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Original Article

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The Effect of a Kettlebell Complex Program according to the Support Surface on Lower Extremity Muscle Activity and Balance in Baseball Players

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Purpose: The purpose of this study was to investigate the effect of a kettlebell complex program according to the support surface on the lower extremity muscle activity and balance of baseball players.
Methods: The participants were divided into two groups; unstable support surface group 1 (11 people) performed the kettlebell complex program on an unstable support surface, and stable support surface group 2 (10 people) performed the kettlebell complex program on a stable support surface. Muscle activity was measured by surface electromyography. Dynamic balance was measured with a balance-measuring equipment. A paired t-test was used to compare groups before and after the experiment. An independent t-test was performed to determine the difference in the degree of change between the two groups before and after the experiment.
Results: The intragroup comparison between stable support surface group 1 and 2 showed significant differences in muscle activity and sense of balance. In the comparison between the groups, the difference in muscle activity in unstable support surface group1 was significant in the biceps femoris and rectus femoris muscles, and significant differences were also found in the sense of balance.
Conclusion: These results suggest that a kettlebell exercise on an unstable support surface is more effective in improving muscle activity and sense of balance than a kettlebell exercise on a stable support surface.

Keywords: Support surface, Kettlebell, Muscle activity, Balance

INTRODUCTION

The athletic performance of a baseball player is related to the functional motion and balance that builds up amount of exercise as a segment underlying interaction by biomechanical kinematic chains.[1] Thus middle and high school baseball players, they are exposed to the risk of injury caused by incorrect motions, excessive amount of practice, and the repetitive motions, thus training couches are developing a method of training considering its characteristics and realizing program of muscle strength that can strengthen power and muscular strength.[2] Lower extremity muscle strength contributes greatly to the improvement of baseball players' performance. For baseball players, velocity is one of their competitive powers, and the strength of the lower body plays an important role in stable pitching.[3]

Continuous minor injuries may lead to chronic injuries, and an appropriate exercise program is needed since these processes may shorten the period of an athlete's life.

The bosu ball exercise is an exercise that can efficiently improve proprioceptive function and balance.[4] Muscular strength and dynamic balance ability were improved when standing-up training was performed on the unstable support surface.[5] Training that gradually increases the intensity of exercise is an exercise method on the unstable support surface, and also a method of reducing the level of stability on the support surface using balance cushion, gym ball, balance pad, and foam roller.[6] Kettle bell is currently being used as a strength training program for athletes to strengthen muscle or as a health exercise program for the general public.[7] Muscular strength, muscular endurance, cardiovascular endurance and flexibility, and physical coordination may be developed at the same time,

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and if you have a Kettle bell, you can exercise much easier than the existing method of weight training.[8] Exercising with Kettle bell showed higher activity in average and maximal muscle activity of hamstring muscle and gluteus maximus muscle,[9] and the exercise for strengthening lower limbs muscle is done through Kettle bell.[10] Therefore, it is an effective way to strengthen strength of lower extremity, physical coordination and balance at the same time and in particular, it is a way that can allow baseball players who need to improve functional motions to have integrated training for all parts of the body.

Kettle Bell exercises that are known to be effective for whole body exercise are related to the studies on muscles of the upper limbs mostly, which have an effect on muscle activity, however studies on the effects of balance and muscles of the lower limbs on stable or unstable support surfaces are poorly researched.

For baseball players, the activity of lower limb muscles and sense of balance are important in the windup posture. thus this study examines the changes and effects on balance and muscle activity of the lower limb through Kettle bell exercises on stable and unstable support surfaces, and presents reference materials for interventions that may be used not only by baseball players However also by patients who need balance and muscle activity in clinical practice by providing an efficient exercise program.

METHODS

1. Subject

The subjects who participated in this study were 21 middle and high school baseball players, and a random experiment was perfomed with 11 people in the Kettle bell complex program on an unstable support surface and 10 people in the Kettle bell complex program on a stable support surface. Each subject of the study was randomly selected as those who agreed to participate in the study, those who had no back pain in the last 3 months, those who had no upper limb pain in the last 3 months, and those who had no lower limb pain in the last 3 months.

