Türk Fizyoterapi ve Rehabilitasyon Dergisi

2014 25(1)28-34

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Geliş Tarihi: 17.07.2013 (Received)
Kabul Tarihi: 12.02.2014(Accepted)

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RESEARCH ARTICLE

THE EFFECT OF THE MUSCLE ENDURANCE TRAINING ON THE CHRONIC LOW BACK PAIN

ABSTRACT

Purpose: To compare two different exercises programs in the treatment of chronic low back pain.

Methods: This study was performed with 63 patients with chronic low back pain. The control group consisted of 32 patients. Classical Strength Exercises (CSE) consisting of stretching and strengthening exercises were applied to the control group. The experimental group consisted of 31 patients. Muscle Endurance Training (MET) consisting of warm-up, endurance exercises and cool down were applied on the experimental group. At the end of the treatment session, a hot-pack was applied to the patients in both of the groups. Postural education and back care advice were also given. Patients attended a therapy program 3 days a week for 6 weeks. The disability, pain and muscle endurance were assessed in the 1st, 3rd and 6th weeks.

Results: The 6th week measurement of disability was lower in the MET group than that of the CSE group ($p<0.05$). There was no significant difference in the VAS score and abdominal muscle endurance. In the 3rd and 6th week, back muscle endurance time was significantly higher in the MET group than that of the control group ($p<0.05$).

Conclusion: Recent studies show that muscle endurance has a great importance in the prevention of Lower Back Pain (LBP). Therefore in the treatment of Chronic Low Back Pain, muscle endurance exercises that increase the level of endurance should be added to the treatment program.

Key words: Endurance training, exercise, fatigue, low back pain

ARAŞTIRMA MAKALESİ

KASSAL DAYANIKLILIK EĞİTİMİNİN BEL AĞRISINA ETKİSİ

Amaç: Kronik bel ağrısının tedavisinde iki farklı egzersiz yöntemini karşılaştırmak.

Yöntem: Bu çalışma, kronik bel ağrısı olan 63 hasta üzerinde gerçekleştirildi. Kontrol grubunu oluşturan (klasik kuvvetlendirme egzersiz programına alınan) 32 hastaya germe ve kuvvetlendirme egzersizlerinden oluşan klasik kuvvetlendirme programı, deney grubunu oluşturan (kassal dayanıklılık egzersiz programına alınan) 31 hastaya ısınma, soğuma ve dayanıklılık egzersizlerinden oluşan kassal dayanıklılık eğitimi uygulandı. Her iki gruptaki hastalara, postüral düzgünlük ve günlük yaşam aktivitelerinde dikkat edilecek durumlarla ilgili eğitim verildi ve tedavi seanslarının sonunda sıcak uygulama yapıldı. Hastalar haftada 3 gün olmak üzere 6 hafta boyunca tedaviye alındı. Tedavi öncesi ile tedavinin 3. ve 6. haftalarında yetmezlik, ağrı ve dayanıklılık ölçümleri yapıldı.

Sonuç: 3. ve 6. hafta elde edilen dayanıklılık sonuçları, kassal dayanıklılık eğitim grubunda klasik kuvvetlendirme egzersiz grubuna oranla daha düşük bulundu ($p< 0.05$). Abdominal kas dayanıklılığında ve görsel analog skalası değerlerinde her iki grup arasında fark bulunmamıştır ($p>0.05$). 3. ve 6. haftada sırt kaslarının dayanıklılık süreleri kontrol grubuna oranla deney grubunda anlamlı olarak yüksek bulunmuştur ($p<0.05$).

Tartışma: Güncel çalışmalar kassal dayanıklılığın, kronik bel ağrısının önlenmesinde önemli olduğunu göstermiştir. Bu nedenle kronik bel ağrısının tedavisinde kasın dayanıklılık seviyesini arttıran dayanıklılık egzersizleri tedavi programına eklenmelidir.

Anahtar kelimeler: Dayanıklılık eğitimi, egzersiz, yorgunluk, bel ağrısı

INTRODUCTION

Low Back Pain (LBP) is one of the most common cumulative trauma disorders encountered in industry (1,2). 50% - 90% of adults will have low back pain at some time in their lives. The patients with low back pain have restrictions in their ability to perform routine activities of their daily lives (3-9). Low Back Pain sustained for more than 12 weeks is called Chronic Low Back Pain (CLBP) (10-12). Chronic Low Back Pain induces various problems, including physical, psychosocial, and quality of life features. CLBP reduces muscle strength, endurance, flexibility, and balance ability (13-15). In the treatment of CLBP, there is a large quantity of published research on the exercises used (16,17). The aim of these exercise programs is to decrease pain, strengthen weak muscles, and improve posture & trunk mobility (16,18,19). However, researches showed that the incidence of LBP is increased in industrial countries and only having good trunk muscle strength is inadequate in the prevention of LBP (16,20).

