Int J Clin Exp Med 2015;8(6):9869-9875
www.ijcem.com /ISSN:1940-5901/IJCEM0008632

Original Article

Comparison of lumbar spine stabilization exercise versus general exercise in young male patients with lumbar disc herniation after 1 year of follow-up

Chaoqun Ye*, Jixin Ren*, Jianzheng Zhang, Chongwei Wang, Zhi Liu, Fang Li, Tiansheng Sun

*Department of Orthopaedic, Beijing Army General Hospital, Beijing 100700, China. *Equal contributors.*

Received March 31, 2015; Accepted June 2, 2015; Epub June 15, 2015; Published June 30, 2015

Abstract: Objective: The safest and most effective conservative treatment for patients with lumbar disc herniation (LDH) has not been established. The purpose of this study was to evaluate the effect of lumbar spine stabilization exercise (LSSE) and general exercise (GE) on pain intensity and functional capacity in young male patients with LDH. Methods: Sixty-three young male adults aged 20 to 29 years with the diagnosis of LDH were enrolled and divided into an LSSE group (n=30) and a GE group (n=33). Patients in both groups received low-power laser (LPL) therapy during the first week of the onset of LDH. Patients in the GE group underwent a GE program. Patients in the LSSE group followed an LSSE program for 3 months. All of the patients were subjected to pain intensity and functional capacity evaluations four times: at pre-and post-LPL therapy, and at 3 months and 1 year post-exercise. Pain intensity of the lower back and legs was evaluated with the visual analogue scale (VAS), and functional capacity was evaluated with the Oswestry Disability Index (ODI). Results: Both groups showed a significant reduction in VAS and ODI scores at 3 and 12 months post-exercise compared with before treatment ($P<0.001$). The LSSE group showed a significant reduction in the average score of the VAS for low back pain ($P=0.012$) and the ODI ($P=0.003$) at 12 months post-exercise compared with the GE group. Conclusions: LSSE and GE are considered as effective interventions for young male patients with LDH. Moreover, LSSE is more effective than GE, and physical therapy, such as LPL, is required during acute LDH.

Keywords: Young male patients, lumbar disc herniation, pain intensity, functional capacity, lumbar spine stabilization exercise, general exercise

Introduction

Lumbar disk herniation (LDH) is a common health problem that mainly occurs in younger adults, and leads to degenerative lumbar spinal disease in older adults [1]. LDH most typically manifests as low back and radicular leg pain and nerve functional deficits, and causes both physical and social functional impairment. Although surgery for LDH is the most common spinal operation [2], the outcome of nonsurgical treatments is favorable in the majority of LDH patients [3]. Nonsurgical treatments are recommended as the primary intervention for the early stages of LDH without cauda equina syndrome in some clinical guidelines that are followed in clinical practice [4-6].

There are numerous nonsurgical treatment options that are available for patients with LDH, in which physical therapy or exercise therapy has been shown to be beneficial for LDH patients [7-9]. Recent systematic reviews have reported that several nonsurgical therapies, such as ultrasound, low-power laser (LPL) irradiation, stabilization exercises (SEs), and manipulation are more effective in altering the prognosis of LDH patients than no treatment or sham manipulation [9]. However, there is still no general consensus regarding the most effective treatment.

SEs are designed to improve spinal stability, and this is one of the most popular rehabilitation programs for increasing athletic performance and relieving pain. These exercises are also called lumbar spine stabilization exercise (LSSE) [10], core stabilization exercise [11], or motor control exercise [12]. These exercises improve the musculature and activation of deep muscles, such as the multifidus and transversus abdominis (TrA) muscles, the diaphragm, and the pelvic floor. These exercises also improve flexibility, strength deficits of the superficial muscles of the spine, and retain precise neural control of these muscles. LSSE has a strong theoretical foundation and is widely used for rehabilitation of the lumbar spine [8, 10, 11]. However, no studies on LDH have compared an LSSE program with other treatments [9]. Even in patients with nonspecific, chronic low back pain (LBP), results of the comparison of LSSE with general exercise (GE) are controversial [12, 13]. Therefore, further studies are required to investigate the safest and most effective conservative treatment for LDH patients [7].

