PalArch's Journal of Archaeology of Egypt / Egyptology

EFFECTS OF THE PAIN-FREE STABILIZATION EXERCISE PROGRAM ON LEG POSITION SENSE DURING ARABESQUE POSTURE OF ADOLESCENT BALLERINAS WITH LUMBO-PELVIC PAIN

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Dae-Hyun Kim, Byung-Ha Hwang, Tae-Ho Kim. Effects Of The Pain-Free Stabilization Exercise Program On Leg Position Sense During Arabesque Posture Of Adolescent Ballerinas With Lumbo-Pelvic Pain-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(10), 909-917. ISSN 1567-214x

Keywords: Adolescent Ballerinas, Lumbo-Pelvic Pain, Position Sense, Stabilization Exercises

ABSTRACT

Purpose: The purpose of this study was to investigate the effect of the Pain-free stabilization exercise program applied to adolescent ballerinas with lumbopelvic pain on the changes in leg position sense.

Methods: 38 adolescent ballerinas with lumbopelvic pain were randomly assigned to ballet training group and stabilization group. The ballet trainees trained 5 times a week for 1 hour a day in a typical ballet school. The stabilization group underwent a stabilization exercise program using a sling and balance cushion 5 times a week for 1 hour per day. The stabilization group stopped the ballet training during the 6-week intervention. The training intervention lasted 6 weeks. The leg extension angles errors were measured in the Arabesque posture.

Results: The results of this study showed that the leg extension angular errors were significantly decreased in the stabilization group.

Conclusion: These results suggest that stabilization training is an effective approach for adolescent ballerinas with lumbo-pelvic pain. Proper stabilization interventions show a better sense of position.

Based on the results, we propose this exercise program for the prevention of injury and improvement of dance performance in adolescent ballerinas with lumbo-pelvic pain. dance

performance without injury, and thereby set up a good dance program.

INTRODUCTION

Because of the constant focus on the body, body concerns are extremely common among ballet dancers [1]. Monitoring growth and screening lower extremity alignment may be useful as injury prevention strategies in adolescent ballet dancers [2]. Estimates of low back pain prevalence in ballet dancers range from 8% to 23% [3]. As dancers pursue their careers, injuries and mental strain are inevitable. In particular, ballerinas, unlike ballerinos, are injured on their own beyond the body's allowance in order to gain better skills such as pointe movements [4].

In clinical trials, many interventions are being used to solve this problem. Clinically recommended exercises for strengthening the Gluteus maximus and medius [5]. Also, during the movement of the lower extremities, intervention of the trunk muscles is necessary for the stability of the trunk [6]. In addition, implementing a core preventive training program strengthens the core muscles to relieve pain and reduce the incidence of injuries [7].

Dynamic sling training and a home exercises program may help to increase strength, decrease pain, and improve function in dancers without aggravating sciatic nerve irritation [3]. Sling therapy can be used for diagnostic of the weak link in muscular-skeletal chain, correction the asymmetry of muscular tone, relief of pain while performing the exercise, and for improvement of the coordination of movements [8].

Many studies have reported that stabilization exercise programs improve the stability of the pelvis. Recently, clinical trials have used a method to improve the stability of the waist-pelvis in an unstable support environment using a sling [9-11]. In addition, vibration exercise devices are being supplied to improve dynamic stability. Strong evidence from well-designed studies indicates that adolescent elite female ballet dancers suffer from delayed onset of growth, maturation, menarche, and menstrual irregularities. However, there is little evidence that this deficit increases the risk of overuse injury, with the exception of stress fractures [12]. However, there is a lack of research on how stabilizing exercise programs using slings and balance cushions affect the sense of leg position for adolescent ballerinas with lumbo-pelvic pain.

Therefore, this study aims to investigate the effect of stabilization exercise program on muscle activity and leg position sensation compared to traditional ballet training for adolescent ballerinas with lumbo-pelvic pain.

METHODS

Subjects

This study was conducted to measure the change in the stabilization exercise program for adolescent ballerina with lumbo-pelvic pain in leg extension angles in the arabesque posture. The subjects were 38 students from the ballet school. Before participating in the study, the ballerinas were fully explained the purpose

and method of the study, and those who voluntarily agreed. The experiment lasted for 6 weeks.

1) Youths between the ages of 14 and 19 who are teaching ballet school.
2) Those with lumbo-pelvic pain who have Visual Analogue Scale 3 or higher.
3) People who can exercise during lumbo-pelvic pain during exercise.
4) People who does not perform other sports activities in everyday life except ballet lessons.
5) People without orthopedic and neurological diseases.
6) Those who have not undergone surgical surgery.

