THE VIBRATION TRANSMISSION AT VARIOUS KNEE ANGLE DURING WHOLE BODY VIBRATION TRAINING

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SUMMARY
Whole body vibration (WBV) is a kind of mechanical stimulus that has been used to exercise training to enhance sport performance. Vibration frequency and knee angle may play important roles in vibration intensity in different segments. The purpose of this study was to discuss the effect of vibration frequency and knee angle in vibration transmission. Five knee angle including 180° (full extension), 160°, 140°, 120°, 100° and three different vibration frequency including 20 Hz, 35 Hz and 50 Hz were tested. Two accelerometers were attached on the thigh and shank. The results found that vibration frequency could affect the vibration transmission in both thigh and shank. The knee angle only could change the vibration acceleration in thigh. Body composition or body fat may also affect vibration transmission. The vibration training should consider these parameters to have better training effect and prevent injury.

INTRODUCTION
Whole body vibration (WBV) is a kind of mechanical stimulus that has been used to rehabilitation or exercise training to enhance sport performance. Vibration frequency and amplitude play important roles in vibration intensity, which determine the loading to the neuromuscular system and loading transmission in different segments. Moreover, the subject’s segmental positions during vibration may also affect the vibration transmission and change vibration loading to the segment. Most previous studies focused on whether the WBV training in neuromuscular system has acute and chronic effect [1, 2]. However, the effect of vibration frequency and subjects’ segmental position during WBV in vibration transmission is still unclear. Therefore, the purpose of this study was to investigate the effect of different knee joint angle and vibration frequency in the vibrations transmission in the thigh and shank.

METHODS
Subjects
Thirteen healthy male subjects participated in the test. Their mean age is 21.31±1.65 years old, height is 170.85±8.09 cm, and weight is 64.92±10.32 kg. All subjects didn’t have lower extremity musculoskeletal injuries history at least one year.

Equipment
ZenPro TVR-5900 Vibration Trainer (Magtonic fitness technology, INC, Taiwan) was used in the WBV training. The vibration amplitude is fixed in 2 mm, and the vibration frequency chose 20 Hz, 35 Hz and 50 Hz to test the effect of vibration frequency in vibration transmission. The Noraxon accelerometer (Model 317A, Noraxon Inc., U.S.A.). This system is used to detect the vibration transmission in the segment. The device with weighing is less than 400 grams. It can simultaneously measure the three axis acceleration changes. The device could measure the range ±6 g acceleration.

procedure
Five different knee angles with 180° (full extension), 160°, 140°, 120°, 100° were tested and placed the accelerometers in the right shank and thigh to detect the vibration transmission, by using the segmental acceleration in these two segments [3]. The accelerometer placement in the right thigh is on the middle position between the right anterior superior iliac spine (ASIS) to the patella, in the rectus femoris muscle. The three axes are set as: the Y axis is parallel to the rectus femoris towards downward, X axis towards the right hand side, and Z axis perpendicular to the skin is forward. An other accelerometer is placed on the thigh and about the gastrocnemius position. It is the middle position between the popliteal and Calcaneus. The Y axis is parallel shaft and towards downward, X-axis towards the lateral of lower leg (right), Z axis is perpendicular to the skin (forward) (Figure 1). Every subject has to vibrate one minute at every condition, we choose the results between 15-45 seconds to calculate its root mean square for statistic analysis. Between each condition test, the subject had at least five minutes rest to prevent the intra test interaction. Two-ways ANOVA was used to test the effect of knee joint angle and vibration frequency in the vibration transmission. The significant level was set in the 0.05.

RESULTS
In the results, we found that the segmental acceleration in thigh would be various in different knee angle and vibration frequency in all three axes and reached the statistics differences. The segmental acceleration in thigh in 35 Hz vibration was smaller than in 20 Hz and 35 Hz. The effect of knee angle in vibration transmission, the results found that the acceleration in knee 180° was larger than other knee angles especially in Y axis and X axis. In the vibration acceleration in the shank, we found that the vibration frequency would make it different, however, the knee angle is not. The acceleration in

Fig. 1 The accelerometer placement and three axes definition.
shank in 50 Hz was smaller than in 20 Hz and 35 Hz, the same was found in the thigh (Figure 2).

**DISCUSSION**

In this study, we found that the segmental acceleration in thigh would change by different knee angle however, this could not find in the shank. This may result from the knee is a key joint to absorb the energy. Previous study also found that in the standing vibration training, the vibration transfer to the ankle is only 55~85%, to the knee is only 8~9% left [4]. The more knee angle is close to the full extension, the vibration transmission is larger to have more impulse. Therefore, for the vibration training, we would not suggest to stand in the full extension.

In the effect of vibration frequency, the segmental acceleration is smaller in the 50 Hz than in the 20 Hz and 35 Hz. This may show that vibration in the higher frequency has lower intensity to the segment. However, one of the theories of vibration training in musculoskeletal system is to simulate the neuromuscular system, higher frequency may provide faster simulation. The effect of vibration frequency in the training is still need more investigation. Moreover, the body fat and body composition may also affect vibration transmission.

**CONCLUSIONS**

Various knee angles and vibration frequency could change the vibration density during the training. Higher vibration frequency has lower segmental acceleration in both thigh and shank. The knee angles only affect the thigh acceleration during the vibration training.

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**REFERENCES**