 6.11 cm, and weight of 64.21 ± 5.25 kg participated in this study. The visual analogue scale (VAS) was used to evaluate pain. The flexibility of hip muscles (rectus femoris, tensor fasciae latae, external rotators and hamstring) was measured using universal goniometer. All data were assessed at baseline and after the intervention. The Shapiro-Wilk test and paired t test were used for statistical analysis at significance level of $P=0.05$.

Results: Our results revealed a decline in pain ($P<0.004$) and an increase in the flexibility of the hamstring muscles in the right ($P<0.003$) and left ($P<0.003$) legs. There were no statistically significant differences in the flexibility of rectus femoris muscle, external rotators, and tensor fasciae latae.

Conclusion: The results suggest that GPR had a significant effect on the level of pain. Further, it affected the flexibility of hamstring muscles in legs. Using GPR is recommended for pain relief and improving the flexibility of hamstring muscles in patients with NSLBP.

Keywords: Chronic non-specific low back pain, Motor control, Global postural reeducation, Flexibility

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Introduction

Low back pain (LBP) is a common multi-factor musculoskeletal disorder in today's societies, [1,2] which is experienced by over 70 to 80% of people at least once in their life.[3] Non-specific low back pain (NSLBP) refers to muscle tension or local stiffness in the region below the ribs and above the gluteal sulcus, which can be defined with or without leg pain.[4] Although most of the time, NSLBP improves spontaneously, half of the patients with this disease have a long history of back pain or several episodes of back pain. According to the current reports, this group of patients alone account for 80% of the costs associated with back pain treatment.[5]

According to Luomajoki et al, one possible underlying mechanism of NSLBP is movement control impairment (MVCI)[6] which can be due to pain, abnormal tissue loading, lack of proprioceptive awareness and, possibly, the lack of a withdrawal reflex motor response.[6] The consensus is increased muscle activity in these individuals as a stabilization mechanism.[7,8]

Research has shown that around 70% of patients with nonspecific back pain suffer

from various mechanical disorders including changes in the strength and length of the spinal muscles, diminished strength of spinal muscles, asymmetry of internal and external rotation of the hip, and pes planus.[9] In previous studies on these patients, the relationship between these mechanical disorders and intensity of NSLBP has been measured.[4] In a study conducted to investigate the relationship between mechanical factors and intensity of back pain, the strength and stamina of the back muscles and those surrounding the hip had a close relationship with the intensity of back pain.[4]

Furthermore, NSLBP causes the patient to experience a vicious cycle, where the patients with chronic back pain (more than three months), experience movement constriction, whereby their physical activity becomes severely restricted, further increasing muscle weakness.[10] Although the effect of interventions on movement defects in patients with NSLBP has not been evaluated systematically so far, most studies have reported a relationship between pain and mobility constriction as well as altered movements and postural patterns with the intensity of back pain. In a study by Stevenson et al on factory workers, it was found that the flexibility of body muscles generally affects the incidence of NSLBP.[11]

Exercise can play a significant role in treating NSLBP. The effectiveness of exercise therapy has been reported as a non-invasive and non-pharmacological method for treating NSLBP across various studies.[12,13]

Studies have suggested that exercise significantly reduces the relapse of NSLBP.[11] In addition, researchers have mentioned various therapeutic exercises for each individual factor (flexibility as well as strength and stamina of muscles), where each of them is specific only to one factor.[12,13] If the therapist applies the special therapeutic exercises to the patient to improve each factor, it necessitates a long time for treatment. Further, the patient does not have the ability to do all the exercises simultaneously. For being completely recovered, most of the factors mentioned should be improved among patients with NSLBP; therefore, a kind of exercise is required which is able to treat most disordered muscles simultaneously.

In the research by van der Velde and Mierau, it was found that a 6-week exercise program improved the flexibility of muscles in patients with chronic non-specific NSLBP.[12] Gordon and Bloxham systematically investigated the effects of exercise and physical activity on NSLBP. They observed that these exercises can improve the flexibility and range of motion of muscles.[13] The results of a study by Leo Rathinaraj et al on the effect of segmental stability of the spine with an existing program in patients with mechanical LBP indicated that exercise plays a vital role in mitigating NSLBP.[14] Nezhad Roomezi et al studied the effect of core stability exercises on the pain and performance of female patients with NSLBP and observed a significant improvement in the extent of pain and performance of the women with NSLBP.[15]

