

Original Article

The Effects of Running in Place on Healthy Adults' Lumbar Stability

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Abstract. [Purpose] The purpose of this study was to examine the effects of running in place while using the abdominal drawing-in method on healthy adults' lumbar stability. [Subjects] A total of 30 subjects were divided into a training group of 15 subjects and a control group of 15 subjects. [Methods] The training group ran in place using the abdominal drawing-in method for 30 minutes per session, three sessions per week, for a total of six weeks. For both the training group and the control group, static lumbar stability (SLS) and dynamic lumbar stability (DLS) were measured before and after the experiment using a pressure biofeedback unit. [Results] Pre- and post-intervention measurements were compared within the training group and the control group. According to the results, the training group showed statistically significant differences in DLS. [Conclusion] Running in place, which can be performed easily regardless of time and location, can be recommended as an exercise that will improve the dynamic lumbar stability of students or office workers.

Key words: Running in place, Lumbar stability, Pressure biofeedback unit

(This article was submitted Nov. 6, 2013, and was accepted Jan. 7, 2014)

INTRODUCTION

Lumbar stability enables movements of the limbs by maintaining the vertebrae properly during postural changes and in loaded states¹⁾. We reviewed previous studies regarding lumbar stability, and noted that they primarily investigated whether training of the deep muscles, such as the transversus abdominis muscle and the multifidus muscles, using diverse exercise apparatuses and methods such as mats, balls, dumbbells, and balance plates in prone or supine positions could stabilize the vertebrae²⁾. Due to the development of industrial society, individuals today exhibit weakened abdominal muscle strength, poor postures, and body imbalance, because of increasingly sedentary lives and lack of exercise³⁾. In particular, previous studies have reported that excessive biomechanical burdens due to sedentary lifestyles lead to chronic weakening phenomena, such as abdominal muscle atrophy, declining muscle strength, and vertebral joint instability, thereby causing pain in the regions around the lumbar vertebrae, reducing endurance, and restricting the range of joint motion⁴⁾. These conditions may eventually even cause damage to the vertebrae and physical disabilities⁵⁾. To find out how to improve reduced lumbar stability resulting from modern people's

living habits, this study asked participants to run in place with the transversus abdominis muscle and the multifidus muscles in contracted states.

Exercises similar to running in place include plyometric training, circuit training, and core stabilization. Plyometric training is a method widely used to improve power, explosive motions are performed while working muscles are swiftly switched from extension to flexion⁶⁾. Circuit training involves arranging many exercises or motions selected in advance in order to continuously train many muscle groups in turn, following the circuit order, without rest between each exercise⁷⁾. Core stabilization exercises can maximize coordination between and within segments to promote the crossing of the lumbar vertebrae and the sacral vertebrae in the human body. These exercises induce continuous segmental movements using mats, slings, Swiss balls, etc. to develop an integrated system ranging from the tip of the toes to the trunk, eventually resulting in muscle strength increases⁸⁾. These exercises commonly train the core muscles used to maintain the stability of the vertebrae, improving the muscle strength and flexibility of the trunk⁹⁾. However, plyometric training, circuit training, and core stabilization exercises require systematic programs implemented under expert guidance. Moreover, they require appropriate equipment and a proper location. Because of these drawbacks, these exercises are not suitable for use by students or office workers trying to improve their trunk stability. On the other hand, running in place can be done easily, regardless of time or place, and is expected to stabilize the trunk by improving the stability and strength of the core region, and thus the abdominal muscles. Therefore, in this research, the subjects performed a running in place exercise, which can

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be performed easily without requiring tools or apparatus or being restricted by location, for six weeks. This was done with a view to improving lumbar stability and examining the changes in the subjects' static lumbar stability (SLS) and dynamic lumbar stability (DLS).

SUBJECTS AND METHODS

Thirty healthy men and women were selected and randomly assigned to a training group of 15 subjects (1 male, 14 female) who performed the running in place exercise, and a control group of 15 subjects (1 male, 14 female) who did not carry out this exercise. Those who had any problems in their muscles, skeleton, or nervous system; those who felt pain in their lumbar region or pelvis; and those who could not run in place due to pain in their knees or ankles were excluded from this study. All the subjects understood the purpose of this study and provided their written informed consent prior to their participation in this study in accordance with the ethical principles of the Declaration of Helsinki.

