Comparison of balance and stabilizing trainings on balance indices in patients suffering from nonspecific chronic low back pain

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Abstract

The objective of the current research was to compare the impact of balance and stabilizing trainings on balance indices in patients with nonspecific chronic low back pain. In this randomized, controlled, single-blinded clinical trial, 20 people suffering from nonspecific chronic low back pain were randomly assigned to two groups of balance and stabilizing trainings. Trainings of both groups were performed for 6 weeks and four sessions per week. The overall, lateral, and anterior-posterior stability indices, pain, and disability were measured using Biodex balance system, visual analog scale, and Oswestry scale, before and after treatment, respectively. Paired *t*-test and independent *t*-test were used for analyzing the data. In the balance group, the pain severity was changed from 6.33 ± 1.63 to 4.33 ± 2.6 (P = 0.005) and dynamic anterior-posterior stability index in the standing position on left leg with closing eyes was changed from 5.56 ± 2.25 to 3.45 ± 1. 57 (P = 0.03). In the stabilizing group, pain severity was changed from 4. 16 ± 1.47 to 1.33 ± 0.81 (P = 0.0001) and disability index was changed from 17.33 ± 5.60 to 5.33 ± 3.93 (P = 0.01). Reduction in pain and disability in the stabilizing group and increase in two balance indices were significant in the balance training group compared to those in other group ($P < 0.05$). Research findings revealed that the impact of stabilizing trainings was significant in reducing pain and disability compared to that in balance trainings.

Key words: Balance trainings, Biodex, low back pain, stabilizing trainings

INTRODUCTION

Low back pain is one of the common problems, which 80% of people experience it at least once during their life.[1,2] The prevalence of low back pain in the general population and working population was reported to be between 14.4% and 84.1%, respectively, in the review study.[3] Depending on the factors involved in its development, low back pain is divided into two specific and nonspecific classes. Low back pain symptoms are diverse, and the pain might have burning nature or seen in the form of cramp or weakness in the legs and thighs.[4]

Balance controlling and maintaining at static and dynamic positions is an essential, to perform, daily physical activity of people. Thus, the index of postural control and maintaining the balance is regarded nowadays as one of the important parameters in evaluating people suffering

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from musculoskeletal disorders.[5] The pain associated with postural disorder is common, and the low back pain is the most common complaint of these patients.[6] Damage to receptors in lumbar and trunk part of body affects the postural control mechanisms.[7]

There are various methods to treat low back pain, such as resting, drug, and therapeutic trainings.[8,9] McGill argued that spinal stability needs to be increased in patients suffering from low back pain.[10] Stabilizing trainings stress more on small, deep, and posterior muscles of the spinal cords, especially multifidus and transverse abdominal muscles. These trainings try to maintain and stabilize muscles' correct position by retraining and increasing the endurance of the muscles. They also try to reduce the pain and improve the function by stabilizing spinal cord.[11] Static and dynamic balance trainings include activities performed by a person to cope with his or her balance limitations.[12] Balance trainings need motor response at the level of brainstem. Controlling the appropriate movement requires reflexive responses at the level of spinal cord, positional responses and automatic balance at the level of brainstem, and conscious responses at the cortex level.[13] Ruhe *et al*. found that increased pain increases the postural oscillations in patients suffering from nonspecific chronic low back pain.[7,14] Mientjes and Frank also indicated that postural oscillations were increased in people suffering from chronic low back pain in the interior and exterior directions.[15]

High prevalence of chronic low back pain causes many physical, psychological, social, and economic problems for patients and society.[16] Balanced disorder plays a vital role in people suffering from chronic nonspecific low back pain.[7] Despite much research on the treatment of patients with nonspecific chronic low back pain, no consensus has been reached so far on the impact of a special type of treatment. Accordingly, we examined the role of low back deep muscles in providing the balance for people suffering from low back pain in the present research. Another point in the case of these muscles is the neural aspect of balance control. Given that both of these factors can be regarded as a factor involved in back pain, we decided to find which of these trainings could improve the neural aspect of back pain. Hence, the objective of the current research was to compare the impact of balance and stabilizing trainings on balance indices in patients suffering from nonspecific chronic low back pain.