For random assignment to each group, 20 cards with A and B written in sealed envelopes were inserted and the subjects were asked to draw one envelope. The card drawn was assigned to the stabilization exercise group (n = 20) for A and the ballet training group (n = 20) for B. During the experiment, two individuals in the stabilization exercise group dropped out due to personal circumstances and proceeded to the final 18 people.

PROCEDURE

Measurement

Before and after intervention, leg extension angles were evaluated to determine the effect of each intervention. All subjects before and after the experiment were measured by one physical therapist. Both exercise groups were pre-measured and post-measurement after 6 weeks of intervention.

Leg extension angles measurement of Arabesque posture

A motion analysis device (motion biofeedback device, Relive, Korea) was used to measure the angle of inclination of the leg during the subject's arabesque posture. Relative angle can be measured by calculating the position of another sensor for one sensor. In addition, this equipment calculates the movement that appears in a plane perpendicular to the set axis (X, Y, Z axis).

After the motion analysis device was fixed to the ankle using a strap, the subject was instructed to hold for 3 seconds after requesting a 90 ° hip joint in the Arabesque position. The error was measured as an absolute value based on 90 °. Through this, the position sense (proprioceptor) of the leg movement was measured. The average value was used by measuring 3 times.

Experimental method

Stabilization exercises

Exercise was performed using a sling (Sling, Redcord, Norway) equipped with a vibration device (Stimula, Redcord, Norway). An anomalous vibration program of 20-80 Hz was used to avoid subject compliance. The difficulty of the stabilization exercise program was set for each individual with painless difficulty using an elastic cord. Also, the intensity was gradually increased. The stabilization exercise was conducted with 10 sets of 4 programs each. The rest

time between sets was set to 20 seconds, and after one type of exercise program, a break was taken for 1 minute. The stabilization exercise program is as follows.

① Unilateral supine bridge exercises
② Side lying abduction bridge exercises
③ Side lying adduction bridge exercises
④ Unilateral prone bridge exercises
⑤ Unilateral supine rotation bridge exercises
⑥ Unilateral prone rotation bridge exercises
⑦ Arabesque posture training on TOGU
⑧ Jumping to balance tool with arabesque posture

Traditional ballet training

The ballet training group practiced traditional ballet training in ballet training centers. Ballet training includes basic turn-out movement training, basic foot postures 1st, 2nd, 3rd, 4th, 5th posture training, and bar walk training such as plié. In addition, repetitive practice training of ballet movements such as cambré, tendu, passé, dégagé, rond de jambe, piqué, fondue, frappé, développé, grand battement, arabesque, assemblé, glissade, etc. In addition, training such as stretching for flexibility and practice of ballet performance to participate in the contest were repeated. Training was conducted for 1 hour per day for 6 weeks.

Statistical analysis

Data measured in this study were analyzed using the SPSS (statistical package for the social sciences) version 23.0 for window software (SPSS Inc., Chicago) program. The general characteristics of the subjects were confirmed by the Kolmogorove-Smirnov test. An independent t-test was conducted to test the homogeneity between the stabilization exercise group and the ballet training group.

Two-way repeated measure ANOVA was performed to compare the measured values before and after the intervention of leg extension angle errors in the Arabesque postures of the two groups. When the interaction was confirmed, an independent sample t-test was conducted for post-testing. The significance level was $\alpha = .025$ by Bon ferroni correction method.

Paired t-tests were conducted to compare changes in the values of the two groups before and after intervention. An independent t-test was conducted to compare changes between groups before and after intervention. Statistical significance α was set at 0.05.

RESULTS

There were no significant differences between groups in the general characteristics of the study subjects. The general characteristics of the study subjects are shown in Table 1.

There was an interaction between the two groups before and after the inter-group difference in the leg extension angles error ($p<.05$). There were no significant differences in leg extension angles error according to the group ($p>.05$) (Table 2).

As a result of comparison between the groups before and after intervention in the stabilization exercise group and the ballet training group, the stabilization exercise group significantly decreased ($p<.05$) and there was no significant difference in the ballet training group ($p>.05$). The stabilizing exercise group had a large effect on the leg extension angles error ($d>0.8$) (Table 3).

In comparison between groups, the stabilizing exercise group was significantly reduced than the ballet training group ($p<.025$). The effect size on the difference value between the two groups of leg extension angles error was large ($d>0.8$) (Table 4).

