The Effect of 6-Week Core Stabilization Training with Thera-band on Static Balance, Pain, Functional Disability, and Energy Expenditure in Females with Mechanical Chronic Low Back Pain

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Abstract

Introduction: The purpose of this study was evaluating the effect of core stabilization trainings with Thera-band on energy expenditure, static balance, pain, and functional disability in patients with mechanical low back pain (MLBP). **Material and Methods:** A total of 30 women with MLBP (height 163.9±4.73, weight 60.4±2.17, age 27±2.6) participated in this research. Pain severity, functional disability, static balance, and energy expenditure were measured using VAS, Oswestry, Force plate, and Polar activity watch, respectively. To analyze data ANCOVA was used (P<0.05). **Results:** Data analysis with ANCOVA revealed a significant difference in the training group for VAS and Oswestry measures, but no significant difference was observed in static balance and the consumed energy (P<0.05). **Conclusion:** According to the research findings, it can be concluded that core Stabilization training with Thera-band can be used to improve the pain and functional disability of patients with MLBP.

Keywords: Energy Expenditure, Energy Expenditure, Low Back Pain, Static Balance, Functional Disability, Force Plate, Polar Activity Watch, VAS, Oswestry

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Introduction

Low back pain (LBP) has been one of the major health-related problems over the past years which has made difficulties for the personal and professional lives of individuals (1, 2). It is also a prevalent disabling condition and an important clinical, social, and economic issue (3). More than 80% of people have suffered this experience at least once in their lifetime (4, 5), with a prevalence of about 60-80% (6). Indeed, it can be said it is the first cause of disability in people under 45 years of age, the second cause of referral to a physician, and the third cause of surgery (7). The pain resulting from low back is considered as a benign disease, and 90% of different types of low back pains are treated by supportive care while 10% leads to surgery (8). A total of 73-75% of all patients who constitute the largest group of patients with low back pain suffer from chronic low back pain (9). The causes of LBP can be categorized as mechanical (97%), non-mechanical (1%), and psychological factors (around 2%) (10). Generally, the factors that develop LBP are different, though the main reason is the reduction in efficiency of discs in the spine (12, 13). Mechanical LBPs are specific or non-specific, and with regard to their duration they can be categorized as acute back pains (6 to 12 weeks) and chronic LBPs (over 12 weeks). LBP should be considered as a syndrome and an important factor in development of functional disability in the patient (9). This leads to a reduction in the level of physical fitness, and as a result, greater disability and chronic low back pain (11). Regardless of the level of physical activity, patients with nonspecific chronic low back pain should walk like healthy people on a daily basis. Walking is one of the most important

and most effective daily human activities which is necessary for having an independent life. Previous studies, with reference to kinetic and kinematic evaluations, have suggested that there is a difference in the efficiency of people with non-specific CLBP while walking compared to healthy people. On the other hand, evidence has shown that people with LBP expend more energy than healthy people during walking (14-17). This can be due to a reduction in the pain or ineffectiveness of the heart, which can itself be a result of low mobility (18).

It has been observed that in case of unsuccessful rehabilitation, postural stability disorder increases in patients with LBP (19). So discovering the causes of postural stability disorder in patients with LBP and handling them during therapeutic intervention are very important. of the most important causes include disorders in strength, coordination and paired function of the muscles of the low back and the pelvis as well as diminished variety of controlling the stabilization (20). Overall, exercises with three important goals are recommended to patients with chronic back pain. Its first and clearest goal is to restore the flexibility and strength of low back muscles and improving the function of endurance activities. The second goal of these exercises is to reduce the intensity of low back pain. Most studies conducted have shown a reduction of 10 to 50% of pain intensity after the therapeutic treatment. The third goal is mitigating the disability resulting from low back pain, resolving the fear and worries, as well as correcting behaviors and beliefs, and potentiating the treatment (21). Accordingly, the aim of the present study was to investigate the extent of effect of stabilizing exercises with Thera-band on pain, functional disability, energy expenditure, and static balance in patients with mechanical CLBPs and to answer the question whether physical exercises can improve the function of these patients with modifying some parameters?