For this reason, we aimed to compare the effect of LSSE with GE on pain intensity and functional capacity in young male LDH patients, to determine the most effective exercise for these patients.

Materials and methods

Design and participants

This study was a controlled clinical trial. Sixty-three young male patients with LDH were included who were diagnosed and treated as outpatients of the orthopedic department in Beijing Army General Hospital from March 2011 to June 2012. The participants were aged 20-29 years during the study. The diagnosis of LDH was confirmed by predominant symptoms in the lower back and leg radicular pain, which are positive signs of straight leg raise testing and nerve root tension, and by magnetic resonance imaging (MRI). Patients with lumbar spinal stenosis, spondylolysis, ankylosing spondylitis, moderate to severe scoliosis, malignancy, fracture, spinal cord compression, and previous back surgeries were excluded. Individuals with limited participation in physical activity that was related to any severe psychiatric or medical comorbidities were also excluded. The patients were randomly assigned to receive GE (GE group) or LSSE (LSSE group).

Procedures and interventions

The study was approved by the Ethical Committee at the Beijing Army General Hospital. All of the participants were voluntary patients and signed an informed consent form.

After completion of baseline evaluations, all of the patients in both groups received LPL therapy during the first week of the onset of LDH. They also received oral and written information about strategies for self-care, including instructions for the exercise program and lifestyle modifications by a physiotherapist in the outpatient department. After 1 week, LPL therapy was finished, and then the patients were instructed to practice the GE program or the LSSE program.

For LPL therapy, a Gal-Al-As diode laser device (NK-808, Wuhan Nankang Company, Wuhan, China) was used at a power output of 450 mV and a wavelength of 810 nm. The diameter of the laser beam at the treatment point was 4 mm. The laser was set to deliver a continuous form of energy and was vertically sent to the treatment point of the low back of the patients in a prone position where herniation was detected on MRI. The distance between the source of the laser and the treatment point was 3 cm. A stimulation time of 8 minutes was used at one time, once a day, for a total of seven sessions.

The GE program included stretching exercises of the limbs and spine, and strengthening of the abdominal flexor muscles and lumbar extensor muscles. These exercises were adapted to individual patient's needs.

The LSSE program comprised progressive deep core muscle exercises and stretching, and strengthening exercises of superficial muscles of the abdomen and trunk [11, 21]. The patients were instructed to activate the deep muscles by conducting isometric contractions of the lumbar multifidus (LM) and TrA, and to find and maintain a neutral spinal position. When activation of these muscles was achieved, static lumbar stability exercises were practiced by curl-up, pelvic bridge, side bridge, and quadruped positions, with alternate arm/leg raises and prone plank. These gradually progressed to dynamic stabilization exercise on a ball or foam roll. Finally, the use of these specific exercises was integrated into the performance of functional activities, daily living activities, and work.

Both protocols of GE and LSSE were conducted for 12 weeks, three times per week. Each session lasted 45 minutes, including 10-minute jogging as a warm-up exercise. During the first month, patients conducted LSSE and GE for

Table 1. Characteristics of patients in the GE group and LSSE group

	LSSE group (n=30)	GE group (n=33)	p
Age (years)	23.64±3.53	24.18±3.60	0.17
Level			
L4/5	13 (43.3%)	14 (42.4%)	
L5/S1	17 (56.7%)	19 (57.6%)	0.570

two sessions per week at the outpatient department and were supervised by physiotherapists. After this time, at least one session per week was supervised.

Functional evaluation and follow-up

Before intervention (baseline evaluations) and 3 months post-exercise, pain intensity in the lower back and leg and functional capacity were evaluated at the outpatient department by the same investigator. Seven days after LPL therapy, pain intensity in the lower back and leg was also assessed. Twelve months post-exercise, all of the patients were contacted via phone by the same investigator to enquire about pain intensity in the lower back and legs, as well as functional capacity.

Pain intensity in the lower back and legs was evaluated using the 0-10 visual analogue scale (VAS) [14]. Functional capacity was evaluated by the Oswestry Disability Index (ODI) [15].

