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Research Article

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Effect of Gym-ball Exercise Program to Pelvis and Spine of the 20's Woman

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| Abstract |

PURPOSE: This study is to investigate the effect of 4 weeks of gym ball exercise on the pelvis and spine of women in 20s.

METHODS: Randomly selected 10 of 20 subjects are allocated to experimental group who will practice gym-ball exercise while the rest 10 subjects are allocated to control group. Values for pelvic obliquity DL-DR, pelvic torsion DL-DR, pelvic rotation, kyphotic angle ICT-ITL (max), and lordotic angle ITL-ILS (max) were measured through recording using 3-dimensional image analyzer as a preliminary inspection. Gym-ball exercise was implemented 3 sessions a week for 4 weeks. Each session consisted of 10 minutes of warm up exercise, 30 minutes of main exercise, and 10 minutes of cool down exercise totaling 50 minutes. Post inspections were measured after exercise.

RESULTS: Experimental group showed statistically significant difference in pelvic obliquity DL-DR, pelvic torsion DL-DR, and kyphotic angle ICT-ITL (max) ($p<.05$) and values of pelvic obliquity DL-DR showed statistically significant difference between two groups ($p<.05$). However pelvic rotation, lordotic angle ITL-ILS (max) did not show a significant difference.

CONCLUSION: These results showed that gym-ball exercise has positive effect in the pelvic obliquity, torsion and spine kyphotic angle and expected to have positive effect on the body balance, body lineup, and coordination.

Key Words: Gym-ball exercise, Spine, Pelvis

Ⅰ. Introduction

High heel shoes are parts of fashion and trend and have been developed in various forms. Various precedent studies were conducted to identify the effect on gait such as motor mechanical analysis of gait posture depending on the height of shoes heel. Repeatedly wearing high heel shoes lays a burden on the feet, changes body line up as the center of body weight changes, and has negative effects on leg and gait. Motor mechanical characteristics and kinematic characteristics are changed to compensate this (Ko et al., 2008; Lee & Hong, 2005).

Increase in the muscle activity of flexor due to wearing high heels reduces the stability by creating instability on feet and ankle muscles, leading to general muscular skeleton problem (Gefen et al., 2002). The result of analysis on the changes in overall physical functions due to use of heightening insole reported that use of these insoles

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affects balancing ability, sense, and range of motion (Jung et al., 2009).

The use of high heels arouse weakening of front side of anterior tibialis and weakens the strength of lower leg along with the dynamic changes of foot to cause imbalance in the lineup of lower limbs, leading to the restrictions on the motion range of leg joints.

Used that brings various effects on muscular skeleton system such as weakening of strength in the foot joints, damage in ligament, ankylosis, and imbalanced body lineup and becomes the cause of instability of ankle (Garn & Newton, 1988).

The high heel shoes affect the soft-tissues in the vicinity of leg by increasing the amount of perpendicular impact during the static and dynamic movement, and may arouse damages in ligament and joint, and weakening of strength in leg and ankle. High heel shoes are considered as causes of overall muscular skeleton lesions because it may lead to weakening of body lineup and may result in chronic instability in ankle (Konradsen, 2002). Likewise, high heel shoes may be the cause of imbalanced lineup of lower limbs, and damages on ankle, balance, and ligament where most of these are considered to influence not only damages on the ankle but also the damages on pelvis or spines.

Gym ball is a low-intensity aerobic exercise where subjects can easily perform the dynamic training of maintaining balance (Hwang & Lee, 2004).

Gym ball exercise relaxes pelvis muscles which are stressed or hardened due to lumbar pains, broadens the motor range of joints in lumbar vertebrae, reduces the pressure exerted on the disk, and serves a role of balancing the spines because subjects have to utilize weight and balance sense in order to maintain same posture on the ball. Also, gym ball exercise improves muscle strength, stamina, flexibility, and coordination (Sung et al., 2005). Gym ball exercise has been used as an exercise treatment tool for stroke, spinal cord, posture correction, and treatment for pains in spines and neck. Ball exercise demands overall developments on reflexes, perception ability, and balancing sense in order to maintain balance in a dynamic motion of leaning one's body to the ball using the stimulation - response interaction (Lee et al., 2003).

