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Original Article

Effects on muscle activities according to the type of bodyblade exercise in quadruped position

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Abstract. [Purpose] Most studies on bodyblade exercise have examined changes in muscle activities in the trunk and shoulders according to the hand position or direction while in a standing position. The present study compared and examined the changes in muscle activities around the shoulders and trunk according to different bodyblade lifting methods during stabilization exercise in a quadruped position. [Subjects and Methods] The present study was conducted on 20 healthy males. The following exercise four types were performed with the bodyblade held by flexing the dominant arm at 180° in a quadruped position. The muscle activity and the ratio of muscle activity were measured. [Results] The SA and IO, EO muscles showed significant differences. Moreover, the SA/UT activity ratio showed significant differences according to the type of exercise. The Tukey's post hoc test results were as follows: for the SA muscle, exercise types 4, 2 were more effective than types 1, 3: and for the IO muscle, types 1, 2 were more effective than types 3, 4. [Conclusion] The present study showed that type 2 scapular stabilization exercise (crossed leg lifting with the hand raised above the head on a vertical plane) showed selective and positive effects on trunk muscle strengthening and stabilization. In future, additional studies are required to design effective exercise programs for pain management and improvement of muscle activities in patients with complaints of shoulder pain due to scapular winging.

Key words: Bodyblade, Quadruped position, Muscle activity

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INTRODUCTION

Recently, various methods of exercise that can be applied in the field have been used to improve balance ability through postural stabilization. One of these methods includes bodyblade exercise that promotes increased muscle strength and endurance by inducing 270 muscle contractions per minute[1)], while the individual resists and controls active vibration. The strong sensory stimulation activates the muscle spindles and increases deep muscle stability by improving proprioception[2)]. Most studies on bodyblade exercise have examined changes in muscle activities in the trunk and shoulders according to the hand position or direction while in a standing position. Meanwhile, other studies reported that exercise in a quadruped position, with the hands and knees on the ground, provides relatively less load on the spine compared to exercise in other positions, maintaining balance in a neutral spine position[3, 4)] and facilitating independent contraction of the lower internal oblique muscle fibers. Based on these reports[5, 6)], the present study compared and examined the changes in muscle activities around the shoulders and trunk according to different bodyblade lifting methods during stabilization exercise in a quadruped position.

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SUBJECTS AND METHODS

The present study was conducted on 20 healthy males aged 24–32 years who voluntarily consented to participate in the experiment. The participants had the necessary muscle strength and joint range of motion to perform the exercise required and did not exhibit any symptoms of scapular winging (protrusion) and/or pain in the neck and shoulder area (Table 1).

This study was approved by the bioethics committee of the Sehan University Center (institutional review board approval no. 2017-20).

The researcher provided a detailed explanation of the exercises required before the start of the experiment. A bodyblade (Mad Dogg Athletics, USA) was used for active vibration stimulation. The participants removed their shirts to allow proper placement of the electromyography (EMG) electrodes. The electrodes were placed in the upper trapezius, serratus anterior, and internal and external oblique muscles on the dominant side. Prior to electrode placement, the site was cleansed with alcohol to minimize resistance and excess hair was removed. The MP 150 system (Biopac Systems Inc., Goleta, CA, USA) was used for surface EMG measurement, the sampling rate for signal acquisition set to 200 Hz and the frequency band filter set to 1–35 Hz. Acquired signals were analyzed using the Acqknowledge 4.2.2 software (Biopac Systems). Since differences between individuals may affect the results, maximal voluntary isometric contraction (MVIC) was performed in manual muscle test position to quantify the action potential. MVIC was performed as follows. For the upper trapezius muscle, measurements were taken while isometric resistance was applied as the participant sat upright without back support and with the shoulder abducted at 90° angle. For the serratus anterior muscle, measurements were taken while resistance was applied to the hand and elbow in a supine position with the shoulder abducted at 90° angle and the scapula protracted. For the external oblique muscle, measurements were taken while isometric resistance was applied with a knee flexion at 45° angle and with torso flexion and ipsilateral rotation while the participant is in supine position. For the internal oblique muscle, measurements were taken while isometric resistance was applied with knee flexion at 45° angle and with torso flexion and contralateral rotation in a supine position. For each muscle, three repeated measurements were taken while maintaining the position for 5 s, with 5 s of rest between measurements and with 2 min of rest between MVIC measurements for different muscles.

The following exercise types were performed with the bodyblade held by flexing the dominant arm at 180° in a quadruped position: 1) crossed leg lifting with the hand raised above the head on a horizontal plane (horizontal), 2) crossed leg lifting with the hand raised above the head on a sagittal plane (vertical), 3) parallel leg lifting with the hand raised above the head on a horizontal plane (horizontal), and 4) parallel leg lifting with the hand raised above the head on a sagittal plane (vertical) (Fig. 1). To minimize muscle fatigue caused by sustained measurements during each exercise, the participants were given 2 min of rest between exercises. Three repeated measurements were taken while each position was maintained for 10 s. The first and last 2 s were excluded from the EMG signals acquired from each muscle, with 6 s of EMG readings used in the study.

The data were statistically analyzed using SPSS 17.0 software for Windows and one-way analysis of variance to compare activities in the upper trapezius, serratus anterior, and internal and external oblique muscles in four stabilization exercise postures in quadruped position and to determine the muscle activity ratios between the serratus anterior and upper trapezius muscles. Post-hoc testing of differences according to the type of exercise was performed using Tukey's test. The significance level was set to $\alpha=0.05$.

Table 1. Characteristics of the study subjects

Character	Mean ± SD	Range
Age (years)	27.8 ± 2.37	24–32
Height (cm)	174.9 ± 2.69	171–181
Weight (kg)	72.2 ± 6.42	61–83

Data are presented as mean ± SD, obtained using the Shapiro-Wilk test.