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 15.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. All data are presented as means and standard deviations. Comparison between the GE and LSSE groups was performed using the independent samples *t*-test. Comparison within the groups was performed using one-way analysis of variance followed by the least-significant difference or Tamhane's test, as necessary. A *p* value of less than 0.05 was considered to be statistically significant.

Results

Characteristics of the patients

All of the patients completed the intervention, evaluation, and follow-up. There were no differences in age and level of LDH between the two groups (P>0.05, **Table 1**).

Effect of LPL therapy, and LSSE and GE programs on the VAS score of LDH patients

There were no differences in the VAS scores for low back and leg pain at pre-intervention (P=0.665 for low back pain, P=0.813 for leg pain), 7 days post-LPL therapy (P=0.686 for low back pain, P=0.912 for leg pain), and 3 months post-exercise between the groups (P=0.066 for low back pain, P=0.08 for leg pain). There was also no difference in the VAS score of the legs at 12 months post-exercise between the groups (P=0.091). However, at 12 months post-exercise, the LSSE group showed a significantly reduced mean VAS score for low back pain compared with the GE group (0.45±0.74 vs 1.27±1.43, P=0.012, **Table 2**).

For comparison within the groups, there was a significant reduction in the mean VAS score for low back and leg pain at 7 days post-LPL therapy and at 3 and 12 months post-exercise compared with before treatment in both of the groups (P<0.001). The VAS scores for low back and leg pain at 3 and 12 months post-exercise were also lower than those at 7 days post-LPL therapy in both of the groups (P<0.001, **Table 2**).

Effect of LSSE and GE on the ODI of patients with LDH

At 12 months post-exercise, the LSSE group showed a significantly reduced mean ODI score compared with the GE group (9.28±4.99 vs 16±10.11, P=0.003). There was no difference in the ODI score at pre-intervention (P=0.665) and 3 months post-exercise between the groups (P=0.066, **Table 3**).

For comparison within the groups, there was a significant reduction in the mean ODI score at 3 and 12 months post exercise compared with pre-intervention in both groups (P<0.001). The mean ODI score at 12 months post-exercise was significantly lower than that at 3 months post-exercise (P<0.001, **Table 3**).

Discussion

In this study, we focused on comparison of the effectiveness of LSSE with GE on pain and functional capacity in LDH patients. However, our preliminary investigation indicated that the LSSE program cannot be accepted by acute

Table 2. VAS scores in the GE group and LSSE group

	LSSE group (n=30)	GE group (n=33)	P*
VAS score for low back pain			
Before	5.7±3.19	5.38±2.69	0.665
7 days	3.33±1.88[2a]	3.16±1.55[3a]	0.686
3 months	1.07±1.16[3a,3b]	1.80±1.68[3a,b]	0.066
12 months	0.45±0.74[3a,3b,*]	1.27±1.43[3a,3b]	0.012
VAS score for leg pain			
Before	6.45±3.25	6.62±2.19	0.813
7 days	3.14±1.59[3a]	3.18±1.15[3a]	0.6914
3 months	1.38±1.59[3a,2b]	2.16±1.79[3a,b]	0.080
12 months	0.66±1.26[3a,3b]	1.34±1.79[3a,3b]	0.091

"Before" indicates before treatment; "7 days" indicates 7 days after treatment; "3 months" indicates 3 months after treatment; and "12 months" indicates 12 months after treatment. Superscript letters indicate intra-group comparisons. [a]Comparison of 7 days, 3 months, and 12 months with before treatment ([2a]P<0.01, [3a]P<0.001); [b]comparison of 3 and 12 months with 7 days ([b]P<0.05, [2b]P<0.01, [3b]P<0.001). [*]Inter-group comparison; [a]p<0.05.