Muscle endurance is important in preventing LBP (21-24). Endurance is mechanically defined as either the point of isometric fatigue, where the contraction can no longer be maintained at a certain level or as the point of dynamic fatigue, when repetitive work can no longer be sustained at a certain force level. Fatigue may decrease the muscular support of the spine and may lead to an increase of strain on the passive structures. Poor endurance of the trunk muscles may lead to muscle fatigue in repetitive, long time loading and may cause a decrease in the muscle response to loads. Therefore, muscle fatigue increases the risk of back injuries (21-24).

In order to prevent and treat these injuries and reduce the recurrence risk, it is important to increase muscle endurance through proper physical training and thus help the muscle resist loadings more efficiently. The main point in endurance training is to increase muscle strength as well as muscle endurance and reduce the recurrence risk of injury of intervertebral discs, facet joints and surrounding structures to minimum, by continuing the musculoligamentous control (22).

In the literature, there are many studies which investigate muscle endurance levels and the effect of fatigue in patients with CLBP. However, there are few studies which focus on the effect of endurance training programs on LBP. The aim of this study was to assess the effects of strengthening exercises and endurance training programs in the treatment of chronic low back pain. Hypothesis of the study was that endurance enhancing exercises should be more effective than conventional strengthening exercises in the reduction of disability in the treatment of chronic low back pain.

Methods

Sixty-three patients who were treated in Izmir Ataturk Education and Research Hospital, Physical Therapy Department for CLBP were involved in the present study. The present study was performed with the approval of the local ethics committee. Required explanations were made and written informed consent was obtained from each patient. The inclusion criteria: 1) The ages between 20-55 years, 2) The presence of low back pain as a primary complaint, 3) The onset of pain was three months. The exclusion criteria if had: 1) Tumors, infection or inflammatory diseases affecting the spine, 2) Spinal or lower limb surgery, 3) Spinal fractures or structural deformities such as spinal stenos, spondylolisthesis and spondylolysis, 4) Signs of nerve root compression 5) Any contraindications for exercise therapy (25-27) .

Study Design: This was a randomized controlled study. Patients were randomly divided into two groups using cards in unmarked envelopes, to receive either Muscle Endurance Training (MET) or Classical Strength Exercises (CSE). The patients were randomly allocated into three groups by the second author who was blinded in measurements and assessments. Additionally, the patients were blind to the intervention.

Interventions: Thirty-two patients in the control group were treated with CSE program including stretching exercises (lumbar extensor muscles, iliopsoas muscles, hamstring muscles, gastrocnemius muscles and pectoral muscles) and strengthening exercises (rectus abdominus crunch, oblique crunch, pelvic elevation, single leg pelvic elevation, lumbal spine extension, on hands and knees position with the raise of one leg, on hands and knees position with the raise of opposite arm and leg). Each exercise was repeated 10 times (28).

Thirty-one patients in the experimental group were treated with MET program including warm up, endurance and cool down exercises. The warm up and cool down period consisted of 5-minute walking, and 10 repetitions of stretching exercises. Endurance exercises consisted of 4 levels. The first level consisted of bilateral shoulder lifts in prone position, the second level consisted of contralateral arm and leg lifts in prone position and the third level consisted of placement of both hands behind the head and bilateral shoulder lifts in prone position. The fourth level consisted of bilateral shoulder lifts with arms fully elevated in prone position. The exercise position was sustained for 10 seconds. If pain was aggravated, the exercise position was continued for only 5 seconds, and it was gradually increased to 10 seconds. After 10 repetitions, the subjects were instructed to rest for about 30 seconds. The rest interval was 1 minute for every 50 repetitions until 300 repetitions were completed. Exercises were performed in 6 cycles consisting of 5 sets with 10 repetitions (22).

At the end of the treatment sessions, hot-pack was applied to relieve discomfort in the lower back in both groups. Postural education and low back care advice were also given. Patients underwent rehabilitation program 3 days per a week during the 6 weeks. Disability, pain and muscle endurance were assessed before treatment and in the 3rd and 6th weeks.

Assessments: Demographic characteristics of the patients (age, BMI, sex, smoking, sport, complaint duration, employment) were collected.

Disability: Disability in daily activity was assessed using the Oswestry disability index (ODI) (26,29,30). The Oswestry disability index, which has been in use since 1980, is a 10-item self-administered questionnaire based upon a scale numbered from 1 to 6 that aims to understand how a patients' back pain has affected everyday life. The sum of the 10 items is transformed into a percentage of maximum score, ranging from 0-100 (26,29,30). Turkish version of the Oswestry disability index was used in the present study (29).

