

Lumbar stabilizing exercises improve activities of daily living in patients with lumbar disc herniation

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Abstract. Lumbar stabilizing exercises (LSE) have been recommended to improve lumbar function in patients with low back injury so that these patients may improve their activities of daily living (ADL). This study has been designed to investigate the effect of LSE in patients with herniated lumbar disc (HLD). Sixty patients (aged 22–55 years old) with HLD at L4-L5 or L5-S1 were randomly arranged into two groups (A and B) of thirty. Group A performed a LSE protocol for four weeks upon recruitment into the study, followed by a four week no-exercise period, whilst group B performed the opposite. Measurements were taken before and after the LSE protocol and no-exercise period and included; pain (measured on a visual analogue scale); trunk flexion; straight leg raising (SLR) angle without pain and time to complete ADL tasks such as climbing 5 steps, 10 meter walking, laying prone from standing position and standing up from prone position. Significant pain relief ($p < 0.0001$), left and right SLR angle improvement ($p < 0.005$), increased trunk flexion ($p < 0.001$) and improved ADL performance ($p < 0.05$) were found after first four week LSE period in group A. The same results were found in group B following their exercise period. These findings indicate that a LSE protocol may improve ADL performance in patients with HLD.

Keywords: Lumbar stabilizing exercise, herniated lumbar disc, ADL

1. Introduction

Nearly 80% of people experience low back pain (LBP) during their life. LBP is the most common cause of activity limitation in people younger than 45 years. In the USA, it is the second most frequent reason for visits to physicians, the fifth ranking cause of admission to hospitals and the third most common cause of surgical procedures [1,9]. 97% of LBP are due to mechanical factors, 1% to non-mechanical factors and 2% are due to visceral disease. Intervertebral disc lesion accounts for 4% of mechanical LBP [6]. It commonly occurs in the L4-L5 or L5-S1 level [21]. The interver-

tebral disc has an important role in providing stability between adjacent vertebra [21], necessary for normal performance during activities of daily living [19] and several studies have defined effective treatment protocols for herniated disc [13,22].

Complete bed rest is not recommended in the first 4 to 6 weeks after onset of symptoms [24]. After 4 to 6 weeks, if the symptoms persist, surgical treatment is recommended, following MRI and CT scan findings [13]. Nearly 10% of all patients are treated in this way [6]. Gibson and colleagues [8] have found that a standard discotomy procedure and micro discotomy may have positive results in terms of pain relief, but it is still unknown how long results remain stable (for example 10 years) [25]. After lumbar disc surgery, it has been reported that 22–45% of patients still report sciatic pain and 30–70% of patients complain of LBP [7,22]. However, other studies indicate a full recovery rate of 60–90% for this type of treatment [15,16,20]. In other

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words, these studies imply that there are still 10–40% of patients who complain of pain, motor dysfunction or reduced ADL performance after surgery [16]. This rate of complaint may indicate limitations of surgical treatment in some herniated lumbar disc patients.

Ito and colleagues showed that if patients with herniated lumbar disc could tolerate the symptoms of disc herniation for two months after onset of symptoms, it is possible to treat them with conservative approaches [13]. Using CT scan techniques, it was shown that 66% of herniated disc cases may normalize or recover either totally or partially with time and that large lumbar herniated nucleus pulposus can decrease and even disappear in some patients treated successfully with conservative care [5]. Although surgical and non-surgical treatment procedures in patients with HLD is still the subject of recent studies [7,22,25,27], there has been no study to investigate the effectiveness of LSE in patients with HLD. Considering the above findings, the fact that lumbar stability may be compromised as a result of a herniated disc and that this stability may not return to the region even after surgical intervention, this study has been designed to investigate the effect of lumbar stabilizing exercise (LSE) in patients with herniated lumbar disc.

2. Methods and materials

2.1. Patients

The study protocol was approved by the local Ethical Committee of the University. Sixty patients with clinically diagnosed herniated lumbar disc at L4-L5 or L5-S1 level, confirmed by MRI or CT scan, participated in this randomized clinical trial study. The patients were referred from outpatient orthopaedic clinics of the Semnan University of Medical Sciences to the physiotherapy department of the University. The inclusion criteria were; history of LBP, sciatic pain and reduced functional performance due to the L4-L5 or L5-S1 disc herniation for more than 2 months. Patients with motor and sensory dysfunction or with Caudal Equine syndrome were excluded from the study. All patients gave their consent to participate in the study.

A computer generated randomization list, drawn up by the statistician, was used to randomly assign patients into one of the two exercise groups, thirty patients in each group. The list was given to the physiotherapy department of the Semnan University of Medical Sciences, in a set of sealed numbered envelopes.