Table 3. Functional capacity in the GE group and LSSE group

ODI	LSSE group (n=30)	GE group (n=33)	P*
Before	76.47±19.04	68.66±21.30	0.134
3 months	29.83±11.29[3a]	29.38±12.56[3a]	0.887
12 months	9.28±4.99[3a,3c,**]	16±10.11[3a,3c]	0.003

"Before" indicates before treatment; "3 months" indicates 3 months after treatment; and "12 months" indicates 12 months after treatment. Superscript letters indicate intra-group comparisons. aComparison of 7 days, 3 months, and 12 months with before treatment ([3a]p<0.001); and ccomparison of 12 months with 3 months ([3c]p<0.001). [*]Inter-group comparison; [**]p<0.01.

LDH patients, while LPL therapy can effectively reduce the intensity of low back and leg pain. Therefore, before performing LSSE or GE, all of the patients in both groups received LPL therapy during the first week of the onset of LDH. We found that LPL therapy reduced pain intensity in the lower back and legs. Both of the LSSE and GE programs further reduced pain intensity in the lower back and legs, and improved functional capacity. Moreover, at 12 months post-exercise, patients in the LSSE group showed a significantly reduced mean score of the VAS for low back pain and the ODI compared with the GE group. This result suggests that the LSSE and GE programs can relieve pain intensity in the lower back and legs, and improve functional capacity in LDH patients. LSSE was superior to GE in the treatment of LDH with regard to low back pain and functional capacity in the long term.

LPL therapy can effectively relieve low back and leg pain by a reduction in the size of the herniated mass of patients with acute LDH [11]. Our patients accepted LPL therapy only for 1 week, and we did not assess the change in disc size by MRI. However, LPL therapy significantly reduced the pain intensity of the lower back and legs, and provided a good basis for our patients to perform the LSSE or GE program. Most patients could begin these exercise programs 5-7 days after LPL therapy, while they hardly performed any exercise pre-LPL therapy in this study.

GE is the most common exercise therapy. GE can improve the range in movement of the spine by stretching exercises, increase muscle power by strengthening exercises, and correct posture deficits by control exercises. These active exercises can significantly reduce pain and improve functional abilities by improving the range in movement, muscle strength, and body posture [16, 17]. LSSE is a comprehensive rehabilitation program involving postural training, deep muscle reactivation, stretching and strengthening of the prime movers of the spine, and subsequent progression to functional exercises [8, 11, 12]. LSSE also improves the range in movement, muscle strength, and body posture by stretching and strengthening of the prime movers of the spine and postural training [8, 12]. Therefore, the mechanism of GE and LSSE for relieving low back and leg pain and improving functional capacity in young male LDH patients is probably associated with improved range in movement of the spine, muscle strength, and body posture.

LSSE is characterized by improvement of dynamic stability of the spine by training the deep trunk muscles, such as the TrA and LM, and correction of motor control [8, 10-12]. Accordingly, the LSSE program significantly reduced the mean score of the VAS for low back pain and the ODI at 12 months post-exercise compared with the GE program. A possible explanation for this finding is improved spinal stability associated with the LSSE program.

Several studies have shown that LSSE improves musculature of the TrA [18], activation of the TrA [18] and LM [19], and proprioception[23]. Improvement of the musculature of the TrA and proprioceptive action, as well as co-contraction of the TrA and LM muscles increase lumbosacral segmental stability [8, 11-13, 18]. This improved lumbo-sacral segmental stability helps to reduce compressive overloads, and attenuates or eradicates back pain associated with instability. This leads to improvement in functional capacity and helps prevent degenerative disc disease [21], based on evidence from previous studies and the relationship between disc degeneration and instability [22-26].

To the best of our knowledge, this is the first study to compare the effects of LSSE and GE programs on pain and functional capacity in LDH patients. Our results are consistent with a recent review of the efficacy of motor control exercise for non-specific LBP patients [10]. This review showed that motor control exercise appears to be superior to the GE program for reduction of pain and disability.

However, Cairns et al reported that LSSE did not present an additional benefit to GE and manual therapy in patients with nonspecific, recurrent LBP [27]. Another meta-analysis in chronic LBP patients demonstrated that core stability exercise is more effective than the GE program in improvement of pain and physical function in the short term, rather than the long term [12]. These discrepancies in the effects of LSSE and GE in different studies may be due to differences in the patients, and differences in the exercise programs in terms of duration, frequency, and intensity of the procedures that were used.