MATERIALS AND METHODS

Design

In this randomized, controlled, single-blinded clinical trial, 20 patients suffering from nonspecific chronic low back pain were randomly divided into two groups of stabilizing trainings (n = 10) and balance trainings (n = 10), using the sequence of random numbers. A physiotherapist was responsible to evaluate the patients, to assess the outcomes, and to analyze the information that was unaware of the research groups. The warm-up trainings were performed for both groups before specific trainings.[17,18] Balance trainings were performed for 6 weeks and four sessions per week.[19,20] The stabilizing group trainings were considered at five levels, designed from easy level to difficult level. At the end of each level of training, the participants need to reach the ability to perform each training 10 times and 10 s at low intensity to enter the next level of training.[17] The research variables were measured and recorded before and after the end of treatment.

Participation and screening

In this research, 20 patients suffering from nonspecific chronic low back pain were selected using a convenient sampling method. Inclusion criteria of research included nonspecific pain of low back with or without spreading to leg, lasted at least 3 months since its onset, not forbidden for training, and age between 18 and 50 years.[21] Exclusion criteria of research included history of inflammatory arthritis, surgery of spinal cord, neurological disease, vestibular disorders or neurological disorder, disorders in hip joints, knee, ankle, and legs, history of headache or noncorrected visual impairment, deformity, lesion seen in the spinal cord, suspicious or confirmed pathologies in the spinal cord, confirmed or suspected pregnancy, disorders in nerve root affecting the strength of the reflexive muscles, history of vertebrae fracture, noncompleting the evaluation, and therapeutic sessions by a patient.[7,15,19] The eligible patients were included to research after signing consent form. This research was approved by the Rehabilitation Department Scientific Committee in Zahedan University of Medical Sciences. All rights of the investigated participants were preserved at all stages of research.

Data collection

To ensure meeting the inclusion and exclusion criteria, participants were interviewed. Meter with precision of centimeter was used to measure the height of participants, digital scale was used to measure body weight of participants (to calculate body mass index [BMI]), the Oswestry pain and disability questionnaire[18] was used to measure the pain and function, and Biodex balance system was used to measure the balance indices.

Randomization

Random dividing of participants into two groups was performed by a clinical physiotherapist using random number sequence.

Measurement of balance indices

Overall, anteroposterior, and lateral stability indices were measured using Biodex balance system (Biodex Medical System Inc., NY, USA, SW45-30D-E6N Model, SD 950-304).[22] Degree of device stiffness in the standing position on one and two legs and opening and closing eyes was selected in both static and dynamic mode. It means that the stiffness degree of plate in the first test was static, and it was dynamic in the second test, in which the stiffness degree of the device plate was set on degree 8.[23,24] Before performing the main test and before intervention, a pretest was performed so that people needs to be familiar with the device and the procedure. Static and dynamic postural stability test was performed in the positions of standing on two legs with opening and closing eyes and standing on one leg (right and left) with opening and closing eyes. Each test included three trials, each trial lasted for 20 s, and 10-s resting time was given between each trial. Five-minute interval was considered between each test.[25,26]

Intervention

Balance trainings with Biodex balance system were given for participants of this group. Each session began with a few minutes of slow walking and a progressive program of stretching the muscles around thigh, knee, and ankle and with the increasing number of repetitions and stretching time. Balance trainings included four trainings of postural stability trainings, stability range, weight transferring, and random control, which training difficulty was changed by changing the stiffness of the Biodex Balance System. This change included static mode and dynamic mode, which varied from stiffness degree of 8–4.[20,23,24] Stabilizing trainings were progressively performed in five steps. In the first step, abdomen drawing in the maneuver was trained for a patient. After that patient could perform this maneuver, he/she entered the next step. In this step, co-contraction of the transverse abdominal muscles and multifidus muscles at different positions of sitting, standing, procumbent, and supine was trained for the patient. At the end of this step, the patient needed to be able to repeat the contraction of the muscles 10 times and maintain each contraction for 10 s. Then, the patient entered the third step. In this step, the patient was asked to move his/her limbs, while he/she has maintained the contraction of the transverse abdominal muscles and the multifidus muscles. In the fourth step, trainings were progressed toward functional maintaining activities and the activities exacerbated the symptoms already. The patient was asked to maintain these muscles active and regularly during everyday activities, especially in activities, in which he/she was expected to experience the pain and disability in those conditions. In the fifth step, after that patient could completely pass through the previous steps, he/she performed aerobic activities of walking and balance such as maintaining the contraction while he/she is placed on the unstable surfaces.[18]