2. Experimental method

In the Kettle bell complex program of unstable support surface group 1, they performed a Kettle bell swing while balancing on bosu ball and contracting the hip muscles for the first exercise, for the second exercise, they placed both feet parallel on the ball, upraised the Kettle bell to chest, stood up while holding it with both hands, and performed squats in a safe position, and for the third exercise, they placed one foot on the bosu ball, lowered the knee of the opposite leg on the floor, and then they lunged. stable support surface group 2 performed the same Kettle bell complex program on a stable support surface. The exercise program of unstable support surface group 1 and stable support surface group 2 were carried out for 60 minutes a day, 3 times a week, for a total of 6 weeks.[11,12]

3. Measurement

1) Surface EMG measurement

This study used Free EMG BTS1000 (BTS COMPANY, Milano, Itary) which is a surface electromyography device in order to find out muscle activity. Hair on the attachment area and dead skin cells were removed using fine sandpaper in order to reduce the skin resistance to the surface EMG signal, and it was attached to the skin surface by rubbing with an alcohol swab for cleaning and the electrodes and the electromyography device were connected. Surface EMG electrodes was attached to gluteus maximus, gluteus medius, rectus femoris, and biceps femoris, the gluteus maximus was attached to the midpoint of spina iliaca posterior superior and the great trochanter of the coxa, and the gluteus medius was attached to the lower midpoint of the crista iliaca, muscle rectus femoris was attached to the mid-point between anterior superior iliac spine (ASIS) and kneecap and biceps muscle of thigh was attached to the mid-point between ischial tuberosity and lateral epicondyle of the coxa. The distance between the two electrodes was 2 cm, and the entire area was wiped clean with an alcohol swab and then attached. And the value of Maximum Voluntary Isometric Contration (MVIC) of each muscle was measured for standardization. For measuring electromyogram, it excluded the first and last 1 second and treated only the signal of 3 seconds as root mean square (RMS). The collected signal of each muscle was normalized as the percentage %MVIC (% Maximal Voluntary Isometric Contraction).

2) Balance measurement

For balance measurement, we used Bio Rescue, RM INGENIERIE, France, which is a balance measuring device. It is composed of a computer screen and an analysis program with the footrest that detects the distance moving according to the center of pressure. In the first test, the subject stood up with the heel aligned with the tip of the footrest and spread the foot about 30 degrees, moved the ball in the square toward 8 directions according to the instructions while looking at the computer screen, and moved without bending the waist in a situation where the feet were attached to the surface as much as possible to evaluate dynamic balance.

Table 1. General characteristics of the subjects

	EG1 (n=11)	EG2 (n=10)	p
Age (yr)	17.09±1.22	17.40±1.35	0.588
Weight (kg)	83.09±11.22	83.60±12.25	0.372
Height (cm)	179.54±4.01	181.90±7.45	0.922
BMI (kg/m^2)	25.64±2.54	25.07±2.08	0.580

Mean±SD.

4. Data analysis

All data were analyzed using SPSS ver 22.0 (SPSS, IBM, USA), and descriptive statistics were used to find out the general characteristics of the subjects. In addition, a single-sampling 'Shapiro-wilk' test was conducted to find out the status of the normal distribution. Matching sample paired t-test was conducted to check the change before and after the experiment, and an independent t-test was conducted for the difference before and after the experiment in order to examine the difference between the two groups after the experiment. The statistical significance level was set as 0.05.

RESULTS

The subjects of the study were 11 of the unstable support surface group 1 and 10 of the stable support surface group 2 which were a total of 21 baseball players. Table 1 shows the general characteristics of the study subjects.

In the comparison of changes in %MVIC in the Kettlebell complex program group on unstable support surfaces, there was a significant increase in gluteus maximus, gluteus medius, rectus femoris, and biceps femoris ($p<0.05$). In balance, it was decreased significantly ($p<0.05$)(Table 2).

In the comparison of changes in the %MVIC of the Kettle bell complex program group on the stable support surface, there was a significant increase in gluteus maximus, gluteus medius, rectus femoris, and biceps femoris ($p<0.05$). In balance, it was decreased significantly ($p<0.05$)(Table 2).

In comparison of %MVIC between the group and change in balance, there were significant differences in rectus femoris, and biceps femoris ($p<0.05$)(Table 2).

