Research Paper

The Immediate Effects of Two Different Exercises on Clinical Outcomes and H-reflex in Patients With Acute Lumbosacral Radiculopathy

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ABSTRACT

Introduction: The evidence has shown that specific exercises effectively treat acute low back pain. This study aimed to investigate the effects of lumbar spinal loading in both directions in the sagittal plane in patients with acute lumbosacral radiculopathy.

Materials and Methods: A total of 20 patients with unilateral acute lumbosacral radiculopathy voluntarily participated in the study. The patients randomly performed flexion or extension back exercise ten times in three sets with 1-min rest between each set. Pain intensity, range of forward bending and straight leg raising (SLR), time of sit to stand, and soleus H-reflex were measured before and after the exercise.

Results: This study showed that flexion compared to extension loading exercises significantly improved pain intensity, SLR degree of freedom, forward bending range of motion, time of sit to stand, and H-reflex latency ($P<0.05$). There was no significant improvement in the H-reflex amplitude of the patients doing either of the exercises ($P=0.07$).

Conclusion: Flexion loading exercises are recommended for reducing pain intensity and improving spinal mobility and neurophysiological function of the nerve root functional status in patients with acute lumbosacral radiculopathy. It seems that flexion exercises with the flatting of lumbar lordosis and opening intervertebral space reduce disk pressure and neural tissue tension.

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1. Introduction

Lumbosacral radiculopathy is a common clinical condition that involves L5-S1 nerve root compression. Nerve root compression may result from disk herniation, vertebral spinal degeneration, or nerve root foramina narrowing [1]. The prevalence of lumbosacral radiculopathy ranged 3%-5%, distributed equally in men and women. Symptoms begin with men in their 40s, whereas women are affected between 50 and 60 years [2].

Although active treatment is recommended for acute lumbosacral radiculopathy, there are many different therapeutic interventions that the efficiency of most of them has not yet been demonstrated [3]. One of them is McKenzie's method of repeated back extension exercises that are based on spinal mechanical loading and online evaluation of clinical conditions such as range of motion, pain intensity, and distribution [4]. Previous studies reported contradictory results about the efficacy of these exercises on the electrodiagnostic findings and clinical condition of patients with lumbosacral radiculopathy [5, 6]. Several studies have reported that back extension improves pain intensity and disability and increases H-reflex amplitude in patients with acute lumbosacral radiculopathy. But some of them have reported no effect on electrodiagnosis findings and clinical condition in patients with low back pain [5, 7, 8]. Another specific exercise that reduces the pressure of the lower back is 90/90 position with repeated flexion movements. This exercise puts the body back in a neutral position by repositioning the hip joints and decompress nerve root [9, 10].

Electrodiagnosis tests provide an objective assessment for measuring the degree of nerve roots compression-decompression in lumbosacral patients [11].

Neurophysiological testing, particularly H-reflex, is routinely used to diagnose first sacral (S1) nerve root radiculopathy [12]. It is 50% sensitive and 91% specific for lumbosacral radiculopathy diagnosis [13]. H-reflex measures parameters of latency and amplitude that assess axonal freedom during a lying prone position [14]. Latency of H-reflex on the affected side prolongs or disappears in nerve root compression conditions. Therefore, H-reflex is helpful for the diagnosis of lumbosacral radiculopathy [15].

However, to the best of our knowledge, no study has assessed the effect of lumbar spinal loading in the sagittal plane in both flexion and extension directions on the clinical condition and H-reflex parameters in patients with acute lumbosacral radiculopathy. Thus, the purpose of this study is to evaluate the effects of repeated flexion versus extension exercises on the clinical outcomes and H-reflex parameters in patients with lumbosacral S1 nerve root compression.

2. Materials and Methods

Study design

The present research is a quasi-experimental interventional study approved by the Ethics Committee of Jundishapur University of Medical Sciences, Ahwaz, Iran (Approval number: IR.AJUMS.REC.1398.607). This study was conducted at the Musculoskeletal Rehabilitation Research Center, Jundishapur University of Medical Sciences, Ahwaz, Iran. All subjects signed written informed consent before the study.

Study participants

A total of 20 subjects with lumbosacral radiculopathy were referred from Golestan Spinal Surgical Center in Ahwaz City, Iran. The participants were included if they were aged between 18 and 45 years with a history of fewer than three months of back pain. They had unilateral lumbosacral radiculopathy due to disk herniation at the L5-S1 level diagnosed by MRI and a neurosurgeon. They had constant lumbosacral regional pain referred below the knee with paresthesia or calf muscles weakness or decreased in Achill tendon reflex. The subjects were excluded if they had any circulatory and neurological disorders, previous spinal surgery, spinal canal stenosis, scoliosis, cancer, cardiac problem, and pregnancies.