Sample size

The sample size was determined according to the pilot study. For this purpose, 10 patients were selected, they were randomly assigned into two groups, and the main stage of research was performed on them. According to the mean and standard deviation obtained from these two groups, the number of samples required for the main research was estimated with 95% confidence and 90% test power.

Statistical analysis

SPSS 17 software (SPSS Inc, Chicago, Illinois) was used to analyze the data. Independent *t*-test and paired *t*-test were used to compare the before and after intergroup and intragroup treatment findings. Significance level (α) was considered to be <5% for statistical comparisons.

RESULTS

The demographic characteristics of the research participants including age, height, weight, and BMI are illustrated in Table 1. The sample size was estimated to be 20 people in two groups (each group containing 10 participants) in the pilot study.

Within-group comparison

In the balance training group, the mean of pain severity was reduced and the mean of the static anterior-posterior stability index in the standing position on two legs with closing eyes, the dynamic lateral stability index in the standing position on two legs with opening eyes, dynamic overall stability index in the standing position on the right leg with opening eyes, dynamic overall stability index in the standing position on two feet legs with closing eyes, dynamic anterior-posterior index in the standing position on two legs with closing eyes, and dynamic anterior-posterior stability index in the standing position on left leg with closing eye increased ($P = 0.005$). In the stabilizing training group, the mean of pain severity and disability was reduced and the mean of the static anterior-posterior stability index in the standing position on two legs with closing eyes, dynamic lateral stability index in the standing position on two legs with opening eyes, dynamic overall stability in the standing position on the right leg with opening eyes, dynamic overall stability index in the standing position on left leg with closing eyes, and dynamic anterior-posterior index in the standing position on left leg with closing eyes increased ($P = 0.005$) [Table 2].

Table 1: Comparing the demographic characteristics of two groups

Variable	Balance trainings group (n=10)	Stabilizing trainings group (n=10)	*P*
Age (year)	37.33±9.79*	26.00±5.58*	0.03**
Height (cm)	179.00±4.19	167.33±7.99	0.01
Weight (kg)	77.00±10.65	70.66±13.90	0.39
BMI (kg/m^2)	23.94±2.30	25.05±3.41	0.52

*Values are mean±SD, **Statistical different at P<0.05. SD: Standard deviation, BMI: Body mass index

Table 2: Comparing the mean of data before and after treatment of overall, anterior-posterior, and lateral stability indices, pain severity, and disability in two groups and comparing the findings of after treatment between the two groups