One of the therapeutic methods that have recently attracted attention is global postural reeducation (GPR) method which was developed in France by Souchard et al.[16] This therapeutic method has been developed based on an integrated idea of the system of muscular chains, which can face shortening resulting from situational, behavioral, and psychological factors. [17] This method has been developed based on identifying posterior and anterior muscular chain and the general stretching of antigravity muscles.[17]

Although this method is widely used across different countries, only a few studies support its clinical and theoretical effects. The studies that have been conducted with regards to GPR training indicated that this method might be effective in treating some musculoskeletal diseases and disorders including NSLBP, disc herniation, and ankylosing spondylitis.[18] The results indicated that GPR intervention in people with back pain resulted in further improvement of pain and disability compared with stability training.[17] Some studies have been developed on functional exercises over the past recent years, the majority of which have mainly dealt with investigating balance disorders and have less addressed disorders of motion and movement control.[19,20]

Therefore, based on what has been mentioned and suggestions of previous researches, the present study aims to investigate the effect of a six-week period of GPR exercises on the pain and flexibility of some hip muscles of men with NSLBP suffering from lumbar MVCI.

Materials and Methods

The present study was a quasi-experimental study with pre- and post-intervention design.

Inclusion and Exclusion Criteria

Inclusion criteria were the diagnosis of NSLBP and lumbar MVCI,[21] being 30-35 years of age, being classified as medium-risk subgroup (patients with an unfavorable prognosis with high levels of physical prognostic indicators appropriate for physiotherapy were excluded) using the STarT Back Screening Tool,[22], having no history of macro trauma and acute lesions, having no history of surgery in the back region and lower extremities, not having functional or congenital kyphosis (using kyphometer) [23] and scoliosis (using scoliometer),[24] having no history of receiving physical therapy over the past three months, and not receiving pharmacotherapy. The exclusion criteria included unwillingness of the patient to continue the therapeutic program, not attending the therapeutic sessions, and having diseases that disrupted participation in the study.

Sample Population and Study Design

Using G-Power software, 27 men with NSLBP[25,26] and deficit in performing Luomajoki and colleagues'

movement control tests[27] were chosen for this research. In this study, purposive sampling method was used and after baseline testing, the patients were allocated to the experimental groups.

After recording the demographic characteristics of the patients, those who had the initial inclusion criteria with NSLBP (Quebec questionnaire)[28] and movement control deficit were included in the research. All of the applicants were tested in terms of movement control so that the statistical population of the research would consist of patients with NSLBP suffering from movement control deficit.[21,27] In the pre-and post-test stages, the evaluation of flexibility and pain was performed on all the subjects under the same conditions using the following method. The pain intensity was measured using visual analog scale (VAS), while the flexibility of rectus femoris, hamstring, external rotators, and tensor fasciae latae muscles was measured by a goniometer, which was performed by the researcher before and after the intervention. After pre-test evaluation, the experimental group performed GPR exercises for six weeks. Two days after the completion of the exercises, post-test was done under pretest conditions, and the data were analyzed further.

Quebec Questionnaire

At the beginning of the study, the Québec Back Pain Disability Scale (QBPDS) which included 20 items, with each having a predetermined score, was used for sampling. For this purpose, the subjects filled this questionnaire. Then, they were examined by specialists for clinical assessment. Those who did not meet the conditions of running the training protocol and intended tests, according to the specialists, and had a QBPDS score of lower than 15 were excluded from the research.[28]

Movement Control Test

In this research, movement control tests were performed after verification by the specialists and filling the questionnaire by the subjects. The subjects performed movement control tests which included six tests (Table 1). When implementing these tests, if the subject had an incorrect performance, the proper method was explained, and if he learned the proper movement but was still unable to do it, the person was considered to have a movement control deficit. In addition, those who had at least two deficits in these tests were included in the present study.[29]

Assessing the Intensity of Back Pain

The intensity of back pain was measured by VAS. This scale has been plotted and graded as a 10-cm line, which was used for measuring the intensity of perceived pain in this study. In this scale, zero represents the absence of pain, 1-3 shows mild pain, 4-6 denotes moderate pain, and 7-10 indicates severe pain. In this study, the patients specified their perceived pain (which they sensed most of the time) by indicating a position on the continuum as the method of measuring pain.[31]

Evaluating Muscle Flexibility

Flexibility of hip muscles was measured using a universal goniometer (Patterson Medical) (Table 2).