Outcome measures

Pain intensity, Straight Leg Raising (SLR) test, sit to stand time, forward bending range of motion, and soleus H-reflex latency and amplitude were measured before and after the exercises.

Pain intensity

A Visual Analog Scale (VAS) was used to measure pain intensity. This scale ranges from 0 to 10, and 10 refers to the worst pain. Patients were asked to determine the average pain intensity before loading, after repeated flexion, and after repeated extension.

Straight leg raising

Straight Leg Raising (SLR) test was used to assess the mechanical movement of the neurological tissue and sensitivity to nerve root compression [16]. The therapist lifts the involved leg while keeping the knee fully extended until the patient complains of pain. The degree of the painful point was recorded before loading and after repeated flexion and extension loading to measure nerve root freedom. The test has a sensitivity of 91% and a specificity of 26% [17].

Sit-to-stand

Sit to stand test is a reliable test for the measuring of patient functional performance. The patients were asked to cross their arms and sit on the chair while hips and knees were 90 degrees flexed and feet on the floor. They were instructed to transfer to a standing position and back to sitting five times in the minimum period. The task's performance time was recorded three times by a stopwatch: before and after repeated flexion and extension loading [18].

Forward Bending Test

The forward bending test is used for the nerve roots degree of freedom. The patients were asked to bend forward with feet together and the knees straight while hanging their arms. The examiner measured the distance between the tip of fingers and floor with a ruler [19].

H-reflex stimulation and recording

Testing procedures were done according to the protocol proposed by Al-Abdolwahab and associates. The patients lay down prone and were asked to comfort the upper extremities at the side. The patient leg was placed on the roll, and their feet were hung from the edge of the table in an anatomically neutral position without any movement. The skin of the popliteal fossa and cuff muscle, and soleus of both legs was shaved with sandpaper and cleaned with alcohol. The TruTrace 4 EMG system DEYMED was used to stimulate and record soleus H-reflex in both legs. The silver chloride surface-stimulation electrodes saturated with gel were placed longitudinally on the tibial nerve at the tibial fossa with a cathode electrode proximal to the anode electrode. The sodium chloride recording electrode was positioned on the soleus muscle 3 cm below the bifurcation of the gastrocnemius muscle at the line of the Achill tendon. The ground metal electrode was placed in the middle of stimulation and recording electrodes on the triceps surae muscle. The electrodes were fixed with tape to minimize movement artifacts. The stimulation parameters included 1-ms pulse duration and intensity that recorded stable H-maximum and H-minimum and M-response. H-reflex was measured three times from both legs and recorded [6]. The signals were amplified 500-2000 times using differential amplification and were filtered at 20-10000 Hz bandwidth [7].

Study intervention

The subjects were randomly performed an extension or flexion exercise first. This option was determined by one coin. In repeated back extension exercises, the patients were asked to lie flat on their stomach with hands on the ground under their shoulders, keep the back and hips relaxed and then use arms to press their upper back and shoulders up. Holding the press-up position for one second as described by McKenzie and May (2003) [4, 20]. They repeat the exercise 10 times in 3 sets with 1 min of rest between the sets. In repeated flexion exercise, the subjects were asked to lie supine with hips and knees bent at 90 degrees on a Swiss ball. The upper body is relaxed on the ground. They were instructed to flex their hips in a manner that was pain free [9, 10, 20]. They repeated the exercise 10 times in 3 sets with 1 min rest between them.

Statistical analysis

Statistical analyses were conducted using SPSS v. 24 (SPSS Inc., Chicago, IL, USA) for windows. The Shapiro-Wilk test confirmed the normal distribution of study variables. Repeated measures analysis of variance (ANOVA) was used to investigate the effect of two exercises on clinical outcomes and H-reflex. A post hoc Least Significant Difference (LSD) test examined two different states. P values less than 0.05 were considered important in this study.

3. Results

The patient's demographic characteristics are presented in Table 1. Mean and standard deviations of clinical outcomes and H-reflex are reported in Table 2.

Visual analog scale

The repeated measures of the ANOVA test results were significant for VAS (Table 2). The Post Hoc LSD test results showed significant decreased pain intensity from baseline after flexor loading exercise ($P<0.01$), but pain intensity had no significant improvement after extension exercise ($P=0.24$).

Table 1. Demographic and functional characteristics of the patients

Variables	Minimum	Maximum	Mean±SD
Age (y)	23.00	45.00	35.45±6.87
HeightLength (cm)	150.00	197.00	165.45±11.97
Weight (kg)	57.00	114.00	76.25±14.99
Disability (Oswestry Disability Index)	10.00	54.00	31.10±11.81
Time since disease (mo)	4.00	60.00	36.85±23.61

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Forward Bending Test

The repeated measures ANOVA test results were significant for the forward bending test (Table 2). The post hoc LSD test results showed that the range of forward bending significantly increased from baseline after flexor loading exercise (P<0.01). The range of forward bending had no improvement after extensor loading exercises (P=0.27).

