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# SPINAL SEGMENTAL STABILIZATION EXERCISES COMBINED WITH TRADITIONAL STRENGTHENING EXERCISE PROGRAM IN PATIENTS WITH CHRONIC LOW BACK PAIN

**SUMMARY**

**Low back pain which lasts for more than 12 weeks is considered chronic lumbar pain. It is the most common diagnosis in physiatry. Numerous highly controlled randomized studies have proved a beneficial effect of the exercises on all symptoms of chronic low back pain. Classic kinesytherapy program does not include strengthening of the deep layer of abdominal and paravertebral musculature which is a part of the so-called inner unit. The strengthening of the stabilizer muscles provides stability of the lumbar region of the spine through coordinated activities of its dynamic segments. The effectiveness of the spinal segmental stabilization exercises was being proved for years in numerous studies, which gained significance and objectivity by introducing contemporary diagnostic methods.**

**This study aims at pointing out the positive effects of the stabilization exercises which were added to traditional program of building the strength and mobility of the spinal column. It also wants to emphasize the need for introducing the spinal segmental stabilization program into everyday clinical practice.**

***Key words:*** **stabilization exercises, chronic low back pain**

## INTRODUCTION

Low back pain is a very common and widespread health problem. More than 80% of the world population has experienced it, at least once in life. According to its duration, it can be acute (lasts less than 6 weeks), subacute (from 6 to 12 weeks) and chronic (lasts more than 12 weeks). Chronic lumbar pain is a significant medical, social and economic problem. It is the second most common reason for seeing a general practitioner, and the first in a group of health problems of patients under 45 years of age. Although approaches and treatment methods of the chronic lumbar pain are various and numerous, for the last few years the new consistent protocols were being intensively developed to solve this persistent health problem effectively. There is a growing number of authors and studies which emphasize the importance of kinesytherapy as fundamental in the treatment of patients with chronic low back pain. Traditional exercise programs which have for years been successfully applied in everyday clinical practice emphasize the strengthening of large muscle groups of the outer layer of lumbar segment combined with stretching. One disadvantage of these programs is their inability to activate the deepest paraventral and abdominal muscles. Since 1999 when the first stabilization exercises program was

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presented by *Richardson* et al. (1), there has been more mention in professional literature of the terms: lumbar spine stability, stabilizer muscles or inner unit. Many authors believe that the instability of the lumbar region of the spine is directly associated with the low back pain. Even those who do not consider it a probable cause, do not deny the importance of these exercises and their effect on the strengthening of deep layers of the lumbar muscle segment which aims at reducing the subjective pain of patients who suffer from chronic low back pain.

Causes of chronic low back pain

It is considered that there are more than 80 entities which can cause pain in the lumbosacral region of the spine. One third of this number includes various pathoanatomic changes of intervertebral discs, whereas the other two thirds are related to pathological conditions of intervertebral joints, especially the facet joints. They are also related to spinal stenosis, as well as the changes in other parts of the lumbar segment (muscles, ligaments, etc.). Certainly, back pain can also be caused by some other conditions which are not directly connected to muscle – skeletal system and elements of spinal column. Numerous gynecological, urological and neurological disorders; spinal, abdominal and lesser pelvis tumors; injuries, postural disorders, etc, may cause back pain and they have to be taken into consideration when reaching a diagnosis. Nevertheless, the most common changes are a part of degenerative rheumatism.

Clinical classification of causes of the low back pain includes three groups of entities:

The first group consists of conditions and systemic diseases which can cause pain. It includes: tumors, infections, fractures, cauda equina syndrome, ankylosing spondylitis, intestinal metastases and tumors which irradiate pain to the low back region.

The second group includes the conditions which have the symptoms of radicular compression – pain radiating from lumbo – sacral spinal region to one or both legs, accompanied by neurological disorders. The third group consists of an unspecific lumbar pain which is neither accompanied by symptoms of nerve root compression nor is it a consequence of some other illness. Most patients that are suitable for stabilization exercise program belong to this group.