These were then opened at the reception, when the qualifying patients had signed informed consent and entered the study. The card inside (A or B) indicated the patient's allocation to one of the two exercise groups. This information was then given to the physiotherapist to administer the appropriate intervention.

2.2. Intervention

Group A underwent a four week LSE protocol followed by a four week no-exercise period, while group B had the no-exercise period in the first four weeks and then the same LSE protocol in the second four weeks.

The LSE protocol included four stages of stabilizing exercises from easy to advanced (Fig. 1). Each stage was taught to the experimental group in the first session of each week, and then the patients were asked to perform the LSE protocol at home, twice daily (morning and evening) and 10 times each for the rest of the week. The accuracy of exercise performance at home was regularly controlled by a physiotherapist during each week. During the no-exercise period, the patients were asked not to perform any therapeutic exercise.

2.3. Outcome measures

The staff who assessed the outcomes were different from the staff administering the LSE protocols, and they were blinded to the exercise groups (A or B). Outcome measures consisted of: a) pain measurement by means of a visual analogue scale (VAS), on which the patients could indicate their assessment along a 10 cm line ranging from 0 (no pain at all) to 10 (the most severe pain imaginable); b) the range of trunk flexion (without pain) when sitting with knees extended and reaching the fingers to the toes (measured by the distance between the tip of fingers and the tip of toes at the end of movement in cm); c) the range of left and right straight leg raising (SLR) without pain by hand-held goniometry and d) the time required to complete the following ADL tasks; I) laying prone on the floor from the standing position, II) standing up from laying prone on the floor, III) climbing steps (5 steps), IV) 10 meter walking (as fast as they can, without pain).

To investigate the effects of the LSE protocol, all measurements were performed at the beginning and end of the four week LSE protocol and again at the beginning and the end of the four week no exercise period in both groups.

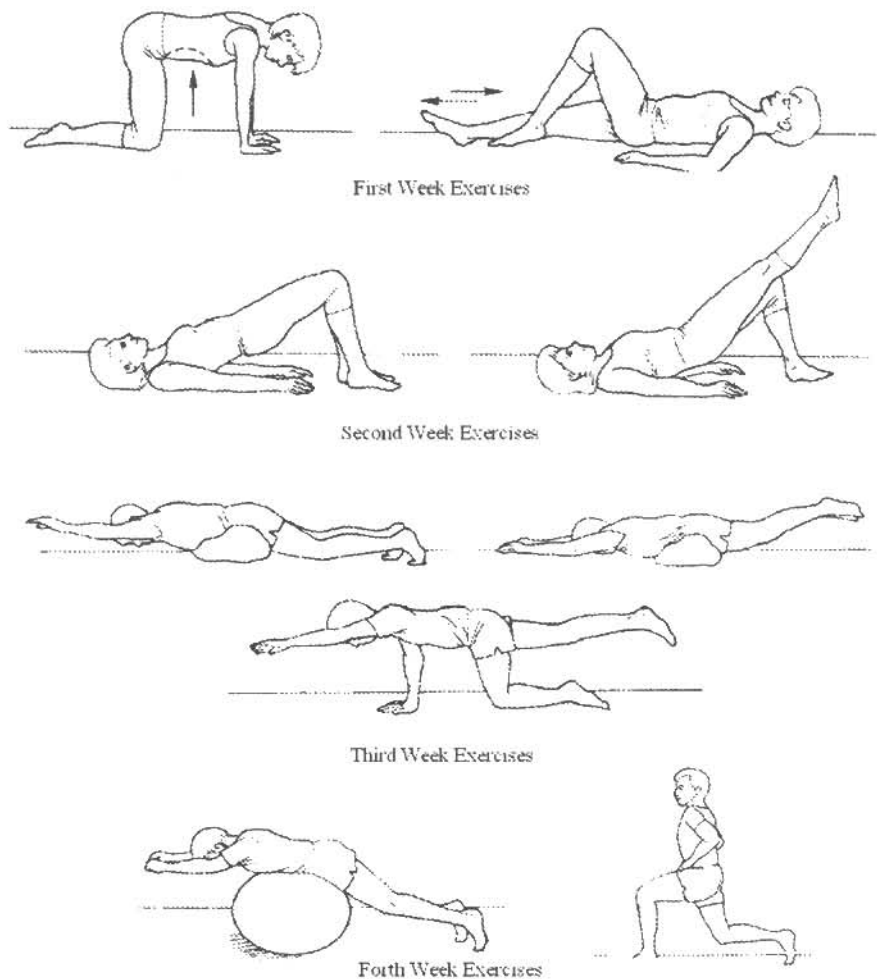


Fig. 1. Four stages of lumbar stabilizing exercises. All exercises were carried forward into subsequent weeks.