Pain: VAS was used for pain perception. VAS is typically represented as a horizontal line in 100 mm length anchored at each end by a verbal descriptor such as 'no pain' and 'worst pain' ever experienced. "0 point" indicated "no pain" and "100 point" indicated "worst pain". Patients are asked to place a vertical mark along the horizontal line indicating their current degree of pain (26, 31). Pain intensity at rest and activity were examined.

Endurance: Trunk extensors: Muscle endurance was measured using the Sorensen test and the Kra-

Table 1. Demographic and clinical characteristics of patients.

	MET(n=31) Mean ± SD	**CSE(n=32) Mean ± SD**	**p**
Mean age(year)	39.16 ± 7.36	40.22 ± 7.95	0.58
BMI (kg/m²)	25.24 ± 4.46	25.47 ± 3.88	0.82
Mean complaint time (month)	23.52 ± 24.11	17.22 ± 19.07	0.25
	N(%)	N(%)	
Gender			
Male	12.90	18.75	
Female	87.10	81.25	0.52
Job			
Employee	3.23	12.5	
Unemployed	77.42	65.63	0.35
Bureaucrary	19.35	21.87	
Sport			
Sportsman	25.8	37.5	0.31
Unsportsman	74.19	62.5	
Smoking			
Smoker	19.35	6.25	0.11
Unsmoker	80.65	93.75	

Statistically significant $p < 0.05$.
MET: Muscle Endurance Training, CSE: Classical Strength Exercises

Table 2. Oswestry and VAS score of MET and CSE groups

	MET(n=31) Mean ± SD	CSE(n=32) Mean ± SD	p
Oswestry			
1st week	32.42±6.49	33.59±6,28	0.46
3rd week	22.77±5.33	25.66±5,92	0.04
6th week	18.29±5.21	21.09±5,79	0.04
VAS			
1st week	5.5±81.36	5.4±10,95	0.55
3rd week	3.5±51.09	3.75±0,98	0.44
6th week	2.26±1.12	2.56±1,01	0.26

Statistically significant p < 0.05.
MET: Muscle Endurance Training, CSE: Classical Strength Exercises

use-Weber test. The capability of the trunk extensors' sustaining the antigravity position was evaluated using the Sorensen test. The patient lay prone with the pelvis at the end of the table. The patient maintained his/her body in the horizontal position for as long as patient can tolerate that position. Before performing the re-test, 10-15 minutes rest was given. Maximum value was taken for assessment (32-35). Abdominals: The Krause-Weber test evaluated abdominal muscle endurance and consisted of three sub-tests: (1) The patient was asked to place both of his/her hands on the contralateral shoulders and lift his/her trunk 25 degrees up from the floor. (2) The patient was asked to lift both of his/her fully extended legs 25 degrees up from the floor. (3) The patient was asked to lie on his/her back with knees bent and lift his/her trunk 25 degrees up from the floor. The patient maintained his/her body in the horizontal position for as long as patient can tolerate that position. Before performing the re-test, 10-15 minutes rest was given. Maximum value was taken for assessment (32).

Statistical analysis: All data analysis was performed with the SPSS®, version 15.0. Descriptive statistics were run for all continuous data to obtain means, standard deviations and ranges. Frequencies and percentages were run for nominal variables. The differences between the two groups were analyzed using independent samples t-test and chi-square test. Statistical significance was p< 0.05.

RESULTS

The demographic characteristics of the patients were presented in Table 1. There was no significant difference between the two groups. 77 patients were invited to participate in the present study. Six patients in the experimental group and 8 in the control group withdrew from the study because they would not be able to complete the treatment program. Sixty-three of the 77 patients completed the original study.

There were no differences between the two groups in the ODI in the measurements performed before treatment (p>0.05) while the disability score was significantly lower in the MET group when compared to the CSE group in the measurements performed in the 3rd and 6th weeks (p<0.05), (Table 2).

In both groups, VAS scores showed a significant decrease in the measurements performed before treatment, in the 3rd and 6th weeks (p<0.05). When the two groups compare there were no significant differences in the VAS score amongst the two groups (p>0.05), (Table 2).

There was no significant difference between the two groups in abdominal muscle endurance in the second and third Krause-Weber tests (p>0.05) while there was significant difference in the first Krause-Weber test between the two groups (p<0.05). When the two groups were compared of the endurance of the back muscles, no significant difference was found in the before treatment (p>0.05) while in the 3rd and 6th weeks, the endurance of the back muscles were significantly higher in the MET group than that of the CSE group (p<0.05), (Table 3).

