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Lumbar Stabilization Exercises in Addition to Strengthening and Stretching Exercises Reduce Pain and Increase Function in Patients With Chronic Low Back Pain: Randomized Clinical Open-Label Study

Kronik Bel Ağrılı Hastalarda Güçlendirme ve Germe Egzersizlerine Ek Olarak Yapılan Lomber Stabilizasyon Egzersizleri Ağrıyı Azaltır ve Fonksiyonu Arttırır: Randomize Açık Klinik Çalışma

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Summary

Objective: Lumbar stabilization exercises aim to activate and strengthen the deep abdominal and back muscles. Exercise program presented in this study combines activation of specific lumbar stabilizing muscles with traditional strengthening and stretching exercises. The main goal of this study was to establish the effect of stabilization exercises on pain reduction and improving functionality in patients with Chronic Low Back Pain (CLBP).

Materials and Methods: This prospective randomized clinical study was conducted in the Clinical Center Nis, from January 2007 until March 2009. 160 patients with CLBP were eligible and met the inclusion criteria. The study group (S; n=100) had specific lumbar stabilization exercises, while the patients in the control group (C; n=60) performed traditional program for CLBP, based on the strengthening and stretching of the large, superficial back muscles. For monitoring the patients, the Oswestry Disability Index (ODI) and Short-form 36 (SF-36) were used.

Results: After the therapy, pain was successfully reduced in both groups with higher statistical significance in the study group ($p<0.001$). Improvement in ODI score was statistically more significant in the study group compared to the control group ($p<0.001$).

Conclusion: Stabilization exercises in addition to the traditional programs are proven to be effective in pain reduction and functional improvement in patients with CLBP. *Turk J Phys Med Rehab 2012;58:177-83.*

Key Words: Low back pain; exercise therapy; treatment outcome

Özet

Amaç: Lomber stabilizasyon egzersizleri derin abdominal ve sırt kaslarının çalıştırılması ve güçlendirilmesini hedefler. Bu çalışmada sunulan egzersiz programı beli destekleyen kasların çalıştırılması ile geleneksel germe ve güçlendirme egzersizlerinin kombinasyonundan meydana gelmiştir. Bu çalışmanın amacı, stabilizasyon egzersizlerinin kronik bel ağrısı hastalarında fiziksel fonksiyonların iyileştirilmesi ve bel ağrısının azaltılmasındaki etkisini göstermektir.

Gereç ve Yöntem: Bu prospektif randomize klinik çalışma Nis Klinik Merkezi'nde Ocak 2007 ile Mart 2009 tarihleri arasında yapıldı. 160 kronik bel ağrısı hastası çalışma kriterlerine uygun bulunarak çalışmaya dahil edildi. Çalışma grubuna (100 hasta) spesifik lomber stabilizasyon egzersizleri uygulanırken kontrol grubuna (60 hasta) geniş, yüzeyel sırt kaslarının güçlendirilmesi ve gerilmesine dayalı geleneksel program verildi. Hastaların takibinde Oswestry Sakatlık İndeksi (OSİ) ve Kısa-Form 36 (SF-36) kullanıldı.

Bulgular: Terapi sonunda ağrı, çalışma grubunda daha fazla olmak üzere, her iki grupta da istatistiksel olarak anlamlı ölçüde azaldı ($p<0,001$). Kontrol grubuna kıyasla, çalışma grubunun OSİ skorlarında istatistiksel olarak anlamlı olmak üzere daha fazla iyileşme izlendi ($p<0,001$).

Sonuç: Geleneksel programlarla kombine edilen stabilizasyon egzersizleri kronik bel ağrısı hastalarında fonksiyonların iyileştirilmesi ve ağrının azaltılmasında etkilidir. *Türk Fiz Tıp Rehab Derg 2012;58:177-83.*

Anahtar Kelimeler: Bel ağrısı; egzersiz tedavisi; tedavi sonucu

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Introduction

Chronic Low Back Pain (CLBP) is a very common and widespread health problem. Eighty percent of the world's population experiences it, at least once in their lifetime (1). Besides pain and functional disability, CLBP is characterized by psychological and socio-economic aspects. Therefore, the treatment requires a multidisciplinary approach and it should be directed not only to reduce pain, but also to improve quality of life parameters (2,3).

