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WHOLE-BODY VIBRATION EXERCISE IS A FEASIBLE RESISTIVE EXERCISE MODALITY FOR OLDER WOMEN

[1]Bo-Ram Han, [1]Dae-Yoen Lee, Si-Woo Jung and [1,2] Hae-Dong Lee
[1] Department of Physical Education, Yonsei University, Seoul, Korea
[2]email: xbridge1997@yonsei.ac.kr

SUMMARY
The aim of this study was to investigate changes in neuromuscular function of older women as a result of 8-week resistance training with whole-body vibration (WBV). Forty women, over the age of sixty, participated in 8-week training followed by 4-week of detraining sessions for this study. Subjects were randomly assigned into three groups: resistance training with WBV (RVT, n=15), resistance training without WBV (RT, n=15) and a control group with no training at all (CON, n=10). Neuromuscular function of plantar flexor was assessed based on changes in the maximal voluntary ankle plantar flexion torque at varying joint angles, muscle inhibition (MI), resting twitch torque and vertical jump height. Following 8-week training, a significantly higher increase in muscle strength and decrease in MI were observed for RVT compared with RT. Also, RVT participants sustained more muscle strength than the RT participants during the detraining measurements. Vertical jump height did not indicate any change of height in the three groups.

INTRODUCTION
Aging-associated degradation of neuromuscular function is an important factor in determining the quality of life and having an independent life [1]. Recently, whole-body vibration (WBV) has been introduced as an alternative or supplementary training modality, showing positive effects, for muscular strength, agility and balance [2]. However, it is yet uncertain how exercise along with WBV stimuli affects neuromuscular function in older population. The purpose of this study was to investigate changes in neuromuscular properties of older women when resistance training with or without WBV.

METHODS
Forty female volunteers (> 60 years) were randomly assigned into three groups: resistance with vibration group (RVT, n = 15; age 63.9 ± 3.3 years, weight 56.6 ± 8.2 kg, height 152.9 ± 4.4 cm), resistance without vibration group (RT, n = 15; 68.5 ± 5.4 years, weight 58.5 ± 7.7 kg, height 153.2 ± 5.9 cm), and the no training control group (CON, n = 10; age 67.1 ± 2.7 years, weight 58.2 ± 7.2 kg, height 154.6 ± 5.2 cm). All subjects gave written informed consent to participate and were also provided the information of the training protocols.

The exercise protocol for the RT consisted of (1) open and close of standing, (2) calf raise, (3) half squat, (4) half squat and calf raise, (5) half squat and torso twist and (6) one leg calf raise. This exercise protocol was performed three times per week the intensity of the exercise was systematically increased. The RVT group used the same exercise protocol for RT but on a vibration platform (TT2590P, Turbo Sonics (frequency: 30-40Hz, Volume: 40-50)).

Measurements were performed for all exercise groups before, during (after the completion of 2-week training) and after the training (after the completion of 8-week training). Following the training session, the measurement was performed again after the 4-week detraining session. Muscle strength was measured as maximal voluntary isometric plantar flexion torques (MVC) at varying ankle joint angles (dorsiflexion -10, 0, plantar flexion 10, 30 degrees) using a custom-built dynamometer. Muscle activities of the soleus(SOL), lateral and medial gastrocnemius (LG and MG), and tibialis anterior (TA) were measured using surface electromyography (Trigno™, Wireless, DELSYS, Boston, MA) and muscle inhibition (MI) was assessed using the twitch interpolated torque (Grass88, Grass, USA). Vertical jump height was estimated from the ground reaction force (ORG-6, ATMI Watertown, MA).

Two-way ANOVA with repeated measures (3[groups] X 4 [time]) and Bonferroni *post hoc* comparisons were used to test statistical significance of the observed differences (p<.05).

RESULTS AND DISCUSSION
Maximal voluntary isometric plantar flexion torques (MVC) were measure at four different ankle joint angles. In the RVT group, MVC significantly increased regardless of the joint angle except the 30 degree over the training session: 0 weeks (62.3 ± 35.4 Nm, 60.2 ± 28.6 Nm, 50.6 ± 21.3 Nm at -10, 0, and 10 degrees respectively), 2 weeks (82.5 ± 22.0 Nm, 82.6 ± 27.8 Nm, 70.9 ± 21.8 Nm at -10, 0, and 10 degrees respectively) and 8 weeks (105.5 ± 30.2 Nm, 96.6 ± 24.3 Nm, 84.5±20.3 Nm at -10, 0, and 10 degrees respectively) (p < .05). In the RT group, MVC significantly increased regardless of the joint angle from 0 weeks (69.7 ± 20.5 Nm, 63.1 ± 17.2 Nm, 53.4 ± 17.4 4 Nm, 32.4 ± 10.6 Nm at -10, 0, 10 and 30 degrees respectively) to 2 weeks (84.7 ± 20.5 Nm, 76.4 ± 24.4 Nm, 66.6 ± 21.4 Nm, 41.3 ± 12.5 Nm at -10, 0, 10 and 30 degrees respectively) (p < .05). However, no more increase in MVC was found to be significant from 2 weeks to 8 weeks. Compared with the RT group, the increase in torques due to training was prominent in the RVT group.