The GPR Protocol

In the present study, for the GPR method, positions which involved mainly the posterior chain length were chosen as this chain is shortened in patients with NSLBP. This method involves lying, sitting, and standing positions. In the present study, five methods were used which included: 1) supine lying, abduction of hand, and opening thighs, 2) supine lying, abduction of hands, and closing the angle of thighs, 3) sitting, abducting the hands, and closing the angle of thighs, 4) standing and bending the trunk forward, and 5) standing against the wall and opening the angle of thighs. The duration of each method varied between 5 and 15 minutes. These movements were performed for 6 weeks and three sessions per each week. Furthermore, in the present study, oral instructions and the manual booklet were used to keep the proper alignment and prevent compensatory movements of the patients.[17]

Statistical Methods

Normality and variance homogeneity of data were tested using the Shapiro-Wilk and Levene tests, respectively.

Table 1. Movement Control Test

	Movement Control Test
1	Waiters bow: Flexion of the hips in upright standing without movement of the low back.[30]
2	Pelvic tilt: Dorsal tilt of pelvis actively in upright standing.[30]
3	One leg stance: From normal standing to one leg stance: measurement of lateral movement of the belly button. (Position: feet one third of trochanter distance apart).[30]
4	Sitting knee extension: Upright sitting with neutral lumbar lordosis; extension of the knee without movement (flexion) of the low back.[30]
5	Quadruped position: Transfer of the pelvis backwards and forwards (rocking) keeping low back in neutral. Starting position 90° hip flexion.[30]
6	Prone lying active knee flexion.[30]

Table 2. Evaluating Muscle Flexibility

	Evaluating muscle flexibility
Rectus Femoris	The patient was placed on the bed in a supine position, such that the leg under study was out hanging off the bedside. 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. At this stage, the goniometer angle, which represented muscle flexibility, was read and recorded.32
External rotator muscles	The patient lied on the stomach and flexed the knee up to 90°. The goniometer center was placed on the tuberosity of the tibia. Its stationary arm was along the vertical line. Its moving arm was placed parallel to the tibia. Next, while the femur was fixed using one hand, the shin was put inwards by the other hand. At this stage, the angle between the vertical line and length of the fibula bone was read, which represented flexibility of the external rotator muscles.[33]
Tensor fasciae latae muscle	The patient was placed in a supine position. The center of the goniometer 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. Alteration of the goniometer angle represented muscle flexibility.[34]
Hamstring muscle	The patient was in a supine position. His 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. The stationary arm was aligned with greater trochanter, while the moving arm was placed parallel to the lateral malleolus. The angle between these two goniometer arms suggested muscle flexibility.[32]

Descriptive and inferential statistics were used for data analysis. To investigate intra-group differences, paired *t* test was used in SPSS software version 21.0. A *P* value of less than 0.05 was considered statistically significant.

Results

A total of 27 men with NSLBP participated in this study. They had a mean age of 31.21 ± 2.5147 years, height of 166.44 ± 6.11 cm, and weight of 64.21 ± 5.25 kg. After initial evaluations and initiation of treatment, 3 patients were excluded from the study due to missing 3 consecutive training sessions.

The results of paired *t*-test indicated a significant difference in the pre- and post-test pain score ($P = 0.004$) (Table 3).

The results of paired *t* test indicated that there were not any statistically significant differences in the flexibility of rectus femoris, tensor fasciae latae, and external rotators hip muscles. On the other hand, a significant difference was noted in the flexibility of hamstring muscle (Table 4).

Discussion

The aim of this study was to investigate the effect of the GPR method on the pain and flexibility of some hip muscles in men with NSLBP suffering from back movement control deficit. The results suggested that these exercises have had a significant effect on the level of pain. Further, the GPR method affected the extent of flexibility of some hip muscles (rectus femoris, tensor fasciae latae, and external rotators), though it was not statistically significant. On the other hand, GPR significantly affected the flexibility of the hamstring muscle.

Table 3. Paired Sample *T* test for Comparing Pain Intensity after Global Postural Reeducation in Individuals with Non-specific Low Back Pain and Movement Control Deficit

Variable	Mean ± SD Pre-test	Mean ± SD Post-test	Percentage Changes	*P* Value
Back pain	6.32±1.54	4.24±1.04	32.91	0.004*

Significant difference ($P \leq 0.05$).

One of the important factors studied in this study is the flexibility of hip muscles (rectus femoris, Tensor fasciae latae, external rotators, and hamstring). One of the muscles of interest in this study was hamstring muscle. It is connected to ischial tuberosity, and shortening of this muscle causes posterior pelvic tilt, diminished back curve, and thus straight back, which results in NSLBP. According to the findings obtained by Zahednezhad et al, the pain intensity level in people with NSLBP has a correlation with the flexibility of the hip muscles.[9] On the other hand, shortened hamstring muscles alongside this weakness can result in posterior pelvic tilt and diminished spinal curvature.[9] The studies have also shown that any change in the normal pattern of the movements of the spine and hip can increase the incidence of NSLBP due to the muscular attachments to them.[9] The results obtained from this study indicated that the GPR method was effective in improving the flexibility of hamstring muscle. Accordingly, since shortened hamstring muscle has the greatest relationship with the pain intensity.[9] It can be stated that the enhanced flexibility of this muscle possibly contributes to pain mitigation.

