Journal of Back and Musculoskeletal Rehabilitation 25 (2012) 149–155
DOI 10.3233/BMR-2012-0321
IOS Press


# The effects of stabilizing exercises on pain and disability of patients with lumbar segmental instability

Yahya Javadian[a], Hamid Behtash[b], Mohammad Akbari[c], Mohammad Taghipour-Darzi[a,*] and Hajar Zekavat[d]
[a]*Department of Physiotherapy, Faculty of Medicine, Babol University of Medical Sciences, Iran*
[b]*Orthopedic Department, Tehran University of Medical Sciences, Iran*
[c]*Department of physiotherapy, Faculty of rehabilitation, Tehran University of Medical Sciences, Iran*
[d]*Department of Radiology, Tehran University of Medical Sciences, Iran*

**Abstract**. *Background data*: Lumbar segmental instability (LSI) is one of the subgroups of non-specific chronic low back pain. Pain, functional disability and reduced muscle endurance are common in such patients.
*Objective:* The aim of this study was to determine the effects of stabilization exercise on pain, functional disability and muscle endurance in patients with LSI.
*Methods*: A randomized clinical trial was carried out on 30 patients who had LSI aged between 18–45 years. They were divided into two groups; the control group underwent routine exercise only while the experimental group performed routine exercise plus stabilization training for 8 weeks. Both had 3 months follow-up. The variables included pain intensity, functional disability and flexion and extension range of motion and flexor, extensor and lateral flexor muscles endurance which were evaluated 3 times; before, post treatment and after three months. The data were analyzed using repeated measurement ANOVA.
*Results*: The results revealed that after treatment, the trunk muscle endurance and flexion range of motion increased significantly and the pain intensity and functional disability decreased significantly in both groups; however the rate of improvement was significantly higher in the experimental group. The process of decreasing pain intensity and functional disability in addition to increasing muscle endurance time were significantly faster in the experimental group during the three months follow up.
*Conclusion:* Regarding the positive effects of stabilizing exercises with routine exercises in reduction of pain intensity, increasing functional ability and muscle endurance, it is recommended to use this method in treatment of patients with lumbar segmental instability.

Keywords: Stabilizing exercise, lumbar segmental instability, pain, functional disability

## 1. Introduction

Lumbar segmental instability (LSI) includes 30–35% of nonspecific chronic low back pain syndromes [1]. Stiffness of motion segment and load endurance decrease in LSI, the motion segment is vulnerable to abnormal motion and eventually painful and probably progressive degenerative changes will occur. In clinical instability, the capacity of a stabilizer system of the lumbar vertebrae for protecting the neutral zone into the physiologic limit will be decreased; however there is not any neuromuscular deficit, vast deformity or unendurable pain [2]. The three components of the lumbar column stabilizer system are passive, active and neural elements. There are two muscles groups in the active component of the stabilizing system. The first group is deep or local muscles and the second group is the superficial or global muscles. Global muscles

*Corresponding author: Mohammad Taghipour-Darzi, PhD, Department of Physiotherapy, Faculty of Medicine, Babol University of Medical Sciences, Babol, Mazandaran, 47176-47745, Iran. Tel.: +98 111 219 9595, Fax: +98 111 2199936; E-mail: taghipourm@yahoo.com.

ISSN 1053-8127/12/$27.50 

do not have an important role in segmental instability. However, because of their attachments and lever arm, local muscles play a very important role in segmental stability. Therefore, any abnormality in the function of local muscles causes a deficit in the stabilizing system and produces segmental instability and finally pain and functional disability [3].

Choosing the proper Exercise Therapy (ET) protocol for these patients depends on the accurate diagnosis of segmental instability from other causes of low back pain [4]. Recently ET procedures of these patients concentrated into the maintenance and increase of lumbar stability. One of the important objects of the protocol is improvement of proprioception in the lumbo-pelvic region with activation of transverses abdominus, multifidus, pelvic diaphragm, and pelvic floor and obliqus abdominus muscles. These muscle groups have very important effects on increasing lumbar segmental stability. The exercise for improving local muscle function is called stabilizing exercise [3].