After the 4-week detraining period following the completion of the training session, MVC was found to decrease significantly in both RVT and RT groups. (RVT: 92.4 ± 20.3 Nm, 87.1 ± 17.5 Nm, 74.9 ± 16.5 Nm at -10, 0, and 10 degrees respectively (p<.05) and RT: 59.2 ± 17.3 Nm, 50.6 ±18.0 Nm, 43.7 ± 14.5 Nm, 28.8 ± 7.5 Nm at -10, 0, 10 and 30 degrees respectively) (p < .05). Decrease in the MI of the RVT group was more prominent than the RT group at the initial phase of the training but returned to the baseline after the 4-week detraining period.

The MI results of the RVT group showed significant decreases over time: 0 weeks (49.8 ± 25.0 %, 46.0 ± 28.4 %, 46.9 ± 25.8 %), 2 weeks (36.6 ± 13.6 %, 28.3 ± 12.3 %, 28.0 ± 8.8 %) and 8 weeks (22.5 ± 8.2 %, 22.1 ± 7.3%, 20.8 ± 4.9 %) of -10, 0 and 10degrees (p < .05). Decreased MI in the RVT group was well sustained 4-week after the completion of the training. The MI results of the RT group was also found to significantly decrease: 0 weeks (27.5 ± 8.1 %, 27.5 ± 8.2 %) and 2 weeks (22.0 ± 7.2 %, 21.6 ± 6.0 %) of -10 and 10 degrees (P<0.05). 0, 10 and 30 degree of ankle were decreased MI at 0 weeks (26.0 ± 8.3 %, 27.5 ± 8.2 %, 40.7 ± 11.6 %) and 8 weeks (21.0 ± 7.7 %, 22.1 ± 6.2 %, 30.8 ± 6.5 %) (p < .05). Following the detraining, the MI returned to the pre-training level (p < .05).

Among the groups, the vertical jump height did not indicate a significant difference during training and detraining.

CONCLUSIONS

The results of this study showed the RVT group had a greater increase in muscle strength after the training session compared with the RT group and also this increased muscle strength was sustained longer than the RT group. Furthermore, a decreased MI indicated better success on neuromuscular activation and durability in the RVT group. Therefore, support is given to show that the methods used in resistance training with whole-body vibration are more effective in older female than exercise using only conventional resistance training.

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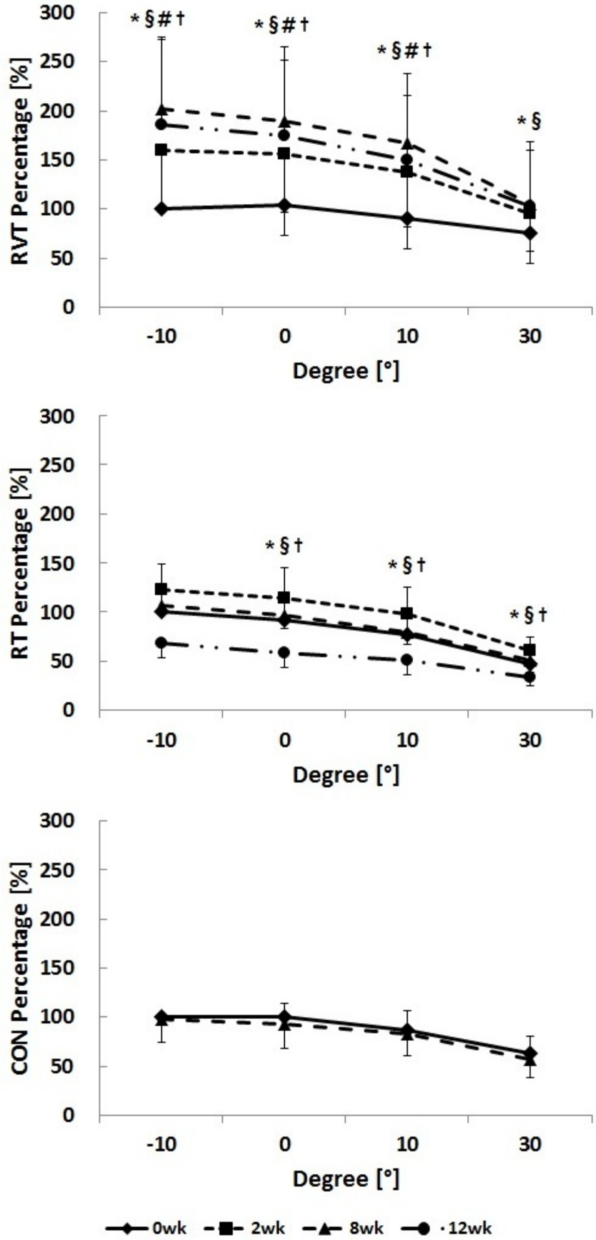

Figure 1: Training and detraining duration of torque-angle relationship of three groups [* : 0wk vs 2wk, § : 0wk vs 8wk, # : 2wk vs 8wk, † : 8wk vs 12wk]

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