2.4. Statistical analysis

An intention to treat analysis was used which involved all patients randomly assigned to their groups. To compare the possible treatment effects a two way ANOVA was used to compare the means of the pain, trunk flexion, left and right SLR and time of ADL performance before and after first four week period and at the end of study ($\alpha = 0.05$).

3. Results

3.1. Baseline evaluation

Initial measurements showed no significant difference between the demographic data and baseline char-

acteristics of patients in the two experimental groups (Table 1). Three patients from group A and five patients from group B failed to complete the full term of the study but their data has still been included in the analysis.

3.2. Effect of treatment

Table 2 shows the mean changes in recorded parameters at the end of the first four week period and at the end of the study in both exercise groups. Significant differences were seen in the mean changes of all measurements between the two exercise groups at the end of first four weeks of the study; however the comparison of these measurements did not show any significant difference in the mean changes at the end of the study between two groups.

Table 1
Demographic data and base line characteristics of patients in the experimental and control groups, means (SD)

Variables	Exercise group	Control group
Age (years)	33.0 (5.1)	32.6 (6.4)
Duration of current main complaints (month)	3.5 (1.4)	4.4 (1.2)
Pain (Visual Analogue Score)	4.29 (0.9)	4.5 (1.1)
Trunk flexion (cm)	-11.36 (3.1)	-13.5 (3.5)
Left SLR without pain (degree)	38.2 (9.3)	45.6 (7.8)
Right SLR without pain (degree)	45.1 (10.2)	40.3 (8.2)
Time for 10 meter walking without pain (sec)	9.5 (2.1)	10.1 (9.2)
Time for climbing five steps (sec)	5.1 (1.1)	4.2 (0.9)
Time for laying prone from standing position (sec)	5.4 (1.5)	5.1 (1.2)
Time for standing from laying prone position (sec)	5.2 (0.9)	5.9 (1.2)

Table 2

Mean changes (95% confidence interval) from baseline values for pain, trunk flexion, SLR angle and time required to fulfill the ADL tasks at the end of each study period. Group A performed four weeks exercise followed by four weeks of no exercise. Group B had four weeks of no exercise followed by four weeks of exercise

	At the end of first four-week			At the end of eight-week study		
	Group A mean (SD)	Group B mean (SD)	Mean differences (95% CI; p)	Group A mean (SD)	Group B mean(SD)	Mean differences (95% CI; p)
Change in pain (VAS)	-3.2 (1.47)	-0.5 (1.17)	-2.7 (-3.5 to -1.9) $p < 0.0001$	-3.5 (1.57)	-2.6 (1.26)	-0.9 (-1.7 to -0.1) $p = 0.23$
Change in trunk flexion (cm)	13.4 (4.12)	3.5 (3.3)	9.8 (5.1 to 13.6) $p < 0.001$	14.6 (5.11)	11.5 (4.15)	3.1 (1.1 to 5.2) $p = 0.14$
Change in left SLR (degree)	31.4 (8.45)	6.1 (4.9)	25.3 (11.8 to 38.8) $p = 0.003$	27.3 (9.51)	29.7 (8.78)	-2.4 (-4.6 to -0.4) $p = 0.26$
Change in right SLR (degree)	30.1 (14.56)	8.3 (7.32)	21.8 (8.9 to 34.6) $p = 0.004$	25.1 (11.23)	21.1 (7.1)	3.1 (0.5 to 5.7) $p = 0.42$
Change in time for 10 m walking (sec)	-5.1 (2.62)	-1.2 (2.86)	-3.9 (-5.4 to -2.4) $p = 0.007$	-4.7 (2.53)	-4.5 (3.93)	0.2 (-1.6 to 2.1) $p = 0.67$
Change in time for climbing 5 steps (sec)	-2.5 (0.84)	-0.9 (1.69)	-1.7 (-2.8 to -0.6) $p = 0.03$	-2.6 (1.18)	-2.9 (1.24)	0.3 (-1.6 to 2.2) $p = 0.85$
Changes in time for laying prone (sec)	-2.7 (1.25)	-0.3 (1.62)	-2.4 (-3.5 to -1.5) $p = 0.02$	-2.9 (1.35)	-2.5 (1.37)	-0.4 (-2.5 to 2.2) $p = 0.72$
Change in time for standing from laying prone (sec)	-2.7 (1.13)	-0.9 (1.06)	-1.8 (-2.6 to -0.8) $p = 0.03$	-2.9 (0.95)	-2.1 (1.24)	-0.8 (-2.4 to 0.9) $p = 0.72$

3.3. Pain perception

Patients' rating of pain at the end of the first four week period significantly favored the LSE protocol ($p < 0.0001$). No significant difference was seen at the end of the study between the two groups.