Exercise using swiss ball can be used for program preventing injuries from falls as it stabilizes the body (Choi et al., 2012) and is effective in improving balance (Han et al., 2008).

Gym ball exercise showed effect of reducing lower limbs lengths and improving balance, and significant decreasing effect on body disturbance area (Ju & Park, 2007).

pelvis stabilizing exercise using gym ball maintained and increased the lumbar extensor muscle strength, lumbar balancing ability, and lumbar flexibility which were declined due to chronic pelvis pains; this exercise was shown to be effective in improvement of pelvis pains and stamina as well (Lee, 2011).

Various studies on the effect of high heel shoes on the strength and muscle activity of feet, ankle, and gait were conducted but limited number of studies focused on the effect of high heel shoes on the pelvis and spines of human body.

Therefore, this study aims to investigate the effect of gym ball exercise on the pelvis and spine angles with women who wear high heel shoes often as study subjects.

Ⅱ. Method

1. Subject

This study selected 20 women in 20s who wear high heel shoes more than 5 times a week from the students of N University in Chungcheongnam-do. The selected students were then randomly allocated to control group (n=10) and experimental group (n=10).

The purpose and methods of this study were well-explained to the subjects and study subjects voluntarily

signed on the experiment participation agreement. This study selected those women with no experience of similar experiments or test. The subjects of this study were not allowed to know the specific purpose of this experiment. Those volunteers with spinal tumor, transposition, and osteoporosis were excluded and study subjects who received other treatment during the period of the exercise were excluded as well.

2. Experiment Method

1) Measuring Equipment

This study used 3 dimensional image analyzer (Formetric II 4D, Germany) in order to measure the angle of gradient and twist of pelvis, lumbar lordosis, and thoracic kyphosis. Characteristics of this equipment are fast and accurate measurement time (0.04～6 seconds), no risk of radiation exposure by using halogen ramp, and expectation of treatment effect through simulation platform function.

2) Experiment Procedure

The subjects of this study agreed to participate to the experiment where they film spine and pelvis using 3 dimensional picture analyzer and perform gym ball exercise. Experimental group Gym ball exercise is taken 50 minutes a session, 3 sessions a week for 4 weeks. The post inspection was measured after the exercise. but control group did not exercise (Table 1).

3) Collection of Data

The subjects stripped the top, face the back toward the camera of the measurement device, and lowered bottoms until the point tailbone is shown. The subjects stood 2 meters away from the Formetric device and the measurement posture is to relax, lower both arms naturally, and face front direction. The legs are horizontally fixed on the foothold with knees straight up.

The anatomical terms and measurement factors used in this study are as follows:

(1) VP (vertebra prominence) 7th cervical vertebral, SP (sacrum point) sacral cornu: VP-SP refers to the

Table 1. Gym-Ball Excercise Program

Classification	Types	Frequency	Duration	Total Period
Warm up Exercise	Stretching	3 sessions a week	10 minutes	
Main Exercise	Balancing while lifting one leg pelvis muscle strength strengthening exercise using muscle strength of lower limbs Abs strengthening exercise Relaxing the pelvis muscle pelvis stabilizing exercise Spinal balancing exercise pelvis muscle and femoral adductor muscle strengthening exercise Rear pelvis muscle strengthening exercise (Hip-up) Musculus transversus abdominis concentrated strengthening exercise Musculus transversus abdominis turning exercise Spinal balancing exercise and gluteus exercise	3 sessions a week	30 minutes	4 weeks
End Exercise	Stretching	3 sessions a week	10 minutes	

distance between 7th cervical vertebral and sacral cornu.

(2) DL (left lumbar dimple) and DR (right lumbar dimple): Refer to the cavernous place on the left pelvis and DM is the middle of DL and DR.

(3) pelvic tilt angle DL-DR[°]: Refers to the difference in the height of DL and DR.

(4) pelvic torsion angle DL-DR[°]: Refers to the pelvis which is twisted to anterior and posterior direction.