The main pathophysiological cause of CLBP is mechanical lumbar syndrome, typically aggravated by static loading of the spine (prolonged sitting or standing), by long-lever activities or levered postures (bending forward, rotation of the trunk, etc.). It includes: nonspecific pain, probably caused by macroinstability or microinstability of the spine with or without radiographic hypermobility or evidence of subluxation (4-6); followed by: intervertebral disc degeneration arthropathy of, facet joints and surrounding structures, spinal canal stenosis, spondylosis and spondylolisthesis. Less than 1% could be due to nonmechanical syndromes: neurologic syndromes, systemic disorders and referred pain (7,8).

In order to provide an adequate therapy for CLBP, it is necessary to establish pain intensity and patient's functional status. Before deciding what exercise program to apply, it is important to check for any restrictions in mobility and pain occurrence during the execution of several selected basic stabilization exercises and also to investigate whether there are some limitations in activities of daily living (3,9).

Positive effects of exercise therapy on pain and functionality in patients with CLBP had been proven by clinical practice and numerous studies (10-12). Traditional exercise programs for CLBP include strengthening and stretching of the large superficial back and abdominal muscles, without stabilization exercises and formation of the protective lumbar muscle corset. The lack of such programs is the inability to activate deepest layers of the back muscles, as well as inadequate pelvis immobilization, which can lead to injury during exercise (9,12-14).

First stabilization exercise program was presented by Richardson et al. (12) in 1999. They emphasized the need for special exercise program, which would enable activation of particular muscles of the lower back in order to stabilize lumbar region and decrease pain and disability. This specific exercise program, better known as segmental stabilization exercises, does not preclude the need for strengthening and stretching aerobic exercises. Applied alone, any lumbar stabilizing maneuver is not sufficient for full recovery of function and reduction of pain, but it can be an essential addition to any traditional exercise program (10,11,13,15,16).

Basic Hypothesis (Research Question)

Is there a difference in rehabilitation outcome, in relation to the level of pain and functionality, when lumbar stabilization exercises are included into the standard kinesitherapy protocol for CLBP?

Objective

To establish the effectiveness of combined lumbar stabilization exercise program for pain reduction and improvement of overall quality of life in patients with CLBP, compared to the traditional exercise program.

Materials and Methods

The research was designed as a prospective, randomized, open-label study. At the eligibility-screening visit, the patients underwent a preliminary assessment to accustom to the assessment procedures.

Eligibility criteria:

1. Low back pain,
2. 18 to 75 years old,
3. With no severe functional and cognitive deficiency (to be able to walk, bend down, sit and stand alone; able to understand and perform demonstrated exercise),
4. More than six months from any surgical intervention, especially neurosurgical interventions (herniated disc, spinal canal narrowing etc),

The results of this assessment were not used during analysis. Final statistical analysis included 160 CLBP patients, who met the eligibility and inclusion criteria (Figure 1).

Inclusion criteria for participation were:

- Low back pain that lasted more than 12 weeks, varying in intensity and irradiation, from mild to very strong,
- Functional limitations in performing certain activities of everyday living: dressing, lifting heavy objects, walking, running, sitting, standing, sleeping, etc.

Exclusion criteria were:

- Proven acute radiculopathy (ENMG) or severe pain below the knee (clinical examination and interview),
- Inability to perform isometric muscle contractions or to be exposed to medium level of physical exertion due to some internal illness (cardiovascular, pulmonary, systemic etc.),
- Some neurological illness (stroke, polyneuropathy),
- Lack of understanding of the study (dementia, language problems),
- Drug or alcohol abuse.

The patients were treated in the Clinic for Physical Medicine and Rehabilitation, Clinical Center Nis, from January 2007 until March 2009. The study was evaluated and approved by the Scientific and Ethics Committee of the Faculty of Medicine University of Nis, Nis, Serbia. All patients gave their written consent for participation in the study.