Materials and Methods

The research is semi-experimental kind which has been conducted as pre-test and post-test in two experimental and control groups. The population of this research consisted of female patients with non-specific mechanical chronic low back pain in the city of Isfahan among whom 30 individuals formed the statistical population of this research. Patients referring to physical therapy clinic were randomly divided into two groups. The training group did core exercises with Thera band three sessions weekly and 60 minutes per session. The confirmation of chronic non-specific back pain disease and also the affirmation of all exercises and supervision on the tests present in this study were carried out by a physiotherapist in Rehabilitation Department of Isfahan University. The inclusion criteria of the research included persistence of symptoms for at least three months, the willingness and consent of the individual to take part in the study, suitability of exercises for the individual based on the clinical evaluation and no history of lumbar spinal cord injury or inflammation in the muscle disk, and lack of severe pains in the low back region. The exclusion criteria of the study included "presence of serious and severe injuries in the lumbar back or pectoral spine, existence of other back disorders like spondylosis or spondylolisthesis history of surgery in the low back region, presence of defect or neurologic problems, psychologic disorders, and specific pathologies of lumbar spine.

After choosing the subjects and positioning them randomly and equally in two groups (experimental and control), the subjects of the experimental group performed core stabilizing exercises in a six-week program with rubber Terra bands (green-colored and confirmed by the physiotherapist). At first, core stabilizing trainings started without rubber bands, and after two weeks the core stabilizing exercises continued with rubber bands. In this study, green rubber bands with medium endurance were used where the duration of each exercise varied within 3-10 seconds proportionate to the muscle strength of each individual. These trainings were carried out during 6 weeks and three sessions per week every other day.

Visual pain scale (VAS) was used to measure pain, including a horizontal bar and with the length of 100 mm (10 cm). One end of this bar is zero meaning no pain while the other end is 10 suggesting the most severe pain. The patients were asked to report the amount of pain felt at that moment while looking at the above-mentioned continuum. This scale is widely used in the studies for examining the magnitude of pain. Its internal reliability has been reported as ICC=0.91 (22, 23).

Oswestry's Functional Disability Questionnaire (OFDQ) was used to measure functional disability of the subjects (22). The questionnaire consisted of 10 sections with 6 choices capturing the performance of individuals in daily activities. Each section grades the extent of disability from 0 (agreeable performance without feeling pain) to 10 (disability in performing the activities due to severe pain). Thus, obtaining a higher score reflects presence of higher disability performance. Choice A is (zero) while other choices have two scores. In sum, the score of each section is 10 and the total disability index is evaluated from zero to 100. Meanwhile, there are also two methods for interpreting the obtained results: A) The sum of scores is regarded as the extent of disability and B) the ranking

Table 1. General Statistical Data of Demographic Characteristics of Subjects

Factor	Group	Mean ± SD	t-value	***P***-value
Age	Experimental	27.45±3.11	0.29	0.27
	Control	26.50±2.02		
Height	Experimental	154.64±25.11	0.42	0.31
	Control	164.20±4.66		
Weight	Experimental	68.18±33.43	0.18	0.89
	Control	59.90±10.07		

Table 2. Descriptive Statistics and Total Results of Analysis of Variance or the Energy Expenditure (M±SD)

Factor	Group	Pre-Test	Post-Test	***P***-value
Energy Expenditure	Exercise	0.31 ± 0.089	0.22 ± 0.11	0.29
	Control	0.35 ± 0.09	0.34 ± 0.2	

Table 3. Descriptive Statistics and Total Results of Variance analysis for Static Balance with Closed Eyes (Millimeter) (M±SD)

Factor	Group	Pre-Test	Post-Test	***P***-value
COP Displacement in ML Plane	Exercise	21.27 ± 6.61	17.01 ± 13.09	0.51
	Control	20.18 ± 8.45	19.72 ± 6.11	
COP Displacement in AP Plane	Exercise	33.25 ± 15.19	26.74 ± 17.81	0.31
	Control	33.81 ± 14.98	36.48 ± 13.03	

Table 4. Descriptive Statistics and the Total Results of Variance for Statistic Balance with Open Eyes (Millimeter) (M±SD)

Factor	Group	Pre-Test	Post-Test	***P***-value
COP Displacement in ML Plane	Exercise	20.27 ± 10.72	17.20 ± 18.89	0.69
	Control	19.66 ± 6.76	20.20 ± 8.63	
COP Displacement in AP Plane	Exercise	35.05 ± 15.92	32.16 ± 11.82	0.53
	Control	28.12 ± 3.48	29.11 ± 88.68	

percentage is as follows: 0 to 20% is mild disability, 20 to 40% represents medium disability, 40 to 60% shows severe disability, 60 to 80% is very severe disability, and 80 to 100% are scored in patients who cannot walk or are hospitalized (22). The internal reliability of this questionnaire has been reported as ICC=0.85 (24).