Table 1. General characteristic of participants

	SEG (n=18)	**BTG (n=20)**	***p***
Age (mean)	15.89±1.53	15.75±1.48	.068
Height (cm)	161±3.65	158.6±4.16	.482
Weight(Kg)	46.39±2.79	45.75±2.75	.778
BMI (Kg/m^2)	17.89±0.83	18.18±0.75	.260

Mean±SD, SEG: Stabilization Exercise Group, BTG: Ballet Training Group.

Table 2. Leg extension angle error values for two groups (N=38)

Variable	**Type III sum of squares**	**df**	**Mean square**	**F**	***p***
Period	222.62	1	222.62	8.071	.007*
Period*Group	226.97	1	226.97	8.229	.007*
Group	164.47	1	164.47	2.006	.165

*$p<.05$

Table 3. Comparison of change in leg extension angle error during Arabesque

posture in the group (N=38)

Group	**Pre**	**Post**	***p***
SEG	10.98±8.51	4.09±2.76	.002*
BTG	10.47±8.27	10.50±8.27	.984

SEG: Stabilization Exercise Group, BTG: Ballet Training Group, *p<.05

Table 4. Comparison of difference in leg extension angle error during Arabesque posture between groups (N=38)

SEG	BTG	*p*	*Effect size d*
-6.89±7.76	-.03±7.12	.007**	0.929

SEG: Stabilization Exercise Group, BTG: Ballet Training Group, *p<.05, **p<.025

DISCUSSION

The purpose of this study was to compare the effects of stabilization exercises and traditional ballet training on the leg extension angles during Arabesque of adolescent ballerina with lumbo-pelvic pain. A variety of systematic anti-injury exercise methods are not introduced for ballerinas who maintain more flexibility and movement than ordinary people. Therefore, this study was intended to present an exercise program for adolescent ballerinas in their growth period to prevent degenerative changes in joints, damage to the waist spine and pelvic joints, and to improve their dance performance.

The error of leg extension angles was decreased in the stabilization exercise group. In addition, even among the groups, the error of the stabilizing exercise group was further reduced. The human body's sense of position is recognized through two methods: first by receiving signals from the myocons, recognizing the location of different body parts, and second by visual, auditory and tactile receptors [13]. Patients with back pain are weaker in posture than healthy people due to lack of location accuracy because of the change in the input of pericardial sensory information of the musculoskeletal muscle near the spine [14]. Previous studies have reported that therapeutic exercise above vibration stimulates proprioceptive sensation, improving location accuracy by 39% on average for patients with back pain [15]. A prior study also reported that the proprioception facilitation exercise methods for female handball players improve joint position sense [16]. Sacco and his colleagues reported that vibration affected posture control and improved the use of proprioception sensory feedback during functional active exercise [17]. Chow and his colleagues also reported that the application of vibration to patients with back pain increased their ability to adjust posture and reposition their waist [18]. This seems to be the result of the stabilization movement helping to activate the proprioception sensation by exercising on an unstable support surface using vibration state slings and balance cushions. Subjects were instructed to use 90° leg extension when posing

in the Arabesque position, and did not receive feedback until the end of the study to see how much difference they had in their leg denigrating angles. There was no change in the angle of leg extension after six weeks of arbitration in the ballet training group, but the stabilization group made a significant difference in the same direction and corrected the error on its own. This is seen as a result of the vibration stabilization exercise, which stimulates proprioceptor activation rather than continuing traditional ballet training [14]. This is seen as helping to improve the leg's sense of position by stimulating the proprioceptor of youth ballerina with lumbo-pelvic pain. Also, improvements in dancers' sense of location lead to improved performance of dance programs.

There are some limitations in this study. First, it was difficult to recruit adolescent ballerinas with lumbo-pelvic pain. It is difficult to generalize the research results to 38 subjects. Second, since the stabilization exercise program was composed of various movements, it was difficult to find out which specific movement training affected a specific result value. Third, it was difficult to restrain variables on other physical activities because it was difficult to limit physical activities other than experimental training as a study of adolescents with many physical activities. Fourth, it was difficult to generalize the change in muscle activity as a result of all movements of ballet since the muscle activity measurement posture was performed only in the arabesque posture. Considering these limitations, it is believed that it will be necessary to develop an exercise program to prevent injuries and improve dance performance of ballerinas in the future through an experiment of an exercise program for adult ballerinas. Further, studies should be conducted with more subjects and the results should be generalized through the measurement of various positions and movements. In addition, the development and study of appropriate stabilization exercise program items will have to be carried out according to functional level or injury period, in line with the individual characteristics of adolescent ballerina with lumbo-pelvic pain. Finally, for exercise programs that include more analytical movements, detailed experiments are required on how motion movements using specific movements produce results.