Straight leg raising

The repeated measures ANOVA test results were significant for the SLR test (Table 2). The post hoc least significant difference test results showed that SLR significantly improved from the baseline after flexor loading exercises (P<0.01). There was no significant improvement in SLR with extension exercise (P=0.10).

Sit-to-stand

The repeated measures of ANOVA test results were significant for sit to stand time (Table 2). The post hoc LSD test results showed the mean values of time sit to stand significantly decreased after flexion exercises (P<0.01). But it had no significant change after extension exercise (P=0.91).

Amplitude and latency

H-reflex amplitude in the result of repeated measure ANOVA test has no significant improvement after loading exercises, but latency was significantly changed (Table 2). The post hoc LSD test results showed that latency response after flexor loading exercises significantly decreased after flexion exercises (P<0.01) and extension exercises (P=0.03), but it declined more after flexion exercises (Table 2).

4. Discussion

This study aimed to examine the effects of lumbar spinal loading in the sagittal plane on clinical outcomes and H-reflex in subjects with acute lumbosacral radiculopathy. This study showed that spinal loading in flexion direction is more effective in pain relief and improvement in clinical tests, such as SLR, forward bending, and sit to stand. Some possibilities would explain it. First, 90-90 position put the back in a neutral position, open the intervertebral space, and reduce the disk pressure and neural tissue tension, which decreases the pain intensity scale [9]. Second, according to the pain-spasm-pain cycle,

Table 2. Summary of repeated measures ANOVA results

Variables	Mean±SD			F Ratio	P
	Before Loading	After Flexor Loading	After Extensor Loading		
Static visual analog scale	5.8±1.60	4.25±2.44	5.25±2.14	5.58	<0.01
Forward bending (cm)	28.15±9.14	19.7±8.08	25.55±10.06	9.63	<0.01
SLR (degree)	57.55±8.48	65.05±8.88	60.4±9.50	11.13	<0.01
Sit-to-stand (s) (cm)	16.25±4.03	13.7±3.81	13.7±3.81	8.14	<0.01
H-reflex latency (ms)	34.85±8.00	27.63±10.12	29.20±10.87	3.308	<0.01
H-reflex amplitude (mv)	4.15±0.52	5.10±0.92	5.31±1.43	9.38	0.07

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pain leads to muscle hyperactivity that results in reduced muscle fluid flow and lactic acid accumulation, which exacerbates pain [21]. Evidence has demonstrated that active repetitive movements increase muscle blood and lymph flow rate that seems to help pain relief [10].

In agreement with this study, Ellengar et al., who studied 56 patients with chronic low back pain in two groups of flexion and extension exercises, reported that flexor exercises increased lumbar spinal mobility in the sagittal plane and reduced pain intensity [22]. Also, Arab et al. showed that active harmonic end range loading exercises versus extensor exercises in chronic low back pain patients significantly decreased the pain and disability [23]. Stelzender et al. showed a shift of intervertebral disk space after unloading the lumbar spine in the supine position, although in this study, clinical outcomes were not assessed [24]. All of them had reduced disability and fewer positive SLR subjects. It can be due to the duration of intervention that was 8 weeks [25].

Findings of this study are inconsistent with Dettori et al., who found no significant difference between flexion and extension exercises in patients with acute radiculopathy [25]. H-reflex latency improved after both repeated flexion and extension. This finding supported possible decompression of the S1 spinal root after those exercises. However, this reduction in latency was greater after flexion exercise.

Al-Abdolwahab et al. studied the effect of repeated extension on patients with subacute and chronic lumbosacral radiculopathy. They found improvement in H-reflex amplitude after repeated extension exercise in patients with subacute low back pain, but chronic groups had no significant remission [6].

Although H-reflex improved in patients with subacute pain, supporting the present study results, there was controversy with chronic patients recovering from electrodiagnostic parameters. It might be attributed to the pathological differences among the patients' groups. Demyelination nerve roots and degeneration of intervertebral disk influence the movement of the nuclear material and decompressing nerve root. The current study had some limitations. First, the effect of more than one session of exercise has not been investigated. In this study, the patients with subacute and chronic symptoms with radiculopathies were not included. The effect of a complete McKenzie program on H-reflex was not assessed, too.

5. Conclusion

Flexion exercises lead to the decrease of lumbar lordosis and opening of intervertebral space. So it seems that flexion exercises compared to extensor exercises significantly improved functional status, spinal mobility, straight leg raising, and pain severity.

Ethical Considerations

Compliance with ethical guidelines

The study proposal was approved by the Research Council of Rehabilitation Sciences Faculty of Ahvaz Jundishapur University of Medical Sciences (Ethics Code: IR.AJUMS.REC.1398.607).

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Authors contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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