It is often not possible to determine the cause of low back pain because of an incorrect or delayed diagnosis, because of the beginning of an analgesic medicament therapy or physical procedures before the final diagnosis is reached, which as a consequence impair the results of the therapy. On the other hand, there are cases where, despite all contemporary diagnostic measures, the specific pathoanatomic problem which causes pain could not be found. In literature, the condition is termed as "mechanical" low back pain.

Numerous authors consider that **lumbar spine segment instability** is the basic pathological mechanism of this disorder.

**Lumbar spine segmental instability**

Lumbar segment of the spine has often been described as a unique dynamic functional spinal unit. The modern biomechanical model displays the lumbar spine in 5 separate parts, called motion segments, which consist of sequences of vertebrae and ligaments. Each segment has the same biomechanical characteristics as the spine itself. Translatory and rotary motions of the segments follow each movement of the lumbar spine. Thus, lumbar flexion causes anterior, whereas lumbar extension causes posterior translation and rotation of the segments. Maintaining an adequate stability of the lumbar spine during movement requires a coordination of activities of each of these segments individually.

Segmental instability appears when an applied force causes dislocation of a part of motion segment which exceeds normal mobility of the segments during the common motions of the lumbar spine. Several authors have tried to define the limits of functional mobility of the segments. Results of *in vitro* studies conducted in a cadaveric model have provided the basic motion measures of the lumbar spine segments. By instability they mean **translation** in the sagittal plane exceeding 3 mm (or 9% of vertebral body width) during flexion or extension of the lumbar spine, verified by an x-ray; or **rotation** of the lumbar motion segments exceeding $9^0$ between L1 and L5 vertebrae. Later studies use *in vivo* model, comparing the x-rays of the participators with the spine set in a neutral position and then in the position of maximum flexion and extension. The results of the studies are very diverse and point to individual differences between the participators, especially in the control group which involved subjects with no low back pain. Many of them had segment motions which exceeded the previously set limits, so some authors changed the border values of lumbar segment movements to 4 - 4,5 mm (10 – 15% of the lumbar vertebra width) when it comes to **translation**, and $15^0$ for L1 – L4, $20^0$ for L4 – L5 and $25^0$ for L5 – S1 for **rotation.**

*Punjabi et al* (2,3) have studied a biomechanical model of the lumbar spine and gave their concept of the stabilizing segmental system dividing it into three subunits: passive (composed of

vertebral bodies, intervertebral joints and joint capsules, ligaments, and passive support of muscular – tendon units), active (spinal muscles and tendons) and neutral (for neutral control of the stabilization. Through information received from the passive and active subunit it activates the muscles of the deep layer which maintain the stability of the lumbar spine). These three subsystems are interdependent and a reduction in the functioning of one of them causes increase in demands of the other two.

Diagnosing the instability of the lumbar spine has always been a great problem. In 1944, Knuttson diagnosed instability of the lumbar spine using lateral radiograph of patients performing maximum active extension in a standing position and maximum active flexion while sitting. As stability parameters, he compared translations and rotations of segments in these positions. A large number of similar techniques followed, but there is still no adequate, precise way to confirm the segmental instability. The latest studies include ENMG as an intermediary means of evaluation of lumbar spine stability by following the contractions of the stabilizer muscles.

Conservative treatment of patients diagnosed with segmental instability as well as those in whom the existence of this pathological condition (unspecific pain in the low back region) is suspected, used to consist in wearing supporting belts and corsets to prevent active flexion. These methods are outdated and they were replaced by **stabilization exercises** which aim at activating the deep layer of lumbar segment muscles which are now considered the most significant therapeutic method in the treatment of patients with painful lumbar syndrome caused by segmental instability.

## Stabilizer muscles and the inner unit

The inner unit is a functional unit composed of: *m. transversus abdominis,* posterior fibers *m. obliquus internus abdominis,* pelvic floor muscles, *m. multifidus* as well as *m. longissimus et iliocostalis pars lumbalis,* whereas the upper border of this dynamic system is formed of a diaphragm.