In the current study, notably, all of the patients in both groups reported that they still kept performing their exercise program at home during the follow-up period. The reasons for this finding could be because of the development of the economy and a change in lifestyle in China, and also because exercise results in higher satisfaction and self-confidence in young male adults. The fact that both of the LSSE and GE programs are easily applicable, not expensive, and can be performed in any location is considered to be an important contributing factor for young male adults maintaining their exercise program without supervision. Accordingly, at 12 months post-exercise rather than 3 months post-exercise, patients in the LSSE group showed a significantly reduced mean score of the VAS for low back pain and the ODI compared with the GE group. This result suggests that only long-term regular LSSE is superior to GE in the treatment of LDH.

There are several limitations in this study. We had a small number of patients, and no placebo laser, LSSE, or GE treatment was included in this study because of the results of our preliminary investigation. Another limitation of our study is that we did not measure activation of deep trunk muscles, muscle strength, and lumbar stability. We focused on the effect of exercise therapy on pain and functional capacity in LDH patients, not the associations between physical changes of deep muscle and improvement in pain and functional capacity. Further studies are required to explore the underlying mechanisms to clarify the effect of these exercises on pain intensity and functional capacity.

In summary, LSSE and GE can effectively reduce pain intensity in the lower back and legs, and improve functional capacity in young male LDH patients. Moreover, in the long term, LSSE is more effective than GE in reducing pain intensity in the lower back, and in improving functional capacity. However, during the acute phase of LDH, physical therapy, such as LPL, is needed to relieve pain intensity. These results suggest that LSSE should be an essential component of the treatment plan for LDH patients, and that combination of LSSE with physical therapy, such as LPL, is an effective and performable program.

Acknowledgements

The study was funded and supported by the Natural Science Foundations of China (grant number: 81171862).

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Tiansheng Sun, Department of Orthopaedic, Beijing Army General

Hospital, Beijing 100700, China. Fax: 86-10-84042490; E-mail: suntiansheng-@163.com

References

[1] Jonsson B, Stromqvist B. Influence of age on symptoms and signs in lumbar disc herniation. Eur Spine J 1995; 4: 202-205.

[2] Jansson KA, Németh G, Granath F, Blomqvist P. Surgery for herniation of a lumbar disc in Sweden between 1987 and 1999. J Bone Joint Surg [Br] 2004; 86: 841-7.

[3] McCulloch JA. Focus issue on lumbar disc herniation: macro- and microdiscectomy. Spine (Phila Pa 1976) 1996; 21 Suppl: 45S-56S.

[4] Troyanovich SJ, Harrison DD, Harrison DE. Low back pain and the lumbar intervertebral disk: clinical considerations for the doctor of chiropractic. J Manipulative Physiol Ther 1999; 22: 96-104.

[5] Luijsterburg PA, Verhagen AP, Braak S, Oemraw A, Avezaat CJ, Koes BW. Neurosurgeons' management of lumbosacral radicular syndrome evaluated against a clinical guideline. Eur Spine J 2004; 13: 719-723.

[6] Luijsterburg PAJ, Verhagen AP, Braak S, Oemraw A, Avezaat CJ, Koes BW. General practitioners' management of lumbosacral radicular syndrome compared with a clinical guideline. Eur J Gen Pract 2005; 11: 113-8.

[7] Hahne AJ, Ford JJ, McMeeken JM. Conservative management of lumbar disc herniation with associated radiculopathy: a systematic review. Spine (Phila Pa 1976) 2010; 35: E488-504.

[8] Kennedy DJ, Noh MY. The role of core stabilization in lumbosacral radiculopathy. Phys Med Rehabil Clin N Am 2011; 22: 91-103.

[9] Unlu Z, Tasci S, Tarhan S, Pabuscu Y, Islak S. Comparsion of 3 physical therapy modalities for acute pain in lumbar disc herniation measured by clinical evaluation and magnetic resonance imaging. J Manipulative Physiol Ther 2008; 31: 191-198.