There was no financial support by any institution or organization.

The patients were recruited consecutively from the outpatient department of the Clinic and assigned to one or the other exercise program on the basis of "Even-Odd" coincidence rule: first served patient had traditional kinezitherapy program, second served had stabilization exercises, third again traditional, etc.

The authors were not included in the first recruitment process (eligibility and randomization), and that was as far as concealment procedure went. We maintain the view that for

exercise therapy, concealment procedure is not applicable. It is the matter of great importance that the attending physician is involved in every segment of exercise therapy with CLBP patients, in order to provide: information, education, to plan type and level of exercises, to control and monitor the way prescribed exercises are performed.

Study Group (SG) included 100 patients with CLBP (60 female and 40 male, mean age: 49.5±11.8 years). Patients attending this group had a combined exercise program that included spinal segmental stabilization exercises. The program consisted of 15 exercises, designed to combine isometric contraction of stabilizing muscles of the lower back, abdominal wall and the pelvic floor, with aerobic set of exercises for CLBP. Each session began in a standing position. After several relaxation and breathing exercises, the patients were given instructions how to form stabilizing corset by joint isometric contraction of the multifidus and transversus abdominis muscles (4,13,15,17). The verification of the achieved stabilization was carried out by the therapist and the patients themselves, palpating the contracted muscles. The participants learned how to maintain and properly quantify achieved contractions while doing simple exercises. After the initial stabilization training, the patients were ready to begin with strengthening and stretching aerobic exercises (15,18). The program was performed in standing, sitting, kneeling and lying positions. During the exercises, the patients were trying to keep their trunk and pelvic girdle inactive. The program consisted of different sets of exercises such as: pelvic elevation (bridging), abdominal training (curl-ups), mixed extension/flexion stretch of the spinal column (cat-camel), hook-lying (posterior pelvic inclination), etc. We also included exercises on unstable support (Swiss Ball), in order to improve proprioception, coordination and balance (19-21).

Control Group (CG) consisted of 60 patients with CLBP (37 female, 23 male; mean age 49.5±12.4). Their treatment was carried out according to traditional Regan-Michelle's protocol, strengthening and stretching aerobic exercises, without pelvic immobilization and core stabilization. The program was designed to activate the large muscle groups in the superficial layer of the lower back and abdomen in order to improve overall muscle strength and endurance.

All subjects had a total of 20 therapeutic treatments, for 4 weeks (5 days per week). Each treatment lasted 30 minutes.

The Oswestry Disability Index (ODI) (22,23) was selected to evaluate the functional ability. General information (demographics, social and mental status) and overall health issues of the participants were gathered by the SF-36 Health Survey (24,25).

All data were collected before and after the therapy.

Entry, spreadsheet and graphical display of data were performed using MS Excel program. Calculations were carried out by SPSS, version 15.0. Descriptive parameters are presented as frequencies and percentages, while continuous (measurable) variables are presented as mean values (X) and Standard Deviations (SD). To compare the frequency of certain descriptive variables Pearson's chi square test was used. Yates's correction and Fisher's exact test were also applied, because of the sample size.

Student's t-test for paired variables was used to examine changes in continuous variables after therapy, and t-test for unpaired variables was used to examine continuous variables differences between groups. Relations between parameters were

Table 1. Demographics (SF-36).

Characteristic	Study group	Control group
Number of patients	100	60
Age (years)	49.5±11.8	49.5±12.4
Height (cm)	170.6±8.7	170.8±9.6
Weight (kg)	76.8±14.6	75.2±10.4
Sex (%)		
Male	40	38.3
Female	60	61.7
Education (%)		
Elementary	6.7	15
High school	68.3	58
College	10	16
Postgraduate	0	2
Relationships (%)		
Alone	13.3	12
Married	71.7	72
Living with someone	8.3	8
Divorced	3.3	4
Work (%)		
Working	37.3	27.3
Sick leave during therapy	13.6	13.1
Unemployed	18.6	6.2
Location of pain (%)		
Primary / Secondary		
Low back	100	100
Neck - right	38	46.7
Neck - left	34	35
Hip - right	32	36.67
Hip - left	36	31.67

Table 2. Assessment of low back pain in both groups, before and after the therapy.

