Effect of Whole Body Vibration Exercise on Muscle Activity when Using Elastic Resistance Bands

William C. Hawkins, B. Swart, ^R. Amick
Faculty: M.E. Rogers, J.A. Patterson

Department of Human Performance Studies
^ Department of Industrial and Manufacturing Engineering

Abstract.

INTRODUCTION: Whole-body vibration (WBV) has been shown to increase muscle fiber recruitment during isotonic contractions. No prior published studies have used elastic resistance. **PURPOSE**: The main purpose of this study is to investigate the acute effects of a single bout of WBV on electromyography (EMG) activity during exercise when using elastic resistance. **METHOD**: 30 participants (14 male; 16 female) aged 18-30 were recruited for this study. EMG activity was then determined while participants performed the arm curl and squats using elastic resistance under three conditions: no vibration exposure, during acute vibration exposure, and following acute vibration exposure. Three upper extremity muscles were monitored during the arm curl. Vibration was administered using a vibration platform (Wave®; ProElite, Windsor, ON Canada) at a frequency of 35Hz at 4mm displacement amplitude. **RESULTS:** Results indicate no statistically significant differences between the three conditions for the upper body but there was a decrease in the primary muscles involved in the concentric phase of the squat immediately after vibration exposure. **CONCLUSION:** These results suggest that there may be an effect of vibration on muscles in the lower body following vibration.

Introduction

Whole-body vibration (WBV) training is a method of exercise where the individual is exposed to varying frequencies and amplitudes of a mechanical vibratory stimulus. WBV has been shown to increase neuromuscular activity (Abercromby et al., 2007; Roelants et al., 2006) and may improve muscle strength (Cardinale & Rittweger, 2006). However, no prior published studies have used elastic resistance with in conjunction with acute WBV.

Method

Electromyography (EMG) activity was determined while participants performed the arm curl and squat using elastic resistance under three conditions: no vibration exposure, during acute vibration exposure, and following acute vibration exposure. 30 young adults (15 male; 15 female) aged 18-30 years participanted in this study. Based on placement configurations suggested by the SENIAM project (Surface ElectroMyoGraphy for the Non-Invasive Assessment of Muscles), surface EMG electrodes were attached above muscle belies of the following muscles of the lower body: gastrocnemius, vastus lateralis, vastus medialis, biceps femoris, gluteus medius; and the following muscles for the upper body: biceps brachii, triceps brachii, and lateral deltoid. Data were collected during the concentric phase of each exercise repetition and averaged across the 10 repetitions for each muscle. Raw EMG data were filtered with a low pass of 10 Hz and a high pass of 500 Hz, notch filtered (low cutoff of 50 Hz and high cutoff of 70 Hz) , and smoothed using a 100 ms sliding moving average. The EMG data are presented in terms of absolute mean electrical activity (millivolts).

The initial exercise activity (i.e., arm curl or leg squat) was randomly assigned. Participants completed a warm-up of 10 repetitions for the assigned activity using a yellow band. Participants performed 10 repetitions of either the arm curl or leg squat using a green elastic resistance band without vibration treatment. Participants then performed 10 repetitions of the activity while standing on a vibration platform (Wave®; ProElite, Windsor, ON Canada) at a frequency of 35Hz at 4mm displacement amplitude. Immediately following this, participants performed the same activity while standing on the floor. Following a 5 minute rest and a 10 repetition warm-up using a yellow band, participants repeated the trials with the other activity with a green band.

Repeated measures analysis of variance (ANOVA) tests were used to determine if vibration caused different muscle activation rates during the concentric phases of the activities. Follow-up post-hoc analyses were used to determine the nature of any main effects differences. A probability value of less than 0.05 was considered statistically significant and less than 0.10 was considered clinically significant.

Results

For the arm curl protocol there were no statistically significant differences ($p<0.05$) for biceps brachii, triceps brachii nor medial deltoid during the concentric phase before (control), during, and immediately following vibration interventions (Table 1).

Table 1. Upper Body milliVolts (Mean ± SD)

Muscle	Pre-Vib	Vib	Post-Vib	P value
Biceps	1.42±1.10	1.38±.84	1.35±.92	.463
Triceps	0.45±.36	0.44±.03	0.43±0.39	.259
Deltoid	0.24±0.44	0.20±0.21	0.20±0.20	.773

For the squat protocol, statistically significant main effects ($p<.05$) were observed in the vastus medialis and vastus lateralis muscles and a clinically significant main effect ($p<.10$) was noted for the gastrocnemius (Table 2). Post-hoc analysis revealed that the level of muscle activation immediately following vibration treatment was less than during the pre-vibration and vibration treatments. There were no differences in the biceps femoris between the three trials.

Table 2. Lower Body milliVolts (mean ± SD)

Muscle	Pre-Vib	Vib	Post-Vib	P value
Biceps Fem.	0.68±1.06	0.73±1.22	0.65±1.24	0.116
Gastroc	0.81±0.82	0.56±0.94	0.52±0.82*	0.097
Vastus Med.	1.52±0.70	1.52±0.76	1.38±0.64*	0.003
Vastus Lat.	1.48±0.69	1.45±0.64	1.33±0.56*	0.001

*Different from Pre-Vib and Vib

Discussion

It has been suggested that whole-body vibration increases EMG activity (Abercromby et al., 2007; Roelants et al., 2006). Most researchers believe that vibration temporarily excites muscle spindles causing mono-synaptic stretch reflex initiation. Our results do not support this phenomenon during vibration exposure, but do suggest that there may be an effect of vibration on muscles in the lower body following vibration.

The prime movers during the concentric portion of the squat (vastus medialis and vastus lateralis) both had reduced EMG activity immediately following vibration. This was likely due to the effects of WBV on the stretch reflex during vibration exposure. Although this study evaluated both upper- and lower-body muscles in similar ways, those of the lower body were inherently closer to the vibration source. Our data indicated no differences between pre-vibration exposure, during acute vibration exposure, and immediately following acute vibration exposure conditions during the arm curl. One possible reason for this is the absorption of vibration by the lower portions of the kinetic chain. By the time the vibration reached the upper extremity it had been dampened enough to prevent the initiation of the mono-synaptic stretch reflex in any of the upper body muscles. Future studies should evaluate the effects of higher WBV frequencies/amplitudes on upper extremity muscle activation.

Conclusions

Our data suggest that vibration does reduce muscular activity as measured by EMG in the lower body. The fact that upper body muscles did not demonstrate differences suggests that much of the benefit of WBV is only experienced by the lower body. It is important to note that there are other benefits of whole body vibration training including increased bone mineral density in post-menopausal women (Cardinale & Rittweger, 2006) and it is entirely possible that these benefits are only experienced in the lower body as well.

References

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