(5) pelvic rotation angle[°]: Refers to the pelvis which is twisted to left or right direction

(6) kyphotic of thoracic vertebra (kyphotic angle ICT-ITL (max)[°]): Refers to the maximum value of kyphotic in the thoracic vertebra.

(7) lumbar lordotic (lordotic angle ITL-ILS (max)[°]): Refers to the maximum value of lumbar lordotic angle.

3. Data Analysis

For data analysis, SPSS 18.0 for windows was used. Kolmogorov-Smirnov Test was used to verify the standard distribution of the characteristics of data. To verify the difference between experiment group (gym-ball group) with control groups Independent t-test was used while paired t-test was used to compare the measurements before and after exercise. The level of statistical significance was set at α=.05.

Ⅲ. Results

1. General Characteristics of the Study Subjects

This study selected 20 women in 20s who wear high heel shoes more than 5 times a week. The study randomly allocated 10 subjects into experimental group and the rest 10 were allocated to control group. The general characteristics of study subjects are as follows (Table 2).

Table 2. General Characteristics of subjects (n=20)

Characteristic	Experimental(N=10)	Control(N=10)
Weight(kg)	57.90±9.28	60.71±6.97
Hight(cm)	159.10±5.61	161.17±4.81
Age(years)	20.00±1.89	20.40±0.70

2. Comparison of the Average pelvis Angle

PO DL-DR, PT DL-DR, PR were measured as a means of identifying the changes of pelvis angle before and after exercise (Table 3).

Measurement of PO DL-DR in experimental group showed statistically significant change from 12.70±9.76 to 3.30±1.82 while measurements of PT DL-DR in experimental group showed statistically significant change from 3.80±2.57 to 1.60±0.69.

But measurements of PR before and after exercise in both control group and experimental group did not have statistically significant difference.

Table 3. A change of pelvis angle between pre-test and post-test (Unit : °)

Variable	Group	Pre-test	Post-test	t	p
PO DL-DR	Control(N=10)	0.63±3.53	0.48±3.10	1.56	.15
	Experimental(N=10)	12.70±9.76	3.30±1.82	3.05	.01*
PT DL-DR	Control(N=10)	0.65±3.40	-0.10±3.00	1.40	.19
	Experimental(N=10)	3.80±2.57	1.60±0.699	2.79	.02*
PR	Control(N=10)	-0.15±3.78	0.29±4.01	-0.64	.55
	Experimental(N=10)	1.50±0.527	1.60±0.69	-2.87	.78

*p<.05

Mean±SD

PO : pelvis_Obliquity, PT : pelvis_Torsion, PR : pelvis_rotation

Table 4. A change of spine angle between pre-test and post-test (Unit : °)

Variable	Group	Pre-test	Post-test	t	p
KA ICT-ITL (max)	Control(N=10)	44.70±7.78	41.30±9.11	.73	.48
	Experimental(N=10)	47.70±8.39	45.66±12.87	2.16	.05*
LA ITL-ILS (max)	Control(N=10)	36.00±9.78	34.40±9.40	.61	.55
	Experimental(N=10)	37.97±8.16	37.46±8.86	1.19	.26

*p<.05

Mean±SD

KA : Kyphotic angle, LA : Lordoticangle

3. Comparison of Average Spine Angle

To investigate the changes of spine angle before and after exercise, KA ICT-ITL (max) and LA ITL-ILS (max) were measured and the results of the measurements are as follows (Table 4).

4. Comparison of Averages of Gym Ball Group and Control Group.

The comparison of averages of spine angles and pelvis angles between experimental group and control group are shown in the below (Table 5).

When experimental group is compared with control group, PO DL-DR in experimental group showed statistically significant decrease over control group. Other measurements showed differences but these differences were not statistically significant.

Ⅳ. Discussion

This study conducted measurement and analysis using 3 dimensional image analyzer to investigate the effect of gym ball exercise on the spine and pelvis of women in 20s who wears high heel shoes habitually.

Choi et al. (2012) reported that swiss ball exercise is considered more effective in balancing ability over core stabilizing exercise based on the result of measuring results of body stabilizing exercise using swiss ball and core stabilizing exercise after 4 weeks and 6 weeks of exercise. Lee (2011) reported that lumbar stabilizing exercise using ball is effective in improvement of symptoms arising from lumbar pain history, balancing ability, as well as stamina.