Numerous neurophysiologic explorations have pointed to the fact that the stated elements are the subject to specific neurological control as opposed to other muscles of the segment, which explains the need for a special program of activation exercises which would target this significant group of muscles. Traditional program of strength building of large muscle groups combined with stretching is an irreplaceable part of kinesytherapy treatment which improves the skeletal - muscle system in general, body shaping and posture. However, these exercises have a limitation in that they activate only the muscles of the outer layer of the lumbar segment (*m. rectus agdominis, m. oblique externus abdominis, m. quadratus lumborum, m. iliopsoas, etc.*) whereas the inner unit is neglected, which disturbs the stability of the lumbar segment and does not alleviate pain. To overcome this disadvantage, every program of strength building and mobility of large muscle groups needs an additional set of stabilization exercises which would activate and strengthen the muscles of the inner unit.

There are several muscles that need special attention. Light exercises in quadruped position with alternate elevation of the stretched leg completely activate the lumbar segment of *m. erector spinae,* the most important spinal extensor, without additional burdening of the lumbar spine. The abdominal muscle group, especially *m. transversus* and *m. obliquus abdominalis,* and the deepest muscle of the paravertebral group *m. multifidus,* are considered most important for the preservation of the lumbar segmental stability. With their position and histological characteristics, they provide musculofacial support to the lumbar-sacral region.

*M. multifidus* belongs to the deepest layer of back muscles. It is a part of *m. transversospinalis*. It is believed that this muscle has more than 70% involvement in the stability of the lumbar vertebrae and controls their mutual movements. It contains a high percentage of tonus fibers, just like *m. transverus abdominis.* The EMG (electromyogram) studies show that the transverse abdominal muscle is the first to contract when an extremity is moved, and in regard to other abdominal muscles, it is also the first to activate with sudden movements of the torso. Compared to other abdominal muscles (*m. rectus abdominis, m. obliquus abdominis ext. et int*.), it has the greatest effect on the stability and unspecific pain in the lumbar-sacral region of the spine. Contracting the gluteal musculature with simultaneous pulling in of the lower abdomen activates these muscles, thus building a protective muscle corset which keeps the lumbar spine stable.

It should be emphasized that patients with disturbed stability of the lumbar segment must exercise the neural control, even though there is no strictly determined program to achieve this. It has been suggested to use an unstable support (Swiss - ball), which has proved successful in the treatment of patients with an unstable knee joint due to the crucial ligament injury, and which also has a growing use in the treatment of chronic lumbar syndrome.

## Spinal segmental stabilization exercises

Exercising program for spinal segmental stabilization for lumbar-sacral spine is based on forming a deep muscle corset by static contractions

of the inner unit muscles. In this way the pelvic region is immobilized and the problematic parts of the spine column are strengthened. The exercises are done in a standing, sitting, kneeling or laying position. The torso and pelvic region are mostly passive, whereas the extremities are active. The obligatory sets are the so-called bridging exercises, done by elevating the pelvic area off the floor, and exercises with an unstable support.

*Richardson and Jull* 1999 (1) were the first to present an exercising program for *m. transversus abdominis and multifidus,* which rests on an assumption that the increase in the strength and stamina of these muscles effects the stability of the lumbar spine, reduces pain and improves the overall functional ability. They emphasized the simultaneous activation of *m. transversus abdominis and m. multifidus* with static contraction of the two muscles during a set of especially outlined active aerobic exercises. Three years later, the same authors published a study in which they demonstrated the biomechanical effects of exercising *m. transversus abdominis* and the impact of these exercises on the stability of the sacroiliac joint, which many experts associate with the stability of the lumbar spine (4). An experimental group performed exercises which targeted only *m. transversus abdominis,* whereas a control group exercised all abdominal muscles. Sacroiliac joint stability was measured by vibrating Doppler sonography technique with EMG recording of the targeted muscle contractions. The results showed that both groups had strengthened the sacroiliac connection but the group with isolated contractions of the stabilizer muscles had much better results.