Hides et al. showed that co-contraction of transverse abdominus and multifidus muscles during Stabilizing Exercise (SE) in the first phase of acute low back pain has the same effects on patients and control groups. But in the long term, the rate of recurrence of low back pain was lower in the SE group [5]. Study of Ylmas et al. on patients after microdiscectomy revealed that SE causes significant difference in pain, function, power and flexibility of lumbar column compared with routine exercise and none exercise (control) groups [6]. Koumantakis et al. compared the effects of SE and routine exercise programs on patients with nonspecific chronic low back pain. They reported that routine exercise produced more improvement in functional disability in the short term but there was not a significant difference among the other parameters. They conclude that the SE would be effective in patients who have at least a level of instability in lumbar motion segments or signs of instability in different segments of lumbar vertebrae [7]. In the other study, Koumantakis et al. compared effects of SE plus endurance exercise with routine exercises alone on physiological and functional parameters of patients with chronic low back pain. The results revealed that eight weeks of exercise did not have significant difference on fatigability of spinal muscles between intra and inter groups. In addition, the SE was effective only on patients who had at least one level of segmental instability [8]. A comparative study among SE, manual therapy and training of the patients at home was conducted by Golby et al. on patients with non-specific chronic low back pain. They reported that SE was more effective than the other treatment protocols on pain and functional disability in the long term [9]. Ferreira et al. compared the effects of routine exercise, SE and manipulation on pain and functional disability of patients with chronic low back pain. They reported that manual therapy caused more pain reduction in the short term. However SE was more effective on pain and disability in long term in comparing two other groups [10]. Sylvani et al. compared the effects of hollowing and bracing exercises on the stability of lumbar vertebrae and reported that the bracing exercise was more effective. They concluded that the hollowing exercise is a part of bracing exercise and it can affect the transverse abdominus directly. This muscle has a very important role in the stabilization of lumbar vertebrae and the lumbo pelvic girdle [11].

Beside the positive effects of the different exercise therapy procedures, there are few clinical trial studies comparing the effects of SE with routine exercise or the other treatment protocols in patients with signs and symptoms of LSI [12,13]. Therefore, we conducted a study to investigate and compare the effects of two exercise therapy protocols for treatment of the patients with signs and symptoms of LSI.

## 2. Materials and methods

### 2.1. Subjects

A clinical trial study was conducted with non-probability sampling. Thirteen consecutive patients aged between 18–45 years participated in this study. Sampling was done according to criteria adopted by Hicks et al. [14]. Patients had to have at least three months low back pain and show one of the trunk aberrant movement patterns (painful arc during flexion and return from flexion, Gowern's sign and instability catch). Also they exhibited negative straight leg rising and a positive prone instability test [14]. Patients with vertebral fracture, disc herniation, acute low back pain, systemic diseases, osteoarthritis, spondylolistesis and spodylolisis, leg length discrepancy, history of spinal surgery, pregnancy and any low back pain with known causes were excluded [12,14].

### 2.2. Procedure

The procedure of study was approved by the Ethics Committee. All subjects were informed about the procedures and signed informed consent prior to participation. The participants were evaluated three times; before treatment, at 8 weeks and 3 months after the last treatment session. A reliability study was done prior to the main study with participation of 15 patients. The patients were evaluated twice with a two day interval.

Participants were divided randomly between the control and experimental groups. The control group was treated under routine exercise only and the experimental group was treated by SE plus routine exercise according to the criteria suggested by Koumantakis et al. [7]. The treatment sessions were divided into warm up exercises and specific training. Warm up lasted 15 minutes, which included cycling and the stretching of trunk, hip adductor, hip abductor and hamstring and gastrosoleus muscles in both groups. The specific exercises in the control group were routine exercises, including: single and double leg knee to chest, bridging, bridging and interval lower limb raising, supine cycling, heel slide, leg slide and lower abdominal crunch in the supine position. Exercises were done in all four positions with intermittent rising of upper and lower limbs cross rising of the upper and lower limbs and finally bridging in the side lying position [7].