In conclusion, it is thought that the stabilization exercise program can be suggested as one of the training methods to improve dance performance and prevent injuries of adolescent ballerinas with lumbo-pelvic pain.

ACKNOWLEDGEMENT

This research was supported by the Daegu University Research Grant, 2020.

Conflicts of interest: The authors declare no conflicts of interest.

REFERENCES

Tiggemann, M., & Slater, A. (2001). A test of objectification theory in former dancers and non-dancers. *Psychology of Women Quarterly*, 25(1), 57-64.

Bowerman, E., Whatman, C., Harris, N., Bradshaw, E., & Karin, J. (2014). Are maturation, growth and lower extremity alignment associated with overuse injury in elite adolescent ballet dancers? P*hysical Therapy in Sport*, 15(4), 234-241.

Kline, J. B., Krauss, J. R., Maher, S. F., & Qu, X. (2013). Core strength training using a combination of home exercises and a dynamic sling system for the management of low back pain in pre-professional ballet dancers: a case series. *Journal of dance medicine & science*, 17(1), 24-33.

Hamilton, W. G., Hamilton, L. H., Marshall, P., & Molnar, M. (1992). A profile of the musculoskeletal characteristics of elite professional ballet dancers. *The American journal of sports medicine*, 20(3), 267-273.

Leinonen, V., Kankaanpää, M., Airaksinen, O., & Hänninen, O. (2000). Back and hip extensor activities during trunk flexion/extension: effects of low back pain and rehabilitation. *Archives of physical medicine and rehabilitation*, 81(1), 32-37.

Niemuth, P. E. (2007). The role of hip muscle weakness in lower extremity athletic injuries. *International SportMed Journal*, 8(4), 179-192.

Viktória, K. B., Brigitta, S., Gabriella, K., Eleonóra, L., Pongrác, Á., András, O., & Melinda, J. (2016). Application and examination of the efficiency of a core stability training program among dancers. *European Journal of Integrative Medicine*, 8, 3-7.

Istomin, A. G., & Lutsenko, O. V. (2014). Sling-therapy in medical rehabilitation. *Inter Collegas*, 1(1), 73-78.

Linek, P., Saulicz, E., Myśliwiec, A., Wójtowicz, M., & Wolny, T. (2016). The effect of specific sling exercises on the functional movement screen score in adolescent volleyball players: a preliminary study. *Journal of human kinetics*, 54(1), 83-90.

Kim, Y. W., Kim, N. Y., Chang, W. H., & Lee, S. C. (2018). Comparison of the therapeutic effects of a sling exercise and a traditional stabilizing exercise for clinical lumbar spinal instability. *Journal of sport rehabilitation*, 27(1), 47-54.

Lükens, J., Boström, K. J., Puta, C., Schulte, T. L., & Wagner, H. (2015). Using ultrasound to assess the thickness of the transversus abdominis in a sling exercise. *BMC musculoskeletal disorders*, 16(1), 203.

Bowerman, E. A., Whatman, C., Harris, N., & Bradshaw, E. (2015). A review of the risk factors for lower extremity overuse injuries in young elite female ballet dancers. *Journal of Dance Medicine & Science*, 19(2), 51-56.

Tsay, A. J., Giummarra, M. J., Allen, T. J., & Proske, U. (2016). The sensory origins of human position sense. *The Journal of physiology*, 594(4), 1037-1049.

Brumagne, S., Cordo, P., Lysens, R., Verschueren, S., & Swinnen, S. (2000). The role of paraspinal muscle spindles in lumbosacral position sense in individuals with and without low back pain. *Spine*, 25(8), 989-994.

Fontana, T. L., Richardson, C. A., & Stanton, W. R. (2005). The effect of weightbearing exercise with low frequency, whole body vibration on lumbosacral proprioception: A pilot study on normal subjects. *Australian Journal of Physiotherapy*, 51(4), 259-263.

Panics, G., Tallay, A., Pavlik, A., & Berkes, I. (2008). Effect of proprioception training on knee joint position sense in female team handball players. *British journal of sports medicine*, 42(6), 472-476.

Sacco, C. C., Gaffney, E. M., & Dean, J. C. (2018). Effects of White Noise Achilles Tendon Vibration on Quiet Standing and Active Postural Positioning. *Journal of applied biomechanics*, 34(2), 151-158.

Chow, D. H. K., Lee, T. Y., & Pope, M. H. (2018). Effects of whole body vibration on spinal proprioception in healthy individuals. *Work*, 61(3), 403-411.