A great number of studies appeared, presenting various programs for segmental stabilization. The studies mostly compared the stabilizing exercises with traditional kinesytherapy programs and other physical procedures. New methods of monitoring the therapy effects came into use: electroneuromyography (ENMG) for controlling the static contractions of separate muscles, magnetic resonance imaging (MRI) and computed tomography (CT) for visualizing different layers and muscle fibers. New, more sensitive and valid questionnaires and scales were composed which effectively transformed subjective parameters into objective and measurable parameters.

The studies produced various results. *O'Sullivan et al* (5) were among the first to directly compare the program of targeted segmental stabilization with aerobic exercises. They compared the combined program of segmental stabilization exercises with classic program of aerobic exercises which activate large muscle groups (swimming, walking, gymnastics) in patients with chronic lumbar pain. The obtained results showed significant reduction of pain and functional incapability in the group which performed segmental stabilization exercises as opposed to the control group. It is an immensely significant fact that the results obtained in the experimental group were still present at a control check-up 30 months later, which points both to a long lasting effect of the exercising program, and the reduction of the percentage of symptom reappearance.

*Koumantakis et al* (6) compared two different kinesytherapy programs, traditional exercises of torso muscles strengthening on the one side, and a combination of the traditional program with segmental stabilization exercises on the other side, emphasizing the activation of *m. multifidus and m. trasnversus abdominis.* The program had gradual progress in intensity and complexity of the exercises and lasted for 8 weeks. In conclusion, it supported both programs, giving a minimal advantage to the combined program but also emphasizing the need for an individual approach. Namely, the authors consider that the patients suffering from chronic lumbar pain with no proved defect of lumbar spine stability had quite good results with the standard exercising program, but also that the stabilization exercises, conducted with indicated patients, elongated the effect of the treatment.

*Hayden J.A. et al* (7) performed systematic review of available literature aiming to find the most suitable exercise program for chronic low back pain. Based on 43 random clinical studies, comparing 72 different exercising programs, they came to conclusion, in accordance with everyday clinical practice, which is an individually conceptualized program that would combine elements of stabilization and aerobic strength building exercises, so as to be suitable to each individual case. It has been proved that patients diagnosed with lumbar segmental instability should be included in the program of segmental stabilization exercises.

*Hides et al.* (8) measuring with MRI the size of *m. multifidus* in patients with lumbar pain before and after the segmental stabilization exercises treatment, displayed statistically significant improvement in the size and strength of *m. multifidus,* especially its deepest layer, which has significant influence on the stability of the lumbar spine. *Deneels and Vanderstraeten* (9) used the CT-scan to prove the existence of atrophy of *m. multifidus* with patients suffering from chronic lumbar pain. The lumbar segment was sectioned in three levels. Comparing the sections with the control group composed of healthy participators, they pointed out the existence of atrophy of this muscle

below level L4. *Barker* (10) drew attention in his study to *m. psoas*, which had not been given significant role in achieving the lumbar spine stabilization. He used the MRI to compare the sections of *m. multifidus, m. transversus abdominis* and *m. psoas*. The results showed atrophy of all three muscles in patients with unilateral low back pain, which proved the need for targeted exercising of *m. psoas* as well, with strengthening of previously defined stabilizer muscles.

The ENMG became a standard in demonstrating and following the effect of stabilization exercises. Electrodes are applied to the examined muscles and their activity during the exercises is monitored. *Souza et al* (11) placed the electrodes onto *m. erector spinae, rectus abdominalis, abdominal oblique* and *gluteus maximus,* observing the electromyographic activity of the muscles during two representative stabilization exercises of spinal stabilization. In that way, they tried to determine which exercises most effectively activate the targeted muscles. This enables the construction of highly specialized programs adjusted to individual needs of the patients. Similar study was conducted by *Mori* (12), who used electromyography to monitor the stabilizer muscles during 7 different exercises on an unstable support, pilates ball, examining the effectiveness of each exercise for the activation of each individually monitored muscle.