Specific exercises program in the experimental group included all routine exercises and SE. These exercises contained bracing and hollowing exercises in supine, bridging, kneeling, sitting and standing positions. SE exercises were conducted in dynamic situations including associate movements of extremities, on the Swiss ball and the wobble board in advanced phase. The duration of exercise therapy was the same for the two groups [7].

### 2.3. Measurement

The study variables included Pain intensity accordance to VAS [15], Lumbar flexion and extension range of motion that were measured by modified-modified Schober's test [16], Endurance of trunk flexor and extensor muscles in accordance to the Ito procedure [17], Endurance of trunk lateral flexor muscles in accordance to the side support test [7] and Functional disability based on modified Oswestry's questionnaire [18,19].

### 2.4. Statistical analysis

Intra Correlation Coefficient (ICC) and Standard Error of Measurement (SEM) were utilized for reliability. The Kolmogorov Smirnov (KS) test, Repeated Measures ANOVA and Independent t-test were used for comparison between the groups by SPSS version15.

Table 1
ICC& SEM value of variables

| SEM | ICC | Variable(S) |
|---|---|---|
| 1.31 | 0.92 | Pain(mm) |
| 1.72 | 0.91 | Flexor endurance(S) |
| 1.72 | 0.85 | Extensor endurance(S) |
| 1.79 | 0.77 | Right lateral flexor endurance (S) |
| 2.79 | 0.7 | Left lateral flexor endurance (S) |
| 0.42 | 0.85 | Flexion range of motion (cm) |
| 0.37 | 0.68 | Extension range of motion (cm) |
| 1.48 | 0.95 | Modified oswestry test |

mm = Millimeter; S = Second; cm = Centimeter.

### 2.5. Results

The results of this study revealed that pain intensity, flexion and extension range of motion, endurance of trunk flexor, extensor and lateral flexor muscles and modified Oswestry disability index had high reliability (ICC = 0.7–0.92). The results are shown in Table 1.

The results of the exercise protocol on participants during the three phases of evaluation are shown in Table 2. Based on study results, the mean difference for flexion range of motion, flexion, and extension, left and right lateral flexion muscles endurance increased in both groups. The pain and functional disability decreased. There was significant difference before and after treatment between all the above variables. Although the range of lumbar extension increased in both groups, there was not any significant difference after treatment (P = 0/11). In addition, pain intensity and functional disability decreased and flexion range of motion, flexor, extensor and lateral flexors' muscles endurance in the experiment group increased more than the control group after the 3 month- follow up. There was significant difference in all the above variables between two groups. But again there was not any significant difference in the extension range of motion (P = 0/61) (Table 2).

The changing of pain intensity, functional disability and trunk flexor endurance between the two groups during three phases of evaluation is shown in diagram 1, 2 and 3 respectively.

## 3. Discussion

The results of the present study revealed that SE plus routine exercises were more effective than routine exercises alone in reducing pain intensity, functional disability and increasing muscle endurance in patients with signs and symptoms of LSI. The effects of SE plus routine exercises had more permanent effects than