Variable	balance trainings group (*n*=10)			Stabilizing trainings group (*n*=10)			Comparing the findings after treatment
	Before treatment	After treatment	*P*	Before treatment	After treatment	*P*	*P*
Pain severity	6.33±1.63*	4.33±2.06*	0.005**	4.16±1.47*	1.33±0.81*	0.00**	0.008**
Disability	29.33±8.26	22.66±14.51	0.22	17.33±5.60	5.33±3.93	0.01	0.01
SOSIBEO	0.56±0.37	0.23±0.081	0.07	0.35±0.16	0.25±0.10	0.11	0.76
SAPSIBEO	0.36±0.27	0.18±0.70	0.11	0.26±0.13	0.20±0.08	0.17	0.73
SMLSIBEO	0.35±0.30	0.10±0.00	0.10	0.13±0.10	0.13±0.10	0.99	0.44
SOSIRUSEO	1.13±0.51	0.88±0.20	0.20	0.71±0.17	0.65±0.13	0.23	0.04
SAPSIRUSEO	0.58±0.17	0.60±0.12	0.84	0.48±0.14	0.40±0.12	0.13	0.02
SMLSIRUSEO	0.83±0.46	0.55±0.16	0.10	0.38±0.13	0.38±0.07	0.95	0.04
SOSILUSEO	1.45±0.66	1.05±0.43	0.05	0.80±0.26	0.80±0.25	0.99	0.25
SAPSILUSEO	1.01±0.66	0.68±0.36	0.14	0.63±0.29	0.60±0.23	0.79	0.64
SMLSILUSEO	0.81±0.36	0.64±0.25	0.23	0.35±0.08	0.40±0.12	0.36	0.05
SOSIBEC	1.10±0.56	0.76±0.37	0.13	0.93±0.30	0.83±0.43	0.47	0.78
SAPSIBEC	0.95±0.31	0.65±0.37	0.02	0.78±0.23	0.58±0.19	0.04	0.70
SMLSIBEC	0.80±0.57	0.28±0.21	0.09	0.38±0.18	0.40±0.48	0.91	0.59
SOSIRUSEC	3.91±1.32	3.76±2.40	0.85	3.81±1.02	2.53±0.60	0.06	0.25
SAPSIRUSEC	3.11±1.15	3.30±2.35	0.76	3.25±1.13	1.93±0.51	0.05	0.19
SMLSIRUSEC	1.80±0.83	1.28±0.58	0.28	1.35±0.15	1.23±0.40	0.05	0.19
SOSILUSEC	3.83±1.76	3.53±0.58	0.65	3.85±1.41	2.71±0.85	0.09	0.25
SAPSILUSEC	2.90±1.62	2.93±1.30	0.95	3.28±1.60	208±1.00	0.10	0.23
SMLSILUSEC	1.93±1.10	1.53±0.70	0.10	1.45±0.27	1.31±0.30	0.22	0.50
DOSIBEO	1.65±0.62	1.06±0.50	0.07	1.13±0.45	1.31±0.37	0.56	0.35
DAPSIBEO	1.16±0.52	0.83±0.45	0.26	0.71±0.29	1.01±0.48	0.34	0.51
DMLSIBEO	0.93±0.37	0.46±0.19	0.00	0.73±0.30	0.61±0.18	0.47	0.20
DOSIRUSEO	2.40±1.05	1.75±0.78	0.03	1.76±0.62	1.60±0.31	0.53	0.67
DAPSIRUSEO	1.66±0.85	1.13±0.60	0.03	1.23±0.38	1.08±0.22	0.49	0.85
DMLSIRUSEO	1.38±0.50	1.05±0.43	0.10	1.00±0.47	0.96±0.47	0.89	0.66
DOSILUSEO	3.71±3.58	2.35±1.17	0.38	2.31±0.76	1.71±0.80	0.34	0.30
DAPSILUSEO	1.65±1.00	1.50±0.37	0.74	1.40±0.44	1.33±0.65	0.87	0.60
DMLSILUSEO	3.01±3.43	1.48±1.21	0.31	1.60±0.66	0.88±0.50	0.14	0.28
DOSIBEC	6.09±3.96	3.33±3.09	0.03	4.76±2.35	3.38±1.49	0.12	0.97
DAPSIBEC	4.06±2.46	2.13±1.97	0.02	3.23±1.65	2.35±0.85	0.27	0.81
DMLSIBEC	3.63±2.49	2.10±1.96	0.05	2.83±1.33	1.95±1.12	0.02	0.87
DOSIRUSEC	5.78±2.662	3.71±2.71	0.11	5.50±1.39	4.31±20.8	0.15	0.67
DAPSIRUSEC	4.58±2.54	3.66±1.78	0.38	4.51±0.97	3.00±1.14	0.01	0.45
DMLSIRUSEC	2.63±1.12	1.80±0.95	0.05	2.21±0.99	2.46±1.70	0.74	0.42
DOSILUSEC	7.25±3.75	4.15±1.99	0.05	5.48±1.21	3.76±1.53	0.02	0.71
DAPSILUSEC	5.56±2.25	3.45±1.57	0.03	4.45±1.21	2.80±1.08	0.02	0.42
DMLSILUSEC	3.61±3.18	1.65±0.96	0.11	2.21±0.69	1.88±0.97	0.54	0.68