Fig. 1. The type of body-blade exercise in quadruped position. 1) Crossed leg lifting with the hand raised above the head on a horizontal plane (horizontal), 2) Crossed leg lifting with the hand raised above the head on a sagittal plane (vertical), 3) Parallel leg lifting with the hand raised above the head on a horizontal plane (horizontal), 4) Parallel leg lifting with the hand raised above the head on a sagittal plane (vertical).

RESULTS

No significant difference was noted in the upper trapezius muscle activity according to the type of exercise; however, the serratus anterior and internal and external oblique muscles showed significant differences. The Tukey's post hoc test results were as follows: for the serratus anterior muscle, exercise types 4 and 2 were more effective than types 1 and 3; for the external oblique muscle, types 3 and 4 were more effective than types 1 and 2; and for the internal oblique muscle, types 1 and 2 were more effective than types 3 and 4 (Table 2). Moreover, the serratus anterior/upper trapezius activity ratio showed significant differences according to the type of exercise, while the Tukey's post hoc test results showed that the change in the serratus anterior/upper trapezius ratio was greater in exercise types 2 and 4 than in types 1 and 3 (Table 3).

DISCUSSION

The present study measured the muscle activities in the upper trapezius, serratus anterior, and internal and external oblique muscles during the four types of active vibration exercise in quadruped position performed by 20 healthy adult males. The discussion that follows is based on these results.

According to Ludewig et al.[7] patients with shoulder problems showed less serratus anterior muscle activity, but excessive activation of the upper trapezius muscle. Consequently, various studies have examined exercise for serratus anterior strengthening to stabilize the scapula. Moreside et al.[8] reported that the vertical direction was more effective than the horizontal direction based on the analysis of shoulder and trunk muscle activation patterns according to the position and direction of the bodyblade use. The serratus anterior muscle activity was greater during shoulder flexion using a bodyblade than using a dumbbell as described by Parry et al.[9] In addition, Escamilla et al.[10] reported that bodyblade exercise may be ideal for early shoulder rehabilitation training, since the serratus anterior muscle plays an important role in upward scapular rotation. Kim et al.[11] reported that vibration stimulation from bodyblade exercise improved neck stability through shoulder stabilization induced by decreased upper trapezius and increased serratus anterior activities. The present study showed greater activation of the serratus anterior muscle with bodyblade exercise performed in the vertical direction than the horizontal direction, consistent with the findings in prior studies. This is thought to be due to muscle spindle receptor activation caused by vibration stimulation in the vertical direction, which has an impact on the arm muscles as well as the entire body, resulting in improved muscle balance through inhibition of unnecessary muscle activity. The activities of upper trapezius findings were not significant. It is thought that raising the shoulder to a 180° angle would show a consistent level of muscle activity in the upper trapezius muscle, regardless of the exercise type. Kim[12] stated that high muscle activities were observed in the ipsilateral external oblique and contralateral internal oblique muscles when dominant leg lifts in quadruped position were performed by patients with scapular winging. In the present study, there is a significant difference in trunk muscle activities in both the internal and external oblique muscles. In particular, activity in the internal oblique muscle on the dominant side was significantly lower when parallel leg lift was performed than when the leg was lifted in the direction of the dominant

Table 2. Comparison of muscular activity (%MVIC) according to exercise type

Muscle	M ± SD (n=20)					post-hoc″
	Exercise 1	Exercise 2	Exercise 3	Exercise 4		
Upper trapezius	78.6 ± 3.9	78.4 ± 4.2	80.4 ± 4.5	78.9 ± 3.9		
Serratus anterior	261.5 ± 9.8	330.4 ± 115.1	271.9 ± 14.9	324.3 ± 15.1	*	1,3<4,2
External oblique	31.1 ± 2.7	32.2 ± 2.5	34.4 ± 2.4	35.7 ± 1.8	*	1,2<3,4
Internal oblique	76.8 ± 6.2	74.2 ± 7.4	25.3 ± 3.2	23.3 ± 3.3	*	4,3<2,1

*p<0.001.
″Turkey.
Exercise 1: horizontal & cross, 2: vertical & cross, 3: horizontal & parallel, Exercise 4: vertical & parallel.

Table 3. Comparison of upper trapezius/serratus anterior muscular activation ratio according to exercise type

Muscle	M ± SD (n=20)					post-hoc″
	Exercise 1	Exercise 2	Exercise 3	Exercise 4		
SA/UT	3.33 ± 0.14	4.22 ± 0.25	3.39 ± 0.24	4.11 ± 0.23	*	1,3<4,2

*p<0.001.
″Turkey.
Exercise 1: horizontal & cross, 2: vertical & cross, 3: horizontal & parallel, Exercise 4: vertical & parallel
SA: serratus anterior, UT: upper trapezius.

arm or lifted while crossed. Such results supported the findings of prior studies. Although the contralateral internal oblique muscle activity was not measured, exercise performed on the ipsilateral leg lift results in increased weight bearing on the contralateral leg to maintain posture. As a result, there is increased stability of the muscles surrounding the hip joint, with greater activation in the contralateral internal oblique muscle than in the ipsilateral internal oblique.

The present study showed that type 2 scapular stabilization exercise (crossed leg lifting with the hand raised above the head on a sagittal/vertical plane) showed selective and positive effects on trunk muscle strengthening and stabilization. Thus, this method can be suggested as an exercise program for a selective effect on the serratus anterior muscle.

In future, additional studies are required to design effective exercise programs for pain management and improvement of muscle activities in patients with complaints of shoulder pain due to scapular winging.

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Conflict of interest

None.

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