Table 2
The results of the effects of two methods of exercise therapy in two treated groups

| P | 3 months follow up | | 8 weeks | | Before treatment | | Variable(S) |
|---|---|---|---|---|---|---|---|
| | Exp. | Cont. | Exp. | Cont. | Exp. | Cont. | |
| | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | |
| 0.001 | 18.41 ± 2.15 | 9.58 ± 1.56 | 24.00 ± 2.29 | 18.13 ± 3.54 | 45.06 ± 4.15 | 47.73 ± 3.82 | Pain(mm) |
| 0.001 | 16.83 ± 3.45 | 5.16 ± 2.16 | 20.66 ± 5.21 | 13.46 ± 3.41 | 43.84 ± 5.55 | 45.80 ± 6.64 | Functional disability (%) |
| 0.001 | 80.38 ± 7.47 | 104/81 ± 6.67 | 50.44 ± 5.79 | 56.35 ± 4.59 | 24.00 ± 5.24 | 22.32 ± 5.19 | Flexor Endurance(S) |
| 0.001 | 90.57 ± 4.94 | 115.38 ± 9.76 | 52.11 ± 5.12 | 66.2 ± 7.9 | 22.55 ± 5.17 | 22.50 ± 3.96 | Extensor Endurance(S) |
| 0.001 | 53.26 ± 6.24 | 76.34 ± 9.76 | 44.37 ± 6.24 | 50.77 ± 5.07 | 17.77 ± 2.77 | 16.92 ± 3.01 | Right lateral Flexor Endurance (S) |
| 0.001 | 47.91 ± 5.08 | 67.34 ± 4.65 | 41.80 ± 6.74 | 48.81 ± 6.27 | 19.45 ± 4.45 | 16.96 ± 3.6 | Left lateral Flexor Endurance (S) |
| 0.001 | 11.58 ± 0.51 | 13.5 ± 0.67 | 9.53 ± 0.63 | 10.82 ± 0.52 | 7.16 ± 0.91 | 7.03 ± 0.99 | Flexion range of motion (cm) |
| 0.68 | 3.58 ± 0.51 | 3.58 ± 0.51 | 3.4 ± 0.63 | 3.73 ± 0.45 | 2.03 ± 0.48 | 1.77 ± 0.49 | Extension range of motion (cm) |

Cont. = Control, Exp. = Experiment, mm = Millimeter, S = Second, cm = Centimeter.

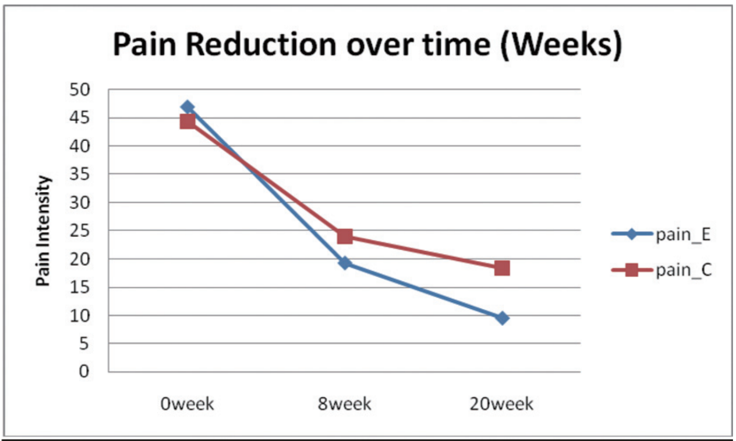


Fig. 1. Trend of pain in patients in two groups.

routine exercises alone. There was not a significant difference for the extension range of motion between the two groups that might be related to it's small range of motion.

McGill et al. reported that the routine exercises can create global muscle dominancy over local muscle which change muscle coordination and then increase pain intensity. However SE had the ability to correct movement patterns and then decrease pain intensity [21].

The results of the study carried out by Kumantakiss et al. showed that the effects of SE plus the routine exercises in comparison with routine exercises alone did not have significant differences in patients without signs and symptoms of LSI. They believed that SE could be effective only in patients who had at least a level of instability in the lumbar vertebral column [7]. The present study showed that exercise protocol in the experimental group was more effective than the control group. It might be related to participants who probably had at least a level of instability in the lumbar vertebral column based on their signs and symptoms.