[10] Barr KP, Griggs M, Cadby T. Lumbar stabilization: core concepts and current literature, Part 1. Am J Phys Med Rehabil 2005; 84: 473-480.

[11] Akuthota V, Ferreiro A, Moore T, Fredericson M. Core Stability Exercise Principles. Curr Sports Med Rep 2008; 7: 39-44.

[12] Byström M, Rasmussen-Barr E, Grooten W. Motor control exercises reduces pain and disability in chronic and recurrent low back pain. A meta-analysis. Spine 2013; 38: E350-8.

[13] Wang XQ, Zheng JJ, Yu ZW, Bi X, Lou SJ, Liu J, Cai B, Hua YH, Wu M, Wei ML, Shen HM, Chen Y, Pan YJ, Xu GH, Chen PJ. A meta-analysis of core stability exercise versus general exercise for chronic low back pain. PLoS One 2012; 7: e52082.

[14] Downie WW, Leatham PA, Rhind VM, Wright V, Brancot JA, Andersont JA. Studies with pain rating scales. Ann Rheum Dis 1978, 37: 378-38.

[15] Liu H, Tao H, Luo Z. Validation of the simplified Chinese version of the oswestry disability index. Spine 2009; 34: 1211-1217.

[16] Dzierżanowski M, Dzierżanowski M, Maćkowiak P, Słomko W, Radzimińska A, Kaźmierczak U, Strojek K, Srokowski G, Zukow W. The influence of active exercise in low positions on the functional condition of the lumbar-sacral segment in patients with discopathy. Adv Clin Exp Med 2013; 22: 421-30.

[17] Kachanathu SJ, Alenazi AM, Seif HE, Hafez AR, Alroumim MA. Comparison between Kinesio Taping and a Traditional Physical Therapy Program in Treatment of Nonspecific Low 1Pain Treatment Centre of Department of Rehabilitation Medicine, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, 107 Yanjiang West Road, 510120 Guangzhou, Guangdong China Back Pain. J Phys Ther SCi 2014, 26: 1185-1188.

[18] França FR, Burke TN, Hanada ES, Marques AP. Segmental stabilization and muscular strengthening in chronic low back pain-a comparative study. Clinics (Sao Paulo) 2010; 65: 1013-1017.

[19] Hebert JJ, Koppenhaver SL, Magel JS, Fritz JM. The relationship of transversus abdominis and lumbar multifidus activation and prognostic factors for clinical success with a stabilization exercise program: a cross-sectional study. Arch Phys Med Rehabil 2010; 91: 78-85.

[20] Lust KR, Sandrey MA, Bulger SM, Wilder N. The effects of 6-week training programs on throwing accuracy, proprioception, and core endurance in baseball. J Sport Rehabil 2009; 18: 407-26.

[21] Barr KP, Griggs M, Cadby T. Lumbar stabilization: a review of core concepts and current literature Part 2. Am J Phys Med Rehabi 2007; 86: 72-80.

[22] Zhao F, Pollintine P, Hole BD, Dolan P, Adams MA. Discogenic origins of spinal instability. Spine (Phila Pa 1976) 2005; 30: 2621-2630.

[23] Iguchi T, Kanemura A, Kasahara K, Kurihara A, Doita M, Yoshiya S. Age distribution of three radiologic factors for lumbar instability: Probable aging process of the instability with disc degeneration. Spine (Phila Pa 1976) 2003; 28: 2628-2633.

[24] Hasegawa K, Shimoda H, Kitahara K, Sasaki K, Homma T. What are the reliable radiological indicators of lumbar segmental instability? J Bone Joint Surg Br 2011; 93: 650-657.

[25] Ohmori K. Clinical application of a novel assessment for lumbosacral stability. J Neurosurg Spine 2010; 13: 276-282.

[26] Weiler PJ, King GJ, Gertzbein SD. Analysis of sagittal plane instability of the lumbar spine in vivo. Spine (Phila Pa 1976) 1990; 15: 1300-1306.
[27] Cairns MC, Foster NE, Wright C. Randomized controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain. Spine 2006; 31: E670-E681.