Furthermore, considering the shortened muscle chain which was observed in the subjects suffering from NSLBP, we applied the GPR method (global active stretching along with isometric contractions) to the subjects. This method prevents the activity of agonist muscles and stimulates antagonist muscles, causing the muscle spindle to stretch. The tonic muscles represent two-thirds of the total of our musculature, they are quite fibrous and of slow contraction and have a high tone. These characteristics reinforce their resistance and make it possible for part

Table 4. Paired Sample *T* test for Comparing Flexibility of Hip Muscles After Global Postural Reeducation in Individuals With Non-specific Low Back Pain and Movement Control Deficit

Muscle	Mean ± SD		Mean ± SD		Percentage Changes (%)		*P* Value	
	Right Leg	Left Leg	Right Leg	Left Leg	Right Leg	Left Leg	Right Leg	Left Leg
Rectus femoris	43.56±2.11	41.34±3.22	43.32±1.23	40.3±2.54	0.55	2.51	0.457	0.652
Tensor fascia latae	26.49±3.19	25.39±3.41	25.45±5.28	26.04±3.32	3.92	-2.56	0.334	0.365
Hamstring	82.44±5.06	85.30±7.11	90.43±6.36	91.35±5.38	-9.69	-7.09	0.003*	0.003*
External rotators	37.42±6.43	38.56±3.58	36.31±6.83	38.38±6.23	2.96	0.46	0.217	0.328

*Significant difference ($P \leq 0.05$).

of their fibers to remain in permanent contraction and in constant interaction with gravity. Its characteristics guarantee us the possibility of being erect and achieving stability, hence the reason why they are commonly known as postural muscles.[35,36] This group tends to stiffen and shorten, and its injury is commonly the result of overuse or misuse. Additionally, due to their arrangement in the joints, when they become more hypertonic and shorten, they add a compression and shearing component to joints that could evolve in a morphological change and therefore an unbalance of tensions and possibly pain. The GPR method has been designed considering the physiology of each muscle group and focuses on the elongation of the tonic muscles conditioned at the same time by an eccentric contraction of the dynamic muscles while achieving decompression and correct alignment of the joint segments.[35,36]

In patients with NSLBP, this can result in improved mobility of the spine and reduced bodily pain.[37] Among the possible reasons for the effectiveness of these exercises in improving the flexibility of hamstring muscles, one can mention that the reeducation exercises induce posterior and anterior muscle chain to stretch and affect the flexibility of hip muscles, which could possibly be effective in mitigating pain intensity. Although we cannot definitely say that GPR exercises alone are effective for patients with NSLBP, these exercises can be considered as an important part of the therapeutic method for patients with NSLBP.

In our research, the reason for the insignificant effect of GPR on the improvement of the flexibility of tensor fasciae, latae, rectus femoris, and external rotator muscles could be attributed to the short duration of the exercise program (6 weeks). On the other hand, GPR significantly improved pain and flexibility of hamstring muscles in patients with NSLBP. Evidently, this type of exercises prevents the activity of agonist muscles and stimulates antagonist muscles, causing the muscle spindle to stretch. In people with chronic NSLBP, this can result in improved mobility of the spine, flexibility, and diminished pain. The findings of our study on the improvement of pain were similar to those obtained by Bonetti et al, who evaluated the effects of GPR method on pain and functional disability. In this study, GPR method improved the pain and functional disability in the patients with NSLBP.[17]

Conclusion

Overall, the results of this study suggest the positive role of GPR method in improving pain in patients with NSLBP suffering from back movement control deficit. In addition, no dissatisfaction or side effect was reported by the patients in this study.

This finding alongside the results of previous studies can be considered a great contribution to exercise therapy in these patients. One of the limitations of this study was the absence of a control group.

Ethical Approval

This study was approved by the Ethics Committee of Sports Sciences Research Institute (Code: IR.SSRI.REC.1397.267).

Conflict of Interest Disclosure

The authors declare that they have no competing interests.

Informed Consent

All participants were informed about procedures, and they signed an informed consent form prior to participation in study procedures, in accordance with the declaration of Helsinki.

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