Hick's et al. showed that the percentage of changes in functional disability was an important index for anticipating the effects of SE in the short and long term, so that, if the percentage of changes at the end of the treatment was 50% or more, then the treatment program was successful [14]. According to some studies, when the participants were appropriately matched to their treatment protocol they experienced an improvement between 57–83%, whereas patients receiving unmatched treatments experienced improvement ranging from 20–38% [21,22]. The rate of treatment success in O'Sullivan et al. study on patients with spondylolysthesis and spondylolysis was 48% after SE therapy [23]. In our study, the rate of improvement in the control group after eight weeks exercise therapy was 54% and after three months follows up it was 61%; but the improvement rate in the experimental group was 72% and 88% respectively. The above results revealed that the SE plus routine exercises was more effective than just routine exercises in reducing functional disability.

McGill et al. [24] and Richardson et al. [25] believed that the role of muscle endurance is more important than

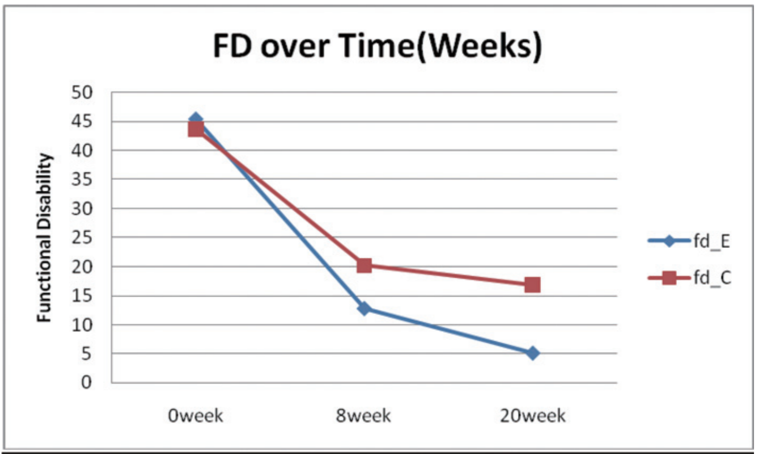


Fig. 2. Trend of functional disability in two groups.

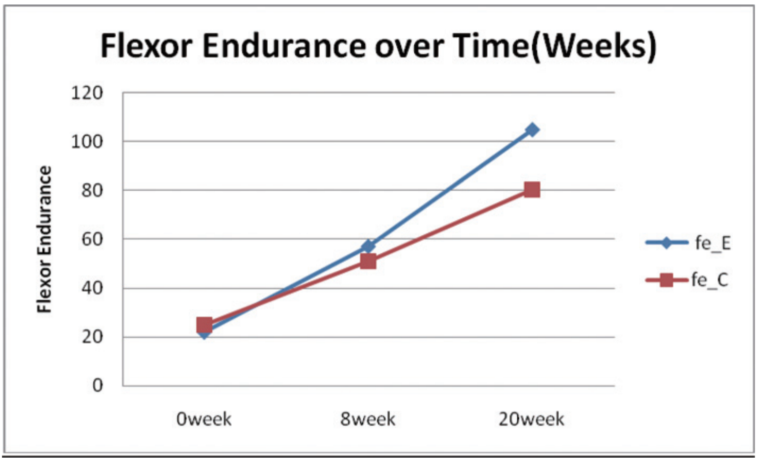


Fig. 3. Trend of flexor muscles endurance in two groups.

muscle power in the protection of lumbar segmental stability. Decreasing of activity level, hypomobility and functional abnormality in chronic low back pain led to a decrease of both mitochondria and the rate of oxygen uptake in muscle cells [26]. The cross sectional area of local stabilizer muscles especially multifidus decreased, it can be followed by muscle atrophy and a decreased amount of type I muscle fibers and oxygen. All of the above changes increase muscular fatigability and finally causes a decrease in muscle endurance [25–28]. The routine exercises may increase about 2–3% of cross sectional areas of the local muscle, especially multifidus. This amount of change does not have any significant [29].