It is important to emphasize that parameter objectivization and measurability of physical therapy results are imperative in contemporary explorations in rehabilitation. Results obtained in this way display real values and effects of the conducted therapy and they enable the creation of highly specialized programs which satisfy the needs of every patient, fulfilling the tendency for individual approach in therapy.

Based on indicated positive effects, segmental stabilization exercises have become an inseparable part of kinesytherapy treatment of low back pain in patients with suspected lumbar spine instability. Since March 2007, the Clinic of Physical Medicine and Rehabilitation in Nis has successfully applied the combination of spinal segmental stabilization exercises with the Regan-Michele spine column exercises program. Over 100 participants have passed training for establishing and maintaining the tonus of stabilizer muscle with a set of gymnastic exercises and controlled breathing exercises. Patients suffering from chronic lumbar pain had for the first time exercised on an unstable support, the pilates ball (Swiss ball). The results were monitored by functionality tests and questionnaires (SF-36, Oswestry disability score, five-leveled pain scale). The program was very effective in the sense of both decreasing the subjective pain experience of patients and improving the overall life quality.

The problem which appeared during the program was an inadequate and insufficiently objective monitoring of the achieved stabilization, more precisely of the static contraction of the targeted muscles (*m. multifidus* and *m. transversus abdominis*). In relation to this, the latest studies dealing with segmental stabilization program use the ENMG as an objective and precise method for examining the targeted contractions, and a valid method for monitoring therapy results. The imaging techniques, such as MRI and CT, used for monitoring the changes in the outlook of muscles during the program, are also being applied. The thickness and roundness of fibers are measured and the results are compared with the patients functionality status and subjective symptoms.

## CONCLUSION

After adequate diagnosis of the cause of pain in the lower back and awareness of instability of the lumbar segment, the need for the application of the segmental stabilization exercises could be clearly indicated. Strengthening of the lumbar corset and correct exercising of static contractions of the stabilizer muscle are means for achieving stability of the lumbar spine segment which turns into an adequate basis and support to higher parts of the spine column. This is the way to improve posture and mobility, reduce subjective sensation of pain and enhance the overall life quality of patients suffering from chronic lumbar syndrome.

Based on presented facts, we came to conclusion that spinal segmental stabilization exercises must be a part of kinesytherapy program for patients with low back pain.

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## VEŽBE SEGMENTNE STABILIZACIJE LUMBALNE KIČME KAO DODATAK TRADICIONALNOM KINEZITERAPIJSKOM TRETMANU BOLESNIKA SA HRONIČNIM LUMBALNIM SINDROMOM

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## SAŽETAK

**Bol u donjem delu leđa, koji traje duže od 12 nedelja, smatra se hroničnim lumbalnim bolom. Najzastupljenija je dijagnoza u fizijatrijskoj kliničkoj praksi. Brojnim strogo kontrolisanim randomiziranim studijama dokazan je pozitivan efekat vežbi na sve simptome hroničnog lumbalnog sindroma. Klasičan kineziterapijski program ne obuhvata jačanje dubokog sloja abdominalne i paravertebralne muskulature, koja gradi takozvanu unutrašnju jedinicu. Jačanjem mišića stabilizatora postiže se stabilnost lumbalne kičme preko koordinisane aktivnosti njenih dinamičkih segmenata. Efikasnost vežbi spinalne segmentne stabilizacije dokazivana je godinama kroz mnogobrojne studije, koje su uvođenjem savremenih dijagnostičkih metoda dobile na značaju i objektivnosti.**

**Cilj ovog rada bio je da ukaže na pozitivne efekte vežbi stabilizacije kao dodatka tradicionalnom programu jačanja snage i pokretljivosti mišića kičmenog stuba i da ukaže na potrebu uvođenja programa segmentne spinalne stabilizacije u svakodnevnu kliničku praksu.**

***Ključne reči:*** **vežbe stabilizacije, hronični lumbalni bol**