A force plate made in Switzerland was used to measure static balance. In this test, the subjects were asked to stand for 60 seconds on the force plate (Kastler 50×60 square centimeters) without no extra movements. Situational fluctuations of the individuals in both open-eyed and closed-eyed states were recorded with three replications of each state. During the open-eyed tests, the individuals looked at the X mark which was installed at a distance of 2.5 meters and at the same level of the eyes on the wall. After each test, the individual stepped aside from the force plate and rested for 30 seconds on the chair before starting the next test. The orders of open-eyed and closed-eyed states were randomly chosen. The distance between the legs while standing on the force plate for every individual was considered equal to the width of shoulders of each individual through drawing the trace of foot on the force plate in all tests as fixed and unchanged. The frequency of sampling was 120 Hz (25). The static balance in opened-eyed and closed-eyed states was measured using the extent of displacement of CPO in AP and ML planes.

Energy expenditure was examined by Accurate Plus Monitor Polar Device for recording the heart beats while resting and during walking of patients with chronic mechanical back pain (validity and reliability have been reported previously (26, 27)). The walking speed was calculated by distance traversed within the time interval of 10 minutes. Heart beats while walking and resting along with the speed of walking are the variables that have been used to evaluate energy expenditure. In the formula below, strike is converted into beats:

Equation 1. Energy Expenditure

$$\frac{\text{Heart beat while walking} - \text{Heart rate during rest}\,\frac{\text{Strike}}{minutes}}{speed\ while\ walking\ \frac{\text{M}}{Minutes}} = \text{PCI}\,\frac{\text{Strike}}{M}$$

Descriptive statistics (mean and standard deviation) and inferential statistics (ANCOVA) were used to interpret results in SPSS version 22. Significance level was $p<0.05$.

In order to observe the ethical issues of the research, the research process and its objectives were first explained to the patients and written consent was received from the participants.

Results

The mean and standard deviation of demographic data are reported in Table 1. There were no significant differences in demographic characteristics of subjects.

Table 2 presents the effect of exercise on the oxygen consumed in the control and experimental groups; the results of test box revealed lack of a significant difference in the covariance matrices of dependent variables in the groups. Further, Leven's test indicated that the variance error of dependent variables was equal among the groups. Finally, factorial analysis showed that exercise did not have any significant effect on the amount of oxygen consumed in the control and experimental groups and interaction effect in all conditions.

The variable of VAS decreased to 6.4 units significantly after the exercise program in the exercise group while this variable increased to 9.6 unit in the control group. The results also showed that exercise had no significant effect on balance in the eye open and closed states both in AP direction (P=0.74) and ML direction (P=0.91).

Table 3 provides the magnitude of balance in the anteroposterior and interior-exterior directions with closed eyes and after the training program. The results of test-box showed lack of significant difference in covariance matrices of dependent variables among the groups. Further, the closeness of the eyes did not have any significant effect either on the balance of individuals from the anteroposterior and interior-exterior directions.

Table 4 reports the extent of static balance in the anteroposterior and internal external directions with open eyes before and after the training program. The results of box revealed lack of any significant difference in the covariance matrices of dependent variables between the groups. Further, the openness of eyes did not have any significant effect either on the balance of individuals in anteroposterior and interior exterior directions.

Discussion

The aim of the present study was to investigate the effect of 6 weeks of core stability trainings (CST) with Thera-band on energy expenditure, static balance, pain severity, and functional disability in females with mechanical LBP.