DISCUSSION

The principal finding of the present study was that back muscle endurance time was significantly hig-

Table 3. Sorenson and Krause-Weber Tests

	MET(n=31) Mean ± SD	CSE(n=32) Mean ± SD	p
Sorensen			
1st week	49.13±21.92	46.6±23.31	0.66
3rd week	83.61±26.31	66.09±29.46	0.01*
6th week	98.33±30.11	77.03±29.81	0.01*
KW1			
1st week	40.27±32.45	34.30±21.61	0.39
3rd week	68.26±40.68	47.95±30.55	0.03*
6th week	85.25±45.19	57.40±30.57	0.01*
KW2			
1st week	23.49±19.04	23.85±18.20	0.94
3rd week	38.93±23.29	30.66±18.41	0.12
6th week	47.66±30.03	36.86±19.53	0.09
KW3			
1st week	37.30±29.91	32.65±19.88	0.46
3rd week	57.75±39.29	44.34±25.55	0.11
6th week	67.32±41.65	51.40±26.76	0.07

Statistically significant $p < 0.05$.
MET: Muscle Endurance Training, CSE: Classical Strength Exercises, KW: Krause-Weber

her in the muscle endurance group than the control group at the 3rd and 6th week of the treatment. There was no significant difference in the VAS score and abdominal muscle endurance between the groups.

CLBP increases disability rate, and reduces individuals' quality of lives limiting the activities of their everyday lives. One of the aims of treatment is to reduce disability rate and increase their quality of lives reducing their pain and thus increasing their activities. Studies performed on this subject have shown that pain and disability rates reduce in patients with CLBP through exercise programs carried out.

Velde et al. evaluated the effects of six-week exercise in patients with CLBP. At the end of six weeks, the scores showed a statistically significant decrease (23).Barker et al used the ODI and evaluated the effects of regular exercises on the disability of the patients with CLBP who had received hydrotherapy. No significant differences were found in the disability scores during the resting end exercising periods (36). Sung PS carried out a study to determine the effects of the exercises on muscle endurance and functional status. All patients were assessed using the ODI. As a result, the Oswestry score improved significantly from pre to post treatment phases (37). In many studies conducted, different forms of exercises used in the treatment of low back pain were shown to reduce disability. There still is no definite opinion about which form of exercise is more effective. In this study, we found that the Oswestry score significantly decreased in the MET group in comparison with the CSE group. Disability score was found to be lower in the MET group. These results might be interpreted that endurance training program improves muscle endurance, elevates the fatigue threshold of the muscles and increases durability of the muscles responding to loading. The reason of the difference in disability is thought to be because of the endurance levels. The endurance levels increase with exercise and this leads to an increase the durability of muscles against loading.

The important role of the exercise training in reducing pain in treatment of CLBP is well-known (23,36,38).The results of the present study were parallel the current literature. The change in pain severity using VAS before treatment and in the 3rd and 6th weeks was evaluated and reduction of pain was found to be significant in both groups.

Back muscle tissue can be affected the direct and indirect injury which is aggravated by muscle fatigue. Muscle fatigue causes decreased the muscular support of the spine and also increased mechanical stress of the functional components of the spinal

colon. External loads are transmitted much easier to the soft tissue of the spine when paraspinal musculature loses its ability to generate tension as a result of fatigue. Muscle fatigue can impair motor coordination and control (18). As a result, injury to the spine may occur due to unexpected load or position of the joint. Studies showed that endurance exercise programs given to individuals both elevate the endurance level and increase the resisting time of the muscles.

The studies showed that endurance training of the trunk muscles should improve endurance level, elevate the fatigue threshold, and reduce disability & incidence of LBP (21,38-40). Chock et al evaluated the effects of trunk extensor endurance training on pain and disability. Their study indicated that endurance training of trunk extensors reduced pain and disability after 3 weeks of exercise program (22). In the present study, the endurance time of abdominal and back muscles was also evaluated. At the end of the 6th week, back muscle endurance was significantly higher in the experimental group. There was no significant difference between the two groups in abdominal muscle endurance.

The prime limitation of the present study was that, although 85% of the patients were sedentary, 15% of were sportsmen. Effects of the MET program in professional athletes should be evaluated. Second limitation was isokinetic measurement is required to evaluate muscle endurance of the patients.

In conclusion, the present study showed that trunk endurance training program should increase endurance time while strength exercise program does not any effect on the endurance time in patients with CLBP patients. The muscle endurance levels can be increased with the use of endurance enhancing exercises. In this way, the ability of the muscle to respond to a sudden, recurrent and longtime load may increase. Therefore, endurance training may help to reduce the risk of low back pain and disability.

Conflict of interest statement: All authors have no conflicts of interest with respect to the data collected and procedures used within this study.

Ethical statement: The authors confirm this study meets the guidelines of the Declaration of Helsinki and after local ethical approval all subjects provided written informed consent.

Funding: Authors declare that they have no sponsor in the study design, in the collection, analysis and interpretation of data; in writing of the manuscript; and in the decision to submit the manuscript for publication.

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