*Values are mean±SD, **Statistical different at $P<0.05$. SD: Standard deviation, SOSISBEO: Static overall stability index, bilateral standing, eyes opening, SAPSIBEO: Static anterior-posterior stability index, bilateral standing, eyes opening, SMLSIBEO: Static mediolateral stability index, bilateral standing, eyes opening, SOSIRUSEO: Static overall stability index, right unilateral standing, eyes opening, SAPSIRUSEO: Static anterior-posterior stability index, right unilateral standing, eyes opening, SMLSIRUSEO: Static mediolateral stability index, right unilateral standing, eyes opening, SOSILUSEO: Static overall stability index, left unilateral standing, eyes opening, SAPSILUSEO: Static anterior-posterior stability index, left unilateral standing, eyes opening, SMLSILUSEO: Static mediolateral stability index, left unilateral standing, eyes opening, SOSIBEC: Static overall stability index, bilateral standing, eyes closing, SAPSIBEC: Static anterior-posterior stability index, bilateral standing, eyes closing, SMLSIBEC: Static mediolateral stability index, bilateral standing, eyes closing, SOSIRUSEC: Static overall stability index, right unilateral standing, eyes closing, SAPSIRUSEC: Static anterior-posterior stability index, right unilateral standing, eyes closing, SMLSIRUSEC: Static mediolateral stability index, right unilateral standing, eyes closing, SOSILUSEC: Static Overall stability index, left unilateral standing, eyes closing, SAPSILUSEC: Static anterior-posterior stability index, left unilateral standing, eyes closing, SMLSILUSEC: Static mediolateral stability index, left unilateral standing, eyes closing, DOSISBEO: Dynamic overall stability index, bilateral standing, eyes opening, DAPSIBEO: Dynamic anterior-posterior stability index, bilateral standing, eyes opening, DMLSIBEO: Dynamic mediolateral stability index, bilateral standing, eyes opening, DOSIRUSEO: Dynamic overall stability index, right unilateral standing, eyes opening, DAPSIRUSEO: Dynamic anterior-posterior stability index, right unilateral standing, eyes opening, DMLSIRUSEO: Dynamic mediolateral stability index, right unilateral standing, eyes opening, DOSILUSEO: Dynamic overall stability index, left unilateral standing, eyes opening, DAPSILUSEO: Dynamic anterior-posterior stability index, left unilateral standing, eyes opening, DMLSILUSEO: Dynamic mediolateral stability index, left unilateral standing, eyes opening, DOSIBEC: Dynamic overall stability index, bilateral standing, eyes closing, DAPSIBEC: Dynamic anterior-posterior stability index, bilateral standing, eyes closing, DMLSIBEC: Dynamic mediolateral stability index, bilateral standing, eyes closing, DOSIRUSEC: Dynamic overall stability index, right unilateral standing, eyes closing, DAPSIRUSEC: Dynamic anterior-posterior stability index, right unilateral standing, eyes closing, DMLSIRUSEC: Dynamic mediolateral stability index, right unilateral standing, eyes closing, DOSILUSEC: Dynamic overall stability index, left unilateral standing, eyes closing, DAPSILUSEC: Dynamic anterior-posterior stability index, left unilateral standing, eyes closing, DMLSILUSEC: Dynamic mediolateral stability index, left unilateral standing, eyes closing

Between-group comparisons

Findings revealed no difference between the two groups in terms of the variables studied and the patients were matched in two groups ($P > 0.05$). Reduction in the mean of pain severity and disability and increase in the static anterior-posterior index in the standing position on the right leg with opening eyes were seen more in the stabilizing training group, compared to that in balance group ($P < 0.05$). Increase in the static overall stability index in the standing position on the right leg with opening eyes and the dynamic lateral stability index in the standing position on the right leg with opening eyes was higher in the balance training group compared to that in stabilizing training group ($P < 0.05$). No difference was found between the findings of after the treatment in two groups in terms of other variables studied ($P > 0.05$) [Table 2].

DISCUSSION

Research findings support the first hypothesis of research, which states that balance trainings decrease pain and increase the postural stability and stabilizing trainings increase some stability indices and reduce pain disability. However, unlike the second hypothesis of the research, no difference was found between two treatment methods in terms of majority of postural stability indices.