	Study group		Control group	
	before	after	before	after
Pain assessment	3.13±1.30	2.03±1.18***a	3.22±1.29	2.77±1.36*

In group (after vs. before): *** – p<0.001
Between groups (study vs. control): a – p<0.05
*: p<0.05

established using Pearson's coefficient of linear correlation (r). A p value less than 0.05 was considered statistically significant.

Results

The SF-36 was used for demographics and quality of life parameters (Table 1; Figure 2, 3).

There was no statistically significant difference between the groups before the therapy.

Pain

Before the therapy, pain was assessed as moderate in both groups, with no statistically significant difference between them. After the therapy, pain was successfully reduced in both groups ($p<0.001$ in SG, $p<0.05$ in CG), with higher statistical significance in the SG. Comparing the results between the groups, we got a greater pain reduction in the SG compared to the CG (2.03±1.18 to 2.77±1.36, $p<0.05$) (Table 2).

Activities of Daily Living

Dress-up: Before the therapy, ability to dress was impeded by pain in both groups. Pain during dressing was successfully reduced in both groups ($p<0.001$), but the value of pain reduction was statistically more pronounced in the SG ($p<0.05$).

Lifting heavy objects: There was no noticeable improvement of ability to lift heavy objects in both groups before the therapy. Statistically significant improvement was achieved after the therapy only in the SG ($p<0.01$). However, estimations of opportunities for this activity did not differ from the estimations either before or after the treatment between the groups.

(These results were expected, because patients received instructions to avoid carrying heavy loads and lifting objects off the floor, during the ergonomic counseling).

Walking and running: Before the therapy, walking and running were minimally disturbed in both groups, with no significant difference between them. After the therapy, estimated abilities to walk and run were statistically favorable in both groups, but with a higher level of significance in the SG ($p<0.001$ in SG, $p<0.05$ in CG).

Sitting and standing: were estimated as a bit more difficult before the therapy, with no statistically significant difference between the groups. After the therapy, both activities improved with qualitatively better results in the SG ($p<0.001$ in SG, $p<0.05$ in CG - only for standing).

Sleep disturbance: After the therapy, occurrence of sleep disorders was decreased in both groups ($p<0.001$). Comparing

Table 4. Assessment of overall functional disability in performing various activities of daily living ODS (%).

	Study group		Control group	
	before	after	before	after
ODS	34.28±17.83	23.44±14.47***c	38.10±17.74	32.83±17.90***

In group (after vs. before): *** – p<0.001

Between groups (study vs. control): c – p<0.001

Table 5. Correlations between overall ODS with pain and disturbed activities of everyday living after the therapy.

	Study group r	Control group r
Pain	0.54***	0.59***
Dressing	0.61***	0.51***
Lifting heavy objects	0.60***	0.52***
Walking and running	0.74***	0.79***
Sitting	0.70***	0.71***
Standing	0.68***	0.65***
Sleeping	0.49***	0.70***
Social activities	0.74***	0.81***
Traveling	0.74***	0.75***
Sex life	0.66***	0.78***

*** p<0.001

*ODS: Oswestry Disability Index Score

Table 3. Assessment of pain disturbed activities in both groups, before and after the therapy.

Pain disturbed activities	Study group		Control group	
	before	after	before	after
Dressing	1.22±1.11	0.50±0.81***a	1.50±1.03	1.03±0.92***
Lifting heavy objects	2.34±1.56	2.04±1.59**	2.75±1.30	2.48±1.31
Walking and running	1.77±1.07	1.35±0.91***	1.78±1.11	1.57±1.17*
Sitting	1.67±1.18	1.37±1.18***	1.65±1.15	1.62±1.21
Standing	1.79±1.11	1.43±1.08***	2.07±1.30	1.80±1.26*
Sleep disturbance	1.22±1.35a	0.52±0.88***c	1.78±1.53	1.27±1.33***
Social and recreation activities	1.79±1.71	1.05±1.31***b	2.00±1.77	1.75±1.62*
Traveling	1.32±1.41	0.88±1.20***	1.20±1.35	1.12±1.35
Sexual function	0.89±1.35	0.55±1.09***a	1.10±1.56	1.02±1.48

In group (after vs. before therapy): * – p<0.05, ** – p<0.01, *** – p<0.001

Between groups (study vs. control): a – p<0.05, b – p<0.01, c – p<0.001

the SG with the CG, there was statistically less sleep disturbance in the SG (p<0.001).