The results revealed that CST could reduce the pain and functional disability of the experimental group. Also, the results showed that core stability trainings mitigated the pain and functional disability in the experimental group which is consistent with the results of other studies. Ramsi *et al.* examined the effect of core exercises on pain and function of non-specific chronic low back pain patients. They found that core exercises reduced the performance and functional disability in these patients (30). Standaert and Goldby also evaluated the effect of musculoskeletal physical therapy on chronic low back pain. They observed that severity of pain and disability diminished (31, 32). Arokoski *et al.*, who examined the activity of para-spinal lumbar and abdominal muscles, measured functional disability using the disability score index. They found that the disability index did not change, which is in contrast with the results of this study (33). The reason for this discrepancy is that firstly in Arokoski study, the subjects were asked to do the exercises at home. Further, the exercises were not specialized, and the popular exercise group was used for lumbar muscles (33). Note that, in patients with low back pain, the trunk control is impaired and deep muscle activity is reduced, due to lack of muscle use, tone reduction, atrophy, decreased strength, muscle tightness, as well as stiffness of the ligaments and joints (33, 34).

Samadipour *et al.* also concluded that changes in pain intensity and improvement in patients' function were significant in the stabilizing group within a shorter time and from the first week afterwards, which is consistent with the results of this study (35).

The present study found no statistically significant effect of core stability training with Thera-band on energy expenditure in chronic mechanical back pain. Although there are many studies on the walking performance of patients with chronic low back pain in relation to kinetic and kinematic parameters, no studies have been conducted on the effect of training on energy expenditure of these patients during walking. Research has shown that energy expenditure in these patients is more than the typical physiologic use index, which can be discussed in two aspects: firstly, the heart rate of patients with chronic non-specific low back pain fluctuated at rest compared with normal people during the course of the procedure. The walking speed of these patients is also significantly reduced. These people tend to be less active to prevent or mitigate pain, where this low activity makes it difficult for the heart muscle to deliver adequate oxygen during walking. That is why their heart beat rate rises during walking whereby muscles need oxygen for the ability to move. Second, it seems that the increasing energy expenditure in patients with non-specific chronic low back pain tends to slow down their walking. The research results of Ryan (36), Van Weering (37), and Astflack (38) were not in line with this finding.

The results of this study also revealed that 6 weeks of core stability training with Thera band did not affect the results regarding static balance with open and closed eyes on the anteroposterior and outer anterior planes in patients with chronic mechanical low back pain. Similarly, Salehi *et al.*

observed no significant effect of six weeks of static and dynamic core stabilization training on the pain and balance of women with non-specific chronic low back pain (39). Yaghmaie *et al.* in a study entitled "the effect of six weeks of core stability training on the balance, pain, and function of women with chronic low back pain", found a better balance in their results, which did not match this part of the study (40). The possible reason for the inconsistency of the results could be due to the number of subjects or the duration of exercise time, as well as uncontrollable limitations of subjects, such as their lifestyle.

Hoppes *et al.* (41), Trampas *et al.* (42), Desai *et al.* (43), Muthukrishnan *et al.* (44), and Brech *et al.* (45) all concluded a significant difference in balance score after applying various core stability trainings. Regarding the number of research on the effect of training programs on the balance of patients with low back pain and the lack of significant effect of exercises with Thera-band on the balance of patients with low back pain, this study suggests that future research should be conducted by increasing the number of subjects and prolonging the duration of the training program with Thera band to observe the significant effect of these exercises on balance.

The results of this study suggested that core stabilizing training can improve chronic low back pain without any medication or electrical intervention. Indeed, a functional static and dynamic resistance training exercise influences the core muscles of the body and develops the sensory-motor part of the muscles of the trunk and the organs. Exercise with Thera band seems to be able to cover the intended therapies for low back pain.

Conclusion

The core stability exercises significantly reduced the pain, severity, and functional disability of people with low back pain. Since these exercises have reduced the pain and disability of chronic mechanical back pain patients, chiropractic clinics, physicians, and physiotherapists can use inexpensive and cost-effective exercises with Thera band in the recovery program for patients with low back pain.

Limitations

The lack of full control over the physical activity of the participants in the research has been a limitation of this research.

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Authors' contributions:

All authors made substantial contributions to conception, design, acquisition, analysis and interpretation of data.

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