Findings of the research suggest some points. First, reduction in the pain and disability after stabilizing trainings was more than its reduction after balance trainings. Second, the impact of one type of training on other indices of the research is lower compared to that of other trainings. Among 36 indices studied, two stability indices in the balance group and one stability index in stabilizing group showed difference with other group. However, it is required to refer to two points here to conclude in this regard: postural stability and control of lumbar movements. The motor control is a varying process, even for simple tasks, examined and modified based on analyzing the sensory inputs and motor orders and the movement created. Deep sensory information, resulting from joint and muscle receptors, plays a vital role in this process.[14] While all muscles are involved in controlling the movements and stability of spinal cord, deep muscles play a vital role in controlling the intervertebral movements since they control the spinal cord in dynamic situations. In patients suffering from low back pain, the strategy for controlling the trunk muscles is changed and disrupted (delayed activity and reduced tonic activity), and these muscles become atrophic. In line with current research, Akbari and Jahanshahi Javaran found that stabilizing trainings were more effective than common trainings in control of pain and improving the function in patients with spondylolysis and spondylolisthesis.[4] In addition, in line with the current research, Hides *et al*. found that stabilizing trainings had a higher impact than standard medical cares on reducing the pain and improving cross-sectional area of multifidus muscle among the patients suffering from low back pain without instability symptoms.[27] Moreover, Costa *et al*. researched to examine the impact of motor control trainings in patients suffering from nonspecific chronic low back pain, and they concluded that these trainings increased the cross-sectional area of multifidus muscle and thus reduced the pain of the patients.[28]

Postural stability means one's ability in maintaining his/her position, especially body mass center in specific spatial ranges, known as limits of stability. Stability limits refer to ranges of a spatial level, in which one can maintain his/her position without changing the level of reliance. These ranges are not constant and they depend on different aspects of environment, biomechanics, and work of people. Stability means creating balance among the forces creating and disturbing the stability.[29] Information of each of the sensory tools is integrated with that of other sensory tools to cause appropriate motor response. Dysfunction in visual, somatosensory, and vestibular systems leads to postural dysfunction.[30]

Now, we explain the most important points of the research findings in the documented way. Previous research suggests the impact of stabilizing trainings on improving the pain and function in people suffering from chronic low back pain, as this research confirmed it. In addition, with regard to impact of balance trainings on balance indices, most of the studies, unlike the current research, suggest stability improvement. It seems that the type of trainings used in this research could cause such difference in results. Trainings stabilizing the spinal cord can be useful in patients suffering from low back pain without providing a specific reason, based on a randomized controlled trial, and only based on this hypothesis that drop in the activity of trunk muscles leads to instability symptoms.[31] There are inconsistent views between our study and some other studies on the impact of stabilizing trainings. Results of some studies are in line with those of the present study, while results of some other studies are in contrast with those of the present study.[17] There are other views on the local stabilizing muscles of the spinal cord, which could justify using these trainings in pain without symptoms of instability. It might be a reasonable justification for more reduction of pain in patients of stabilizing trainings group in our study. The tonic fibers of these muscles have an anti-gravity postural supporting role. These fibers are influenced by nonusing, reflexive control, and pain. The nature of this dysfunction is vital in determining the type of training to restore stability or supporting role.[32] Accordingly and based on other reasons that will be stated later, trainings of these muscles should be effective in reducing the low back pain. Thus, the main objective of stabilizing trainings is the restoration of deep muscle natural control, reducing the activity of superficial muscles, and maintaining the natural control. The key point in this attitude is retraining deep muscles of trunk separate from the superficial muscular system and before trainings of coordinating the deep and superficial muscles.[31] The attitude of movement control suggests that simple, functional training alone does not lead into restoration of trunk muscle coordination. Supported by several studies, it suggests that after recovery and returning to normal function, trunk muscles still adapt to pain.[33] Moreover, new information indicates that the coordination of abdominal muscles is restored only by trunk-specific trainings[34] and lack of treating the musculoskeletal disorder would be associated with pain recurrence.[27]

CONCLUSION

Findings of this research revealed no significant difference between balance trainings and stabilizing trainings in terms of impact of postural stability indices measured while stabilizing trainings were more effective in reducing pain and disability compared to balance trainings.

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Conflicts of interest

There are no conflicts of interest.

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