The study of Kovacs et al. showed that routine exercises can not affect the oxygen consumption of stabilizer muscles because this kind of exercise cannot increase cross sectional area of these muscles [26]. The study of Macdonald et al. showed that SE could increase the muscle endurance time in local muscles. These muscles have high parentage of type I muscle fibers, blood vessels and mitochondria. Therefore, due to the specificity principle in exercise therapy, the high intensity of global muscle contraction during routine exercises leads to inhibition of local muscles. But SE increases the activity level of local muscles and then improves oxygen consumption, reduces fatigability of type I muscle fibers and finally increases muscle endurance [30]. The present study revealed that muscle endurance increased in the experiment group more than the control group. This result could be related to the specific effects of SE on local muscle activities. Therefore, SE can improve activity, function and endurance of local muscles. Muscle endurance is an important factor in producing and maintaining the stability of lumbar vertebral segments. Impairment in muscle endurance and functional disability are important problems in patients with segmental instability and therefore, the improvement of these factors is crucial. Besides the useful effects of SE on muscle endurance and functional disability and their very obvious role in improving the patients with segmental instability, using the SE is proposed for the treatment of patients with signs and symptoms of LSI.

## 4. Conclusion

The stabilizing exercises plus routine exercises are more effective than the routine exercises alone in decreasing pain, increasing functional ability and muscle endurance of patients with signs and symptoms of LSI. Stabilizing exercises increase activity level and decrease fatigability of local muscles.

## Acknowledgments

We would like to thank Tehran University of Medical Sciences for their funding support of this study.

## Conflict of interest

There is no conflict of interest.

## References

[1] O'Sullivan PB. Lumbar segmental instability Clinical presentation and specific stabilizing exercise management. *Manual Therapy* (1) (2005), 2-12.

[2] Panjabi MM. Clinical spine instability and low back pain. *Journal of electromyography and kinesiology* 13 (2003), 371-379.

[3] Barr KP, Griggs M, Cadby T. Lumbar stabilization: Core concepts and current literature, part I, *Am J Phys Med Rehabili* 84 (2005), 473-480.

[4] Airakasinen D,Brox JI, Cedraschi C, Hilderbrandt J, Klabrmotfett J, Kovacs F, Mannion AF, Reis S, Staal JB, Ursin H, Zanoli G. Erupean guidelines for the management of chronic non specific low back pain. *Eur spine J* 15(suppl.2) (2006), 192-300.

[5] Hides JA. Jull GA. Richardson C. Long-term effects of specific stabilization exercises for first-episode low back pain *Spine* 26 (2001), E243-E248.

[6] Yilmaz F, Yilmaz A, Merdol F, Parlar D, Sahin F, Kuran B. Efficacy of dynamic lumbar stabilization exercise in lumbar microdiscectomy. *J Rehabil Med* 35 (2003), 163-167.

[7] Koumantakis GA, Watson PJ, Oldham JA. Trunk muscle stabilization training plus general exercise versus general exercise only: randomized controlled trial of patients with recurrent low back pain. *Phys Ther* 85 (2005), 209-225.

[8] Koumantakis, WatsonPJ, Oldham JA. Supplementation of general endurance exercise with stabilization training general exercise only, Physiological and functional outcomes of a RCT of patients with recurrent low back pain. *Clin Biomech* (Bristol, Avon) 20 (2005), 474-482.

[9] Golby LJ, Moore PA, Marion E. A RTC Investigating the efficiency of musculoskeletal physiotherapy on chronic low back disorder. *Spine* 31 (2006), 1083-93.

[10] Ferreira ML , Ferreira PH, Latimmer J , Herbert RD , Hodges PW, Matthew DJ, Maher CG, Refshauge KM. Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: A randomized trial. *Pain* 131 (2007), 31-37.

[11] Sylvain GG, McGill SM. Quantification of lumbar stability by using 2 different abdominal activation strategies. *Arch Phys Med Rehabil* 88 (2007), 54-62.