The training group had a mean age of 21.5 ± 0.3 years, a mean height of 161.5 ± 6.0 cm, and a mean weight of 51.7 ± 6.2 kg; the control group had a mean age of 22.2 ± 1.3 years, a mean height of 162.0 ± 5.5 cm, and a mean weight of 53.2 ± 5.2 kg. The χ^2 test was used to analyze the groups with regard to sex, and the independent t-test was used to analyze the groups with regard to age, height, and weight. These analyses showed no statistically significant differences ($p > 0.05$), indicating that the two groups were homogenous.

To help the subjects maintain proper positions while running in place, a 30-cm square was drawn on the floor and each subject was instructed to stand in the center of the square. Each subject was instructed to straighten his/her back, look straight ahead, pull in the chin to maintain the position of the cervical vertebrae, and contract the transversus abdominis and multifidus muscles through abdominal drawing-in to maintain the neutral position of the lumbar region and the pelvis. Each subject then placed their foot approximately 10 cm apart, bent one knee to 90° to raise it to the height of the hip joint, and bent the elbow of the arm on the other side of the raised leg to raise the arm so that the hand was at the height of the eyes. Each subject ran while crossing the arms and legs in the sagittal plane, and repeated the running a predefined number of times. During the exercise, each subject was instructed to pay attention to running in place within the limits of the square while maintaining his/her posture without swinging forward, backward, leftward, or rightward.

To set the appropriate exercise intensities for the subjects and apply gradually increasing loads, two sets were completed during the first and second weeks, and three sets were completed thereafter until the end of the sixth week. Each set was composed of 20 running in place motions followed by a rest for 15 sec, 20 running in place motions, a rest for 15 sec, 30 running in place motions, a rest for 20 sec, 30 running in place motions, a rest for 20 sec, and 30 running in place motions. A rest of three minutes was taken after each set, and one running in place motion was defined

as touching the ground once with each foot. The speed of running in place was designated as 17 motions per 10 seconds. Light stretching for five minutes was performed as a warm up before the beginning of the main exercise, and as a cool down after the main exercise. Therefore, one exercise session took 30 minutes. The exercise was performed three times per week for six weeks. The members of the control group did not perform any particular exercise and followed their normal daily lives. Like the training group, their measurements were taken twice.

To evaluate SLS, the contractile force of the transversus abdominis (TrA) was evaluated using a pressure biofeedback unit (PBU, Chattanooga Group, Australia). The PBU consists of a non-elastic inflatable bag connected to a pressure gauge. It is a simple piece of equipment which is used to record and monitor pressure changes during the movements of the lumbar/pelvic regions. The bag is 16.7×24.0 cm and can be used to measure pressure within the range of 0–200 mmHg. Excessive pressure changes during evaluation indicate that the movements of the lumbar/pelvic regions are not being controlled. To measure SLS, each subject adopted a prone position on a hard floor and the PBU was placed at the point below the subject's navel where the anterior superior iliac spines cross each other. The measurement began with a baseline pressure of 70 mmHg. The subjects pulled in their lower abdomens maximally without moving the lumbar region of the hip to reduce the pressure and maintained the same pressure for 10 sec; the change in pressure was recorded. To measure DLS, subjects performed the bent knee fall out (BKFO), as explained by Comerford and Mottram¹⁰. For this measurement, the PBU was placed vertically below the lumbar vertebrae, 2 cm below the posterior superior iliac spine in a supine position, and folded towels of the same height as the PBU were placed on both sides of the PBU in order to minimize trunk sway during movement. The measurement began with a baseline pressure of 40 mmHg. The subject performed abduction of approximately 45° in a posture in which the hip and knee of one leg were bent and the foot was placed in contact with the floor, and then returned to the initial posture; the changes in pressure during the movement were recorded. Higher SLS scores and lower DLS scores signify better lumbar stability.

The measured data were analyzed using the SPSS 12.0 KO (SPSS, Chicago, IL, USA) statistical program, and the collected data are presented as means and standard deviations. The significance of the differences between before and after the experiment in each group was tested using the paired t-test and the significance of the differences between the two groups was tested using the independent t-test. The significance level, α , was chosen as 0.05.