Cho et al. (2010) reported that swiss ball exercise program is effective in function point for the balance of

Table 5. Comparison of changes between experimental group and control group (Unit : °)

Variable	Group	Control(N=10)	Experimental(N=10)	t	p
PO DL-DR	Pre-test	0.76±3.53	12.70±9.76	-2.78	0.01*
	Post-test	0.04±3.10	3.30±1.82		
PT DL-DR	Pre-test	0.65±3.40	3.80±2.57	-1.51	0.14
	Post-test	-0.10±3.00	1.60±0.69		
PR	Pre-test	-0.15±3.78	1.50±0.52	-0.43	0.67
	Post-test	0.29±4.01	1.60±0.69		
KA ICT-ITL (max)	Pre-test	44.70±7.78	47.70±8.39	-0.42	0.67
	Post-test	41.30±9.11	45.66±12.87		
LA ITL-ILS (max)	Pre-test	36.00±9.78	37.97±8.16	-0.69	0.49
	Post-test	34.40±9.40	37.46±8.86		

*p<.05

posture and knee joint. Kim & Kim (2009) conducted regular gym ball exercise on the female high school students for 8 weeks and reported a result of positive effect on stamina, body composition, and blood lipid. Also, Asserted that long term exercise will have positive effect on preventing stress, lowered stamina, obesity, and coronary artery disease, keep the effects, and improve study efficacy. Lee & Kim (2008) reported that 8 weeks of gym ball exercise increased strength in upper and lower body, flexibility of upper and lower body, agility, and balancing ability of the elders.

Thus, gym-ball exercise reduces lumbar pain and improves physical ability. These results imply that gym ball exercise affected changes in the pelvis angles in this study as well as had positive effects on spine as KA ICT-ITL (max) value showed statistically significant difference. Also, Choi and Choi (2010) concluded that gym ball exercise is effective method for patients with lumbar pain as this exercise increased pelvis strength significantly in the experimental group over control group. Sung et al. (2005) conducted 10 week swiss ball exercise on elders in nursing home and reported improvement in stamina, posture disturbance, and number of disturbance in anterior and posterior and lateral directions.

Various studies report the balancing and stabilizing effects of gym ball and swiss ball exercises, and this study considered the balance of spine and pelvis important that it experimented the effect of gym-ball exercise on these. The PO DL-DR and PT DL-DR values in both sides of pelvis decreased significantly and spinal KA ICT-ITL (max) value of experimental group showed positively significant change. Gym-ball exercise will have positive effect in the body balance, reduction of lumbar pain, and posture balance as it showed positive effect on spinal kyphotic angle and adjusted twisted pelvis in the studies mentioned above.

The limitations of this study are as follows. First, The control group did not exercise. Second, the subjects were women in 20s only. Future studies must include women in wide range of age in the experiment to find the correlation between age and pelvis and age and spine. Also, it is recommendable to include the pelvis, spine, knee, and ankle of the women in wide range of age. Second limitation is that the degrees of deformity in pelvis and spine in the women in 20s are not severe. To conduct interesting and important study for the medical development, future studies may find the linkage of not only pelvis and spine but also pain, posture balance, pressure and balance of feet, and strength of lumbar and lower libs of patients with actual deformity in pelvis and spine. The result of this study showed changes in the degree of twist in pelvis and spine but future studies with in depth consideration on the correlation must be conducted.

Ⅴ. Conclusion

This study identified the effect of gym ball exercise on the pelvis and spine of women in 20s who often wears high heel shoes. As a result of filming female students, who wear high heel shoes more than 5 times a week, after exercise for 4 weeks, PO DL-DR an PT DL-DR values in pelvis decreased significantly and positive effect on Kyphotic angle was observed. Also, PO DL-DR value showed positive effect in the comparison between experimental group and control group.

Summing these results, 4 weeks of gym ball exercise on the women, who wears high heel shoes, is a factor having positive effect on the balance of pelvis and spine, leading to the positive effect on the body balance, body line up, and coordination.

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