Social life and recreation: After the therapy, we achieved statistically significant improvement in both groups (p<0.001 in SG, p<0.05 in CG), with slightly better result in the CG (p<0.01).

Ability to travel: Minor disturbance was present in both groups before and after the therapy, with no statistically significant difference between them. After the therapy, we observed statistically significant improvement in SG (p<0.001).

Sexual Activity: Before the therapy, ability to have sex was limited due to pain during certain movements in both groups. After the therapy, we had statistically significant improvement in sexual activity in the SG (p<0.001), and it was more pronounced compared to CG (p<0.05).

All of the activities of daily living are presented in Table 3.

The mean initial ODI score in the SG was 34.28±17.83, and dropped down to 23.44±14.47 at the end of the treatment (p<0.001). ODI score in the CG had average value of 38.10±17.74 at the beginning of the therapy with smaller after-treatment improvement: 32.83±17.90 (p<0.001). After the therapy, we had statistically more significant improvement of ODI scores in the SG than in the CG (p<0.001).

Overall ODI score is presented in Table 4.

The correlation of overall ODI score with pain and activity disruptions, showed high statistical significance and emphasized cause-effect relationship between them (Table 5).

Regarding the patients' emotional status, significant improvement was recorded in both groups after the therapy. Incidence of positive feelings (calm, peaceful, full of pep and energy) increased, whereas, negative emotions (sad, nervous, tired and down-hearted) decreased.

The correlation between these results and ODI scores indicated a direct positive relationship between improvement in functional status of CLBP patients and their mental and emotional status (Figure 2, 3).

Discussion

Lumbar spine segmental instability is considered to be the primary cause of non-specific mechanical CLBP. Many researchers work intensively in order to find adequate, specific exercise program that will significantly reduce pain and increase functioning of CLBP patients (2,7,8).

Our study compared the stabilization exercise program with the traditional treatment for CLBP, based on the Reagan-Michelle's protocol. Data were gathered using the SF-36 Health Survey and ODI (22-25) which are applicable, valid and practical for clinical use, based on the Hayden's meta-analysis (11). In this study, the authors analyzed and ranked a number of randomized trials that used various scales and measurements of pain and activities of daily living, and described most of the studies using the ODI as "positive" or "neutral" in quality, opposed to those who had used other methods of pain and disability evaluation. The Rolland Morris Disability Questionnaire, The McGill Pain Questionnaire, etc.).

All data obtained in our study showed better results in experimental, stabilization exercises group, compared to those

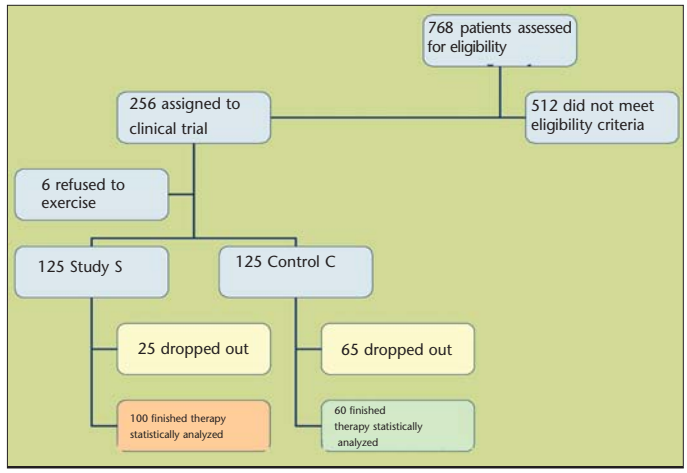

Figure 1. Patients flow-chart.