RESULTS

The pre- and post-intervention measurement results of the training and control groups were compared. According to the results, the training group showed statistically significant differences in DLS ($p < 0.05$), while the control group showed no statistically significant differences in SLS or DLS ($p > 0.05$) (Table 1).

Table 1. Comparison of SLS and DLS between pre-intervention and post-intervention in each group (mean±SD) (unit: mmHg)

Category	Group	Pre-intervention	Post-intervention
SLS	Training group	1.0±1.9	2.1±2.7
	Control group	0.9±2.0	1.0±2.1
DLS	Training group *	3.3±1.4	1.9±0.8
	Control group	3.2±1.8	3.0±2.0

* p<0.05, SLS; static lumbar stability, DLS; dynamic lumbar stability

The pre- and post-intervention measurement results, as well as the changes between them for the training group and the control group, were compared with each other. According to the results, the groups showed statistically significant differences in the post-intervention measurements of DLS and in the changes in DLS between the pre- and post-intervention values (p<0.05) (Table 2).

DISCUSSION

In this study, the effects of running in place while using the abdominal drawing-in method on healthy adults' lumbar stability were examined. Running in place can reduce muscle fatigue and provide loads to diverse muscles to improve the respiratory and circulatory systems, thereby simultaneously improving aerobic exercise ability and muscle strength. This exercise is expected to train the core muscles, which are muscle groups in the trunk and abdomen that maintain the stability of the vertebrae. Previous studies have reported that the abdominal drawing-in method is effective at increasing the activity of the abdominal muscles, particularly the transversus abdominis¹¹.

Exercises similar to running in place include plyometric training, circuit training, and core stabilization in which slings, Swiss balls, mats, etc. are used. Many previous studies have been conducted using these exercises. Myer¹² instructed female high school student athletes to perform plyometric training and core stabilization exercises three times per week for seven weeks to prove that these exercises were effective at improving muscle strength and neuromuscular control. Moreover, Brill⁹ suggested that core stabilization exercises could strengthen the lumbar muscles and improve stability by maintaining the balance of the vertebrae based on the contraction of the transversus abdominis. Endleman¹³ asked 18 healthy adult females and 8 healthy adult males to perform Pilates for six months, to exercise the core region intensively, and measured the thicknesses of the transversus abdominis and obliquus internus abdominis. According to the results, the TrA showed significant differences, proving that training the core region affected abdominal muscle strengthening and abdominal stabilization positively. In this study, the pre- and post-intervention measurement results of the training and control groups were compared. According to the results, the training group showed statistically significant differences in DLS, while the control group did not show any statistically significant

Table 2. Comparison of SLS and DLS between the training and Control groups (mean±SD)

	Category	Training group	Control group
Pre-intervention	SLS	1.0±1.9	0.9±2.0
	DLS	3.3±1.4	3.2±1.8
Post-intervention	SLS	2.1±2.7	1.0±2.1
	DLS*	1.9±0.8	3.0±2.0
Change between pre- and post-intervention	SLS	1.0±2.3	0.1±1.2
	DLS*	1.4±1.4	0.2±1.1

* p<0.05

differences in either SLS or DLS. These results indicate that the running in place exercise did not affect static lumbar stability, but did improve dynamic lumbar stability. These results are similar to those of previous studies indicating that plyometric training, core stabilization exercises, and Pilates improve trunk muscle strength and lumbar stability. Our results suggest that running in place improves dynamic stability, particularly lumbar stability, because the running exercise was performed without swaying in a defined square space while maintaining the contraction of the transversus abdominis by the abdominal drawing-in method. Although there are diverse exercise methods to improve lumbar stability, the exercise methods used in previous studies involved systematic programs carried out under expert guidance and required appropriate equipment and locations for their performance. In contrast, running in place can be easily carried out regardless of time or space. Thus, we recommend it is utilized as an exercise method for improving the dynamic lumbar stability of students or office workers.

ACKNOWLEDGEMENT

This research was supported by Korea Nazarene University Research Grants in 2014.

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