Table 2. Comparison of the results of muscle activity balance between pre and post intervention the experimental 1 and experimental 2 groups

Variable	EG1	EG2	t	p
Gluteus maximus				
Pre	43.66±13.30	40.60±7.37	0.643	0.528
Post	51.86±14.77	46.16±5.90		
Post-Pre	8.19±7.78	5.55±4.01	0.958	0.35
t	-3.48	-4.37		
p	0.006*	0.002*		
Gluteus medius				
Pre	25.20±11.61	22.64±8.36	0.575	0.572
Post	35.50±12.65	30.06±8.50		
Post-Pre	10.3±3.37	7.42±3.26	1.984	0.062
t	-10.12	-7.19		
p	<0.001*	<0.001*		
Rectus femoris				
Pre	36.06±6.08	38.47±6.87	-0.85	0.406
Post	52.14±12.01	45.13±8.81		
Post-Pre	16.07±8.79	6.66±4.31	3.06	0.006*
t	-6.06	-4.89		
p	<0.001*	<0.001*		
Biceps femoris				
Pre	35.10±8.30	29.71±9.50	1.387	0.181
Post	63.60±13.35	47.07±11.19		
Post-Pre	28.50±8.14	17.36±8.66	3.036	0.007*
t	-11.61	-6.33		
p	<0.001*	<0.001*		
Balance				
Pre	7,072.7±1,853.04	6,985.27±1,940.87	0.105	0.917
Post	14,868.1±3,150.58	10,171.1±3,845.02		
Post-Pre	7,795.4±2,879.4	3,185.4±3,836.49	3.088	0.006*
t	-8.56	-2.75		
p	<0.001*	0.02*		

EG1: experimental group 1, EG2: experimental group 2.

DISCUSSION

Kettle bell exercises are considered as effective in improving muscle strength and stability. When you do Kettle bell exercises, the hip, waist, and muscles of the lower limbs are used as stable muscles, therefore you can do the right exercise.[13] Kettle bell exercise is known as an effective exercise for strengthening muscles of the lower limbs and hip muscles.[14] In addition, it helps athletes who were injured on the lower limbs and is known as a recovery exercise.[15] dynamic balance maintains balance when body weight is shifted by external stimulus.[16] Unstable support surface exercise activates proprioceptive sensibility as an exercise method to improve the sense of balance compared to stable support surface, and it is an effective exercise method to improve the ability to change the support surface, which is a basic essential element for maintaining posture as a way of physical coordination and activity for the ability to balance.[8] Park[17] had reported that exercise on an unstable support surface may improve postural control ability and muscle strength, and effectively enhance dynamic and balance abilities, especially, it is reported that a decrease in muscles of

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the lower limbs is correlated with a decrease in balance. As a result of the study, the muscle activity of gluteus maximus, gluteus medius, rectus femoris, and biceps femoris muscle activity increased in the experimental group compared to the control group in the group comparison.

According to previous studies related to this study, Stuart[18] showed maximum muscle activity appeared in biceps femoris and rectus femoris after Kettle bell exercise. In order to compare muscle activity in the kettlebell swing group, men in their 20s applied force to the lower extremity muscles, biceps femoris and rectus femoris, and performed kettlebell swing exercise. As a result of comparison with the general exercise group, there was a significant difference in muscle strength.[9] Yoon[19] mentioned that the muscle activity of muscle gluteus medius increases during squat exercise on the unstable support surface, Tsatsouline[20] said that the hip joint is used a lot during Kettle bell exercise, which increases the muscle strength of gluteus muscle. Therefore, it is considered that it was significant in the activity of rectus femoris and biceps femoris, which require more force than other lower-leg muscles because they need more balance ability when exercising on the unstable support surface rather than the stable support surface. ln addition, there was no statistically significant difference due to the short intervention period considering the preceding studies, but the effect of muscle activity may be confirmed if it proceeds through a sufficient intervention period in the future as the numerical value of experimental groups improves by period.

There was a significant difference in unstable support surface group1 and stable support surface group 2 in the comparison within the group of balance. The balance in the comparison between groups showed significant difference in unstable support surface group1 and stable support surface group 2. Taube[21] reported that exercise on an unstable support surface was effective for dynamic balance ability. In addition reported that the balance exercise that is performed on the wobble board by soccer players and rugby players increased dynamic balance on the unstable support.[22] There was a significant difference in the interaction of within-group comparison and inter-group comparison on the unstable support in this study, thus it derived supporting results preceding studies.

The conclusion of this study is the effect of lower extremity muscle strength and balance during kettlebell exercise on an unstable support surface in middle and high school baseball players. It may be a little problematic to say that this study controlled individual lifestyle and personal exercise of muscle since this study had a small number of subjects and targeted normal middle and high school baseball players people. Therefore, it is hoped that further studies to be conducted which will examine various variables involving a large number of the subjects, and further studies should be continuous which may be used as an exercise therapy intervention for musculoskeletal patients.

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