3.4. Trunk flexion

Comparison between mean changes in reaching the tip of fingers to the tip of toes when seated with legs outstretched showed that the range of trunk flexion increased significantly (56.4%) in the exercise group A ($p < 0.001$) at the end of the first four weeks of study. The same results were seen in group B at the end of the study.

3.5. SLR angle

Measures of SLR angle without pain significantly increased by 80% in the left side ($p = 0.003$) and 60% in the right side ($p = 0.004$) in group A, compared to group B at the end of the first four weeks of study. There was no significant difference between the two groups at the end of the study.

3.6. Physical functioning

Measures of time to complete the functional activities of daily living (ADL) also showed a significant difference between groups at the end of the first four weeks of study. Performing the LSE protocol improved the time of 10 meter walking by 39.7% ($p = 0.007$) and climbing stairs by 48.3% ($p = 0.03$). Patients in group A also performed significantly faster when lay-

ing prone from standing position by 52.4% ($p = 0.02$) and when standing from the laying prone position by 55.1% ($p = 0.03$) after completing the LSE protocol. The same results were seen in group B at the end of the study.

The comparison of mean changes at the end of the second four weeks of study showed no significant difference between the two groups.

4. Discussion

The results of this study indicate that implementation of a protocol of lumbar stabilizing exercises can relieve pain and improve ADL performance in patients with herniated lumbar disc. It has been suggested that stability of vertebral column components is a necessary factor for its normal functioning [14,19]. It has also been confirmed that effective activity of muscles around the vertebrae may help to increase vertebral column stability by controlling the movement of adjacent vertebrae [26]. Several studies have investigated the role of stabilizing exercises [3,10,18], however, these have only confirmed the effectiveness of these exercises on pain relief and normal performance in patients with chronic LBP, not herniated lumbar disc.

In the presence of pathological conditions such as chronic LBP or HLD, there are reports that lumbar stabilizer muscle function may be disturbed and that this upsets the stability of adjacent vertebra [2,12,17]. Hodge and Richardson [12] showed that these muscles may not effectively provide lumbar stability during various movements in patients with LBP. Kong and colleagues [14] also described that muscle "dysfunction" destabilizes the spine and disturbs the functioning of other spinal components.

Although it has been shown that the stabilizing functions of intervertebral discs and muscles may be disturbed in patients with HLD [20], improving muscle function has received less attention in these patients, despite the fact that the malfunction of these stabilizing factors may cause increasing pain and reduce functional performance [19]. Therefore, according to Panjabi's hypothesis "*lumbar vertebral stability is based not only on its structural shape, but also on the accurate performance of its surrounding neuromuscular system*" [19] and it is logical and necessary to pay attention to lumbar stabilizing exercises when aiming to improve the performance of this system and establish lumbar stability in HLD patients.

The results from our study show that a LSE protocol improves the stability of the injured lumbar segment so that the patient's ability to fulfill task performance is increased (reduced time to complete the tasks) and they are able to perform tasks more easily and more comfortably. These findings are supported by Cholewicki and McGill's study [3] which demonstrated an improvement in functional ability of the post vertebral muscles followed by an increase in lumbar stability after instigation of an exercise protocol.

Such changes in patients' performance may be related to changes in several factors including lumbar muscle structure, passive structures and proprioceptive function. Several studies have investigated the effect of exercise therapy on the size and type of muscle fibers in muscles stabilizing the lumbar region, although most of these studies have been performed in chronic LBP patients. Hide and colleagues [11] found that a four week exercise program may increase the size of multifidus muscles. Rissanen and colleagues [23] also showed that lumbar extensor muscle strengthening not only prevents atrophy of the type II fiber multifidus muscles, but may also increase the size of these fibers by 11%, and increase the power of these muscles by up to 19–22%. The above reports emphasise the effectiveness of exercise therapy in the treatment of chronic LBP patients and support our results that show that this treatment may also be applied in patients with herniated lumbar disc. The LSE protocol may strengthen stabilizer muscles and increase their efficiency to stabilize components of the lumbar vertebral column, improving task performance in HLD patients as a consequence. This may help patients perform their activities of daily living with improved ease and comfort.

5. Conclusion

This clinical trial showed that a lumbar the stabilizing exercise protocol may increase lumbar stability and improve ADL performance in patients who have suffered with a herniated lumbar disc for more than 2 months. It may also be concluded that these types of exercise may strengthen the stabilizer muscles, which control and limit the free movement of one vertebra on another. From these results it may also be deduced that the increased stability of adjacent vertebra in the vertebral column may accelerate the recovery process of the herniated disc. The results of this study may encourage physiotherapists to use LSE to treat patients with lumbar herniated disc.

We believe that a prolonged follow-up study investigating the long term effects of a LSE protocol by documenting the recovery of the herniated disc using MRI or CT scans would be useful.

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