[12] Demoulin C, Dstree V, Tomasella M, Crielaard JM, Vanderthommen M. Lumbar functional instability: A critical appraisal of the literature. *Annales Medicine Physique*, doi 10 (2007), 1016.

[13] May S, Johnson R. Stabilization exercises for low back pain: a systemic review. *Physiotherapy*, doi: 10.1016/g.physio.2007.08.010.

[14] Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program, *Arch Phys Med Rehabili* 86 (2005), 1753-1755.

[15] Von korrf M, Jensen MP, Karoly P. Assessing global pain severity by self-report in clinical and health services research. *Spine* 25 (2000), 3140-3151.

[16] Williams R, Binkley J, Bloch R, Goldsmith CH, Minuk T. Reliability of the Modified-Modified Schober and Double Inclinometer methods for measuring lumbar flexion and extension. *Phy Ther* 73 (1993), 33-44.

[17] Ito T, Shirado O, Suzuki H, Takahashi M, Kaneda K, Strax TE. Lumbar trunk muscle endurance testing: an inexpensive alternative to a machine for evaluation, *Arch Phys Med Rehabil* 77 (1996), 75-79.

[18] Fritz JM, Irrgang JJ. A comparison of a Modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale *Phys Ther* 81 (2001), 776-788.

[19] Davidson M, Keating JL. A comparison of five low back pain disability questionnaires: reliability and responsiveness. *Phys Ther* 82 (2002), 8-24.

[20] McGill S. Normal and injury mechanics of the lumbar spine. In: low back disorders: Evidence-Based Prevention and Rehabilitation. Champing, IL, *Human Kinetics* (2002), pp. 87-136.

[21] Delitto A, Erhard RE, Bowling RW. A treatment based classification approach to low back syndrome: identifying and staging patients for conservative treatment. *Phys Ther* 75 (1995), 470-489.

[22] Delitto A, Cibulka MT, Erhard RE, Bowling RW, Tenhula JA. Evidence for use of an extension-mobilization category in acute low back syndrome: a prescriptive validation pilot study. *Phys Ther* 73 (1993), 216-228.

[23] O'Sullivan PB, Twomey LT, Allison GT. Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiological diagnosis of spondylolysis or spondylolisthesis. *Spine* 22 (1997), 2959-2967.

[24] Richardson C, Hides J, Hodges P. Principles of the segmental stabilization exercise model In: Therapeutic exercise for lumbo-pelvic stabilization: A motor control approach for the treatment and prevention of low back pain. 2nd ed. Sydney: Churchill Livingstone (2004), pp. 175-183.

[25] McGill S Lumbar spine stability: Myths and realities, in: low back disorders: Evidence-Based Prevention and Rehabilitation: Champaign, IL, *Human Kinetics* (2002), pp. 137-146.

[26] Kovacs KM, Marras WS, Litsky AS, Gupta P, Ferguson SA. Localized oxygen use of healthy and low back pain individuals during controlled trunk movements *J Spinal Disord* 14 (2001), 150-158.

[27] Demoline C,Crielaard JM, Vanderthommen M. Spinal muscle evaluation in healthy individuals and low back pain patients: A literature review. *Joint Bone spine* 74 (2007), 9-13.

[28] Mannion AF,Kaser L, Rhyner A, Dvorak J, Muntener M. Influence of age and duration of symptoms on fibre type distribution and size of the back muscles in chronic low back pain patients. *Eur Spine J* 9 (2000), 273-81.

[29] Storheim ak, Holm I, Gunderson R, Brox JI, Bo K. The effect of comprehensive group training on cross-sectional area, density and strength of para-spinal muscles in patients sick-listed for sub acute low back pain *J Spinal Disord Tech* 16 (2003), 271-279.

[30] Macdonald DA, Lorimer MG, Hodges PW. The lumbar multifidus: Does the evidence support clinical beliefs? *Man Ther* 11 (4) (2006), 254-263.