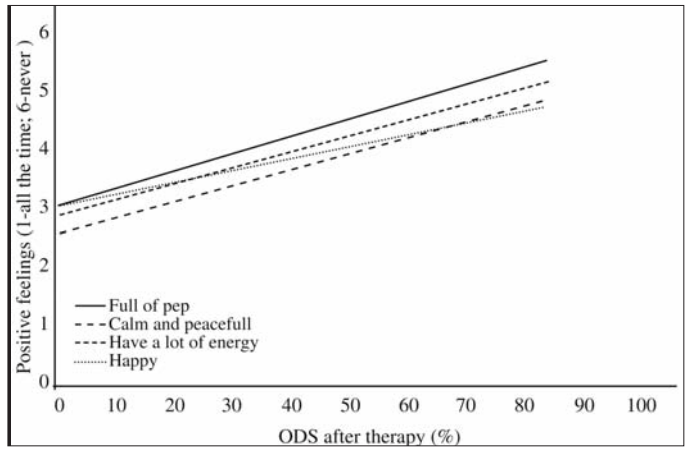

Figure 2. Linear correlation curves between ODS after therapy and frequency of positive feelings.

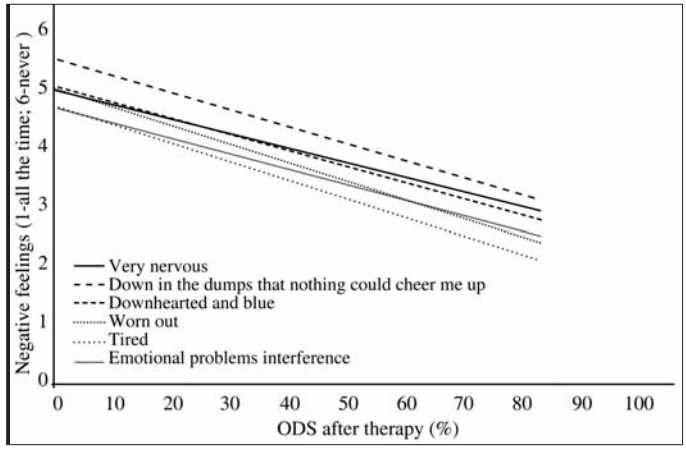

Figure 3. Linear correlation curves between ODS after therapy and frequency of negative feelings.
* ODS: Oswestry Disability Index Score

recorded in the CG. Positive effects were observed in all aspects of functioning, ranging from patients general health status through emotional state, to pain reduction and functional recovery. We also established a high correlation between pain and disability parameters, which can lead us to conclude that by fighting disability we can significantly decrease pain.

In order to compare our results with others, we reviewed a large number of studies that addressed this issue and came across various results. Some of them match with ours (9,12,13,15,16), and some do not (14,26), but it was very difficult to compare them, because of the different methodologies, functional tests and questionnaires that were used. This diversity was confirmed by the systematic literature review conducted by Ferreira et al. (27) who found stabilization exercises to be effective if applied in a controlled and selective manner.

Richardson et al. (12) presented the first exercise program for strengthening the transversus abdominis and multifidus muscles. The program was based on the assumption that the greater power and endurance of these muscles could affect the stability of the lumbar spine as a whole, and thereby, reduce pain and increase overall functional ability. They emphasized the simultaneous activation of the transversus abdominis and multifidus by isometric contractions of these muscles, before and during the execution of various aerobic exercises. A similar principle was applied in our study.

Three years later, the same authors (17), demonstrated the biomechanical effects of transversus abdominis muscle strengthening on sacroiliac joint stability, which is often associated with the stability of lumbar region as a whole. Exercises for the sacroiliac joint were also included in our program.

In studies that followed compared stabilization exercise programs with different physical procedures in order to find the best available therapy for CLBP (8,10,11), the results were diverse. O'Sullivan et al. (28) were among the first authors who compared specially designed stabilization program with traditional aerobic exercises. Their study showed that patients, who performed specifically designed stabilization exercises program, had significantly better results in pain reduction and functional ability compared to the patients who did not have stabilization exercises. They also confirmed the durability of these effects by conducting a control examination after 30 months. The same authors (18) conducted a series of studies with similar outcome on patients with spondylosis and spondylolisthesis, as proven entities of lumbar spine instability.

Hayden et al. (11) conducted a meta-analysis that included 6390 patients. From 61 studies, 43 were related to chronic lumbar pain. Comparing 72 different exercise programs, authors concluded that best effects were achieved with individually and carefully designed exercise programs, which would combine stabilization and strengthening exercises, dosed to suit each individual case.

Only a small number of studies directly compared stabilization exercises with other exercise programs (4,15,16). Our study was most similar to the prospective randomized study published in 2005 by Koumantakis et al. (15). Authors compared the effects of traditional strengthening exercises for low back pain with that of combined stabilization, strengthening and stretching exercise program, based on the activation of the multifidus and transversus abdominis. The program had a gradual progression in intensity and complexity of the given exercises and lasted eight weeks. This study supported both programs giving a minimum advantage to the combined stabilization and strengthening exercise regimen. Koumantakis et al. concluded that the best results were achieved in patients with proven lumbar instability (by roentgenograms of the lumbar spine region in normal position and maximal flexion, extension and rotation). The necessity of individualized and multi-disciplinary approach was clearly emphasized.

From the end of our study in May 2009 to date, there were not many similar studies which could be compared with this one. A systematic review conducted by Macedo LG et al. (29), published in 2009 sheds some light on the matter and supports this kind of motor control exercises suggesting their effectiveness and benefit to another form of intervention in reducing pain and disability for CLBP patients, under some conditional circumstances: to find an optimal implementation of this kind of exercises, to properly evaluate dosage, to define the subgroups of patients with the same indications and to try to combine it with feedback and cognitive interventions.

There are many new studies comparing some exercise programs to others trying to find the best possible protocol for these patients. Dufour et al. (30) compared group-based multidisciplinary biopsychosocial rehabilitation and intensive individual therapist-assisted back muscle strengthening exercises. Both programs were very effective and could be used in combination in order to achieve the best possible results. Unsgaard-Tondel et al. (26) compared motor control exercises (similar to stabilization) and sling exercises with general exercises for CLBP and found no evidence that first two were better in any way than traditional general exercise regimen. Rasmussen-Barr et al. (31) found that graded exercise intervention, emphasizing stabilizing exercises, for patients with recurrent LBP were more effective in improving disability and overall health parameters than other exercise regimens, but with no positive results regarding pain.

Reviewing these and many other research studies and publications, all we can say without fail is that this subject is far from closed and there is a large open space for further investigations. Many authors combine exercises with cognitive and behavioral interventions, which may be the best approach to this complex health problem.

Our experiences show that complete exercise program for CLBP is the one that combines stabilization techniques with specific and individually dosed aerobic exercises. That kind of exercise program enables patients to regain full functionality, to decrease level of pain and to prevent further injuries of the lumbar spine.

Limitations

The main limitation of the presented study is the lack of objectivity in evaluating gathered data. Used test and survey

show only subjective view of patients symptoms. ENMG could be used as objective tool for stabilizing muscle strength and endurance measurement was used only in initial stage of the study as exclusion method for detection of radiculopathy, peroneal and tibial palsy. This can lead to some difficulties regarding reproducibility and generalization of our study. However, we emphasized that improvement of patients symptoms was our only goal in this research and we found that decrease in pain and increase of functionality, which have such substantial statistical importance, could not be dismissed on the basis of subjectivity, mainly because pain and quality of life are subjective parameters.

Conclusion

Specifically designed stabilization exercises program in combination with strengthening and stretching aerobic exercises had positive effect on pain reduction, functionality and quality of life parameters in patients with CLBP.

With high statistical significance, we showed that combined stabilization program was more effective in all tested aspects compared to the traditional exercises for CLBP.

Conflict of Interest:

